ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
PHONE (719) 531-5599
FAX (719) 531-5238

February 20, 2023

Classic Communities
2138 Flying Horse Club Drive
Colorado Springs, CO 80921

Attn: Mark Sherwood

Re: Pavement Recommendations
Jackson Creek Parkway and U.S. State Highway 105
Monument, Colorado
Entech Job No. 230008

Dear Mr. Sherwood:

As requested, Entech Engineering, Inc. obtained samples of the pavement subgrade soil from the proposed acceleration and deceleration lanes for Jackson Creek Parkway on the south edge of U.S. State Highway 105 in Monument, Colorado. This letter presents the results of the laboratory testing and pavement recommendations for additional lanes on U.S. State Highway 105.

**Project Description**

The project will consist of the paving and widening of a section of State Highway 105 to the east and west of Jackson Creek Parkway. The project includes acceleration and deceleration lanes on Highway 105 for Jackson Creek Parkway north of the Monument Junction Subdivision. The roadway section extending from the Interstate 25 off ramp to Jackson Creek Parkway is under CDOT jurisdiction. The section extending from Jackson Creek Parkway to the east is under El Paso County jurisdiction. Currently, CDOT and El Paso County utilize the same pavement design methodology. Subsurface Soil Investigation and laboratory testing were performed to determine the pavement support characteristics of the soil at the proposed subgrade depth. The general layout of the roadway section is presented in the Test Boring Location Map, Figure 1. This report is intended to provide recommendations for the interim paving during construction. Final pavement sections are to be provided by others.

**Subgrade Conditions**

Four test borings were drilled in the roadway sections to depths of 10 feet below the existing roadway. The test boring locations are shown in Figure No. 1. The Test Boring Logs are presented in Appendix A. Representative bulk samples for CBR testing of the subgrade soils were obtained from Test Boring No. 2 at the anticipated subgrade depth. The borings were drilled through the existing roadway which had 8 to 11 inches of asphalt over 5 to 8 inches of road base. Silty to clayey sand fill (Soil Type 1; A-2-6 & A-2-4) was primarily encountered in the test borings at subgrade depth. Soil Type 2 classified as native silty sand. Soil Type 3 is a native silty to slightly silty to clayey sandstone. Soil Types 2 and 3 were encountered below the subgrade influence zone and will not be used in this pavement design.

Sieve Analyses were performed on the Type 1 subgrade soils for the purpose of classification. Sieve analysis on the Type 1 soils indicated that approximately 21 to 34 percent of the soil particles pass the No. 200 sieve. Atterberg limits on the Type 1 soils resulted in liquid limits of no value to 36 percent and plastic indexes of non-plastic to 15 percent. The Type 1 soils classify

as A-2-4 and A-2-6 soils, which have good to excellent pavement support characteristics. The results of the laboratory testing are presented in Appendix B and are summarized in Table 1.

Swell/Consolidation testing was performed on two samples of the Type 1 subgrade soils. Volume changes of 0.4 to 0.8 percent were measured, indicating low expansion potential. These results are below the level in which mitigation for expansive soils would be required for arterials (above 2 percent). Sulfate testing on the subgrade soils resulted in a negligible potential for sulfate attack.

California Bearing Ratio (CBR) testing was performed on a representative sample of the subgrade soils from the proposed roadway alignment. The results of the CBR and classification testing are presented in Appendix B, in Table 1, and are summarized as follows:

Soil Type 1 – Clayey Sand Fill
R @ 90% = 22
R @ 95% = 65
Use R = 50 for design

| Classification Testing | |
|---|---|
| Liquid Limit | 34 |
| Plasticity Index | 15 |
| Percent Passing 200 | 33.7 |
| AASHTO Classification | A-2-6 |
| Group Index | 1 |
| Unified Soils Classification | SC |

**Pavement Design**

CBR values were used to determine pavement sections for the roadways. Pavement sections were determined utilizing the CDOT/El Paso County "Pavement Design Criteria Manual." The roadway classifies as an urban principal arterial, which will use an 18k ESAL value of 5,256,000 to determine pavement sections. Pavement sections were determined for asphalt/basecourse composite sections and asphalt on cement stabilized subgrade sections.

Design parameters used in the pavement analysis for the roadways are as follows:

| | |
|---|---|
| Reliability (Minor Arterial) | 90% |
| Standard Deviation | 0.45 |
| Δpsi | 2.5 |
| "R" Value Subgrade | 50 |
| Resilient Modulus | 13,168 psi |
| Structural Coefficients | |
| Hot Bituminous Pavement | 0.44 |
| Aggregate Basecourse | 0.11 |
| Cement Stabilized Subgrade | 0.11 |

The pavement design calculations are shown in Appendix C. Recommended pavement sections based on the CDOT/El Paso County Pavement Criteria are summarized as follows:

Urban Principal Arterial – Clayey Sand Fill - Soil Type 1
ESAL = 5,256,000

| Alternatives | Asphalt (in) | Basecourse (in) | Cement Stabalized Subgrade (in) |
|---|---|---|---|
| 1 – Asphalt Over Basecourse | 5.0* | 12.0 | -- |
| 2 – Asphalt on Cement Stabalized Subgrade | 5.0* | -- | 12.0 |

*Minimum sections per the CDOT/El Paso County Pavement Design Criteria
Matching the existing pavement section is an alternative that should be evaluated.

**Mitigation**

The subgrade soils did not exceed the swell level in which mitigation would be required for expansive soils (2% with a 150-pound psf surcharge). Mitigation is not required on this site.

**Roadway Construction – Asphalt on Aggregate Basecourse**

Prior to placement of the import materials, the subgrade soils should be scarified, moisture-conditioned, compacted to a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557 at ±2 percent 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. Imported fill materials should be compacted to a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557 at ± 2% of optimum moisture content. Special attention should be given to areas adjacent to manholes, inlet structures and valves.

**Roadway Construction – Stabilized Subgrade Alternative**

Prior to placement of the asphalt, the subgrade shall be stabilized by the addition of cement to a depth of at least 8 inches (see Pavement Sections). The amount of cement applied shall be a minimum of 2 percent (by weight) of the subgrade's maximum dry density as determined by the Modified Proctor Test (ASTM D-1557). The cement should be spread evenly on the subgrade surface and be thoroughly mixed into the subgrade over an 8-inch depth, as specified, such that a uniform blend of soil and cement is achieved. Prior to application or mixing of the cement, the upper 8 inches of subgrade should be thoroughly moisture conditioned to the soil's optimum water content or as much as 2 percent more than the optimum water content as necessary to provide a compactable soil condition. Densification of the cement-stabilized subgrade should be completed to obtain a compaction of at least 95 percent of the subgrade maximum dry density as determined by the Modified Proctor Test (ASTM D-1557) or by the Standard Proctor Test (ASTM D-698). Satisfactory compaction of the subgrade shall occur within 90 minutes from the time of mixing the cement into the subgrade.

The following conditions shall be observed as part of the subgrade stabilization:

- Type I/II cement as supplied; a local supplier shall be used. All cement used for stabilization should come from the same source. If cement sources are changed a new laboratory mix design should be completed.
- Moisture conditioning of the subgrade and/or mixing of the cement into the subgrade shall not occur when soil temperatures are below 40° F. Cement treated subgrades should be maintained at a temperature of 40° F or greater until the subgrade has been compacted as required.
- Cement placement, cement mixing and compaction of the cement treated subgrade should be observed by a Soils Engineer. The Soils Engineer should complete in situ compaction tests and construct representative compacted specimens of the treated subgrade material for subsequent laboratory quality assurance testing.
- Pending the results of the field density testing, micro fracturing of the stabilized subgrade may be required. Soil strengths in excess of 200 psi require micro fracturing.

Based on the soils encountered, subgrade soil problem areas, if any, will be identified at proof roll. We do not anticipate issues with the subgrade in regards to shallow water, frost susceptible soils, groundwater and drainage conditions, soluble sulfates, or cold weather construction.

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

We trust that this has provided you with the information you required. The pavement sections provided are based on general site soil types. If you have any questions or need additional information, please do not hesitate to contact us.

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Daniel P. Stegman

Reviewed by:

Austin M. Nossokoff, P.E.

COLORADO LICENSED
AUSTIN M NOSSOKOFF
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2-20-23
PROFESSIONAL ENGINEER

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Encl.
AAprojects/2023/230008 PR

# TABLE

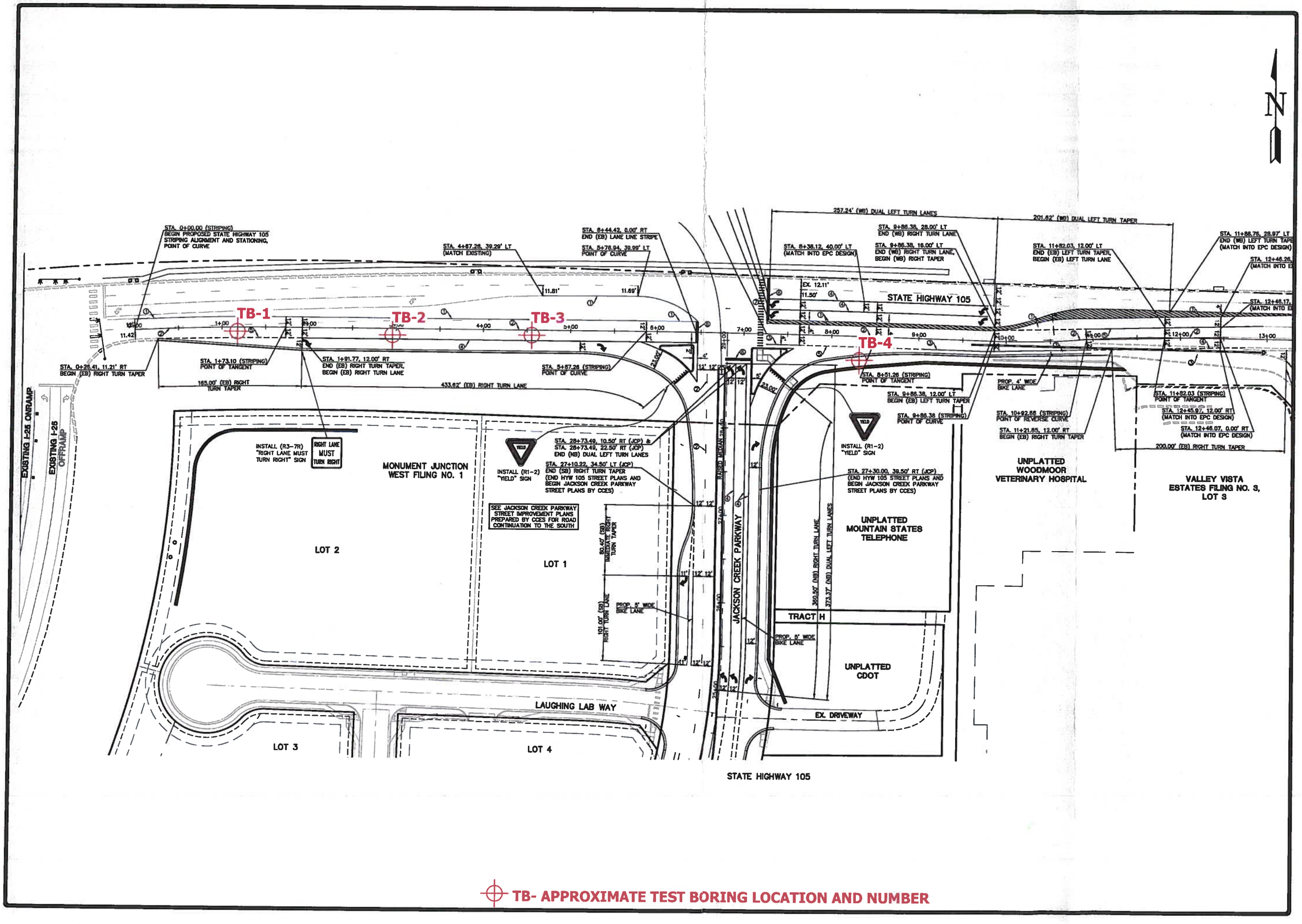
# TABLE 1

## SUMMARY OF LABORATORY TEST RESULTS

CLIENT CLASSIC COMMUNITIES
PROJECT HIGHWAY 105 & JACKSON CREEK
JOB NO. 230008

| 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 | 2 | 0-3 | 12.3 | 124.1 | 33.7 | 34 | 15 | | A-2-6 | 0.4 | SC | FILL, SAND, CLAYEY |
| 1 | 1 | 0-3 | | | 26.5 | 25 | 9 | | A-2-4 | | SC | FILL, SAND, CLAYEY |
| 1 | 1 | 1-2 | 10.6 | 114.4 | 25.8 | 31 | 12 | 0.00 | A-2-6 | 0.8 | SC | FILL, SAND, CLAYEY |
| 1 | 2 | 1-2 | | | 25.2 | 25 | 8 | | A-2-4 | | SC | FILL, SAND, CLAYEY |
| 1 | 3 | 1-2 | | | 21.2 | NV | NP | | A-2-4 | | SM | FILL, SAND, SILTY |
| 1 | 4 | 1-2 | | | 33.5 | 36 | 8 | <0.01 | A-2-4 | | SM | FILL, SAND, SILTY |
| 2 | 1 | 10 | | | 13.1 | NV | NP | <0.01 | A-1-b | | SM | SAND, SILTY |
| 3 | 2 | 10 | | | 11.8 | NV | NP | | A-1-b | | SM-SW | SANDSTONE, SLIGHTLY SILTY |
| 3 | 4 | 5 | 11.5 | 112.1 | 34.4 | 43 | 19 | 0.00 | A-2-6 | 0.1 | SC | SANDSTONE, CLAYEY |

# FIGURE




| REVISION | BY |
|---|---|
| | |

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# TEST BORING LOCATION MAP
## HWY 105 & JACKSON CREEK PARKWAY
## COLORADO SPRINGS, CO
## FOR: CLASSIC COMMUNITIES

| | |
|---|---|
| DRAWN | JAC |
| CHECKED | DPS |
| DATE | 2/6/23 |
| SCALE | 1"=100' |
| JOB NO. | 230008 |
| FIGURE No. | 1 |

# APPENDIX A: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 1/19/2023
Job # 230008

| REMARKS | Depth (ft) | Symbol | Samples | Blows per foot | Watercontent % | Soil Type |
|---|---|---|---|---|---|---|
| WATER @ 9', 1/19/23 | | | | | | |
| 11" ASPHALT, 5" BASE COARSE, FILL 0-9', SAND, CLAYEY, FINE TO MEDIUM GRAINED, BROWN, MEDIUM DENSE, MOIST | | | | 15 | 12.0 | 1 |
| | 5 | | | 28 | 12.7 | 1 |
| SAND, SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST | 10 | | | 19 | 14.9 | 2 |
| | 15 | | | | | |
| | 20 | | | | | |

TEST BORING NO. 2
DATE DRILLED 1/19/2023
CLIENT CLASSIC COMMUNITIES
LOCATION HIGHWAY 105 & JACKSON CREEK

| REMARKS | Depth (ft) | Symbol | Samples | Blows per foot | Watercontent % | Soil Type |
|---|---|---|---|---|---|---|
| DRY TO 10', 1/19/23 | | | | | | |
| 10" ASPHALT, 8" BASE COARSE, FILL 0-6', SAND, CLAYEY, FINE TO MEDIUM GRAINED, BROWN, MEDIUM DENSE, MOIST | | | | 15 | 6.9 | 1 |
| | 5 | | | 18 | 12.4 | 1 |
| SANDSTONE, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST | 10 | | | 50/8" | 13.4 | 3 |
| | 15 | | | | | |
| | 20 | | | | | |

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**TEST BORING LOG**

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | DS | 2/20/23 |

JOB NO.: 230008
FIG NO.: A- 1

TEST BORING NO. 3
DATE DRILLED 1/19/2023
Job # 230008

REMARKS

DRY TO 10', 1/19/23

8" ASPHALT, 6" BASE COARSE, FILL 0-10', SAND, SILTY, FINE TO COARSE GRAINED, TAN, DENSE TO MEDIUM DENSE, MOIST

| Depth (ft) | Symbol | Samples | Blows per foot | Watercontent % | Soil Type |
|---|---|---|---|---|---|
| | | | 38 | 8.8 | 1 |
| 5 | | | 14 | 8.7 | 1 |
| 10 | | | 18 | 13.1 | 1 |
| 15 | | | | | |
| 20 | | | | | |

TEST BORING NO. 4
DATE DRILLED 1/19/2023
CLIENT CLASSIC COMMUNITIES
LOCATION HIGHWAY 105 & JACKSON CREEK

REMARKS

DRY TO 10', 1/19/23

8" ASPHALT, 6" BASE COARSE, FILL 0-10', SAND, SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST

SANDSTONE, CLAYEY, FINE TO MEDIUM GRAINED, TAN, VERY DENSE, MOIST

| Depth (ft) | Symbol | Samples | Blows per foot | Watercontent % | Soil Type |
|---|---|---|---|---|---|
| | | | 29 | 15.8 | 1 |
| 5 | | | 50/11" | 9.1 | 3 |
| 10 | | | 50/11" | 19.1 | 3 |
| 15 | | | | | |
| 20 | | | | | |

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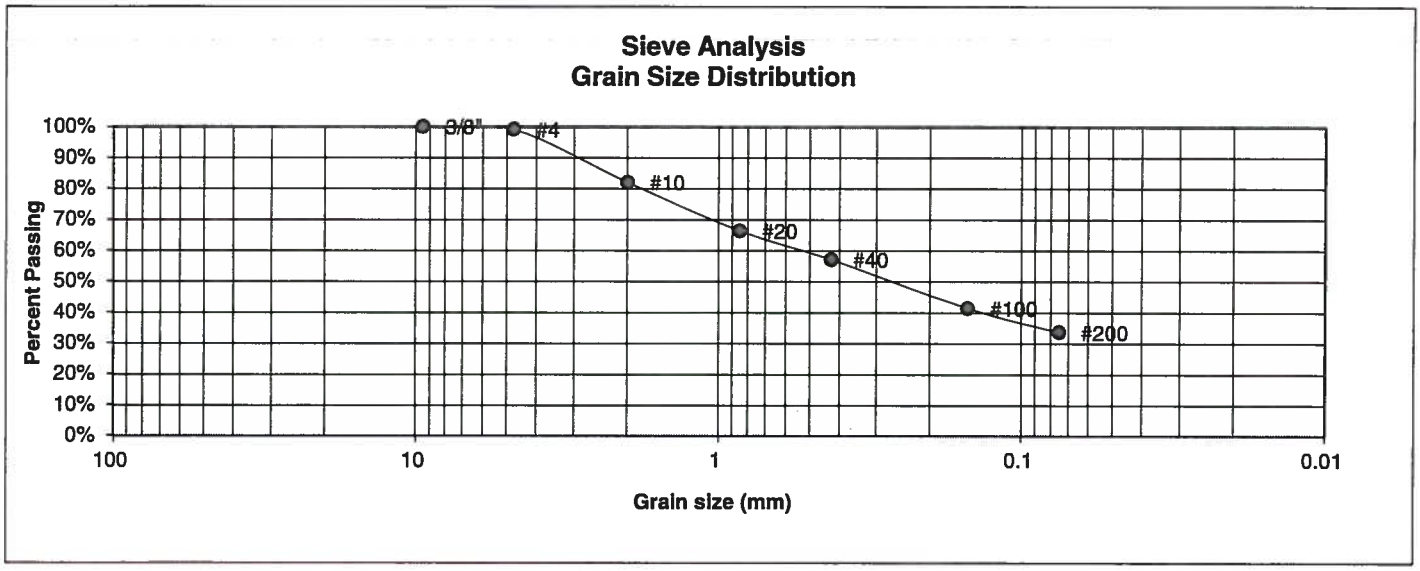
**TEST BORING LOG**

| DRAWN: | DATE: | CHECKED: TJS | DATE: 2/22/23 |
|---|---|---|---|

JOB NO.: 230008
FIG NO.: A- 2

# APPENDIX B: Laboratory Test Results

| | | | |
|---|---|---|---|
| UNIFIED CLASSIFICATION | SC | CLIENT | CLASSIC COMMUNITIES |
| SOIL TYPE # | 1, CBR | PROJECT | HIGHWAY 105 & JACKSON CREEK |
| TEST BORING # | 2 | JOB NO. | 230008 |
| DEPTH (FT) | 0-3 | TEST BY | BL |
| AASHTO CLASSIFICATION | A-2-6 | GROUP INDEX | 1 |




| U.S. Sieve # | Percent Finer |
|---|---|
| 3" | |
| 1 1/2" | |
| 3/4" | |
| 1/2" | |
| 3/8" | 100.0% |
| 4 | 99.1% |
| 10 | 82.1% |
| 20 | 66.4% |
| 40 | 57.2% |
| 100 | 41.4% |
| 200 | 33.7% |

| Atterberg Limits | |
|---|---|
| Plastic Limit | 19 |
| Liquid Limit | 34 |
| Plastic Index | 15 |

| Swell | |
|---|---|
| Moisture at start | |
| Moisture at finish | |
| Moisture increase | |
| Initial dry density (pcf) | |
| Swell (psf) | |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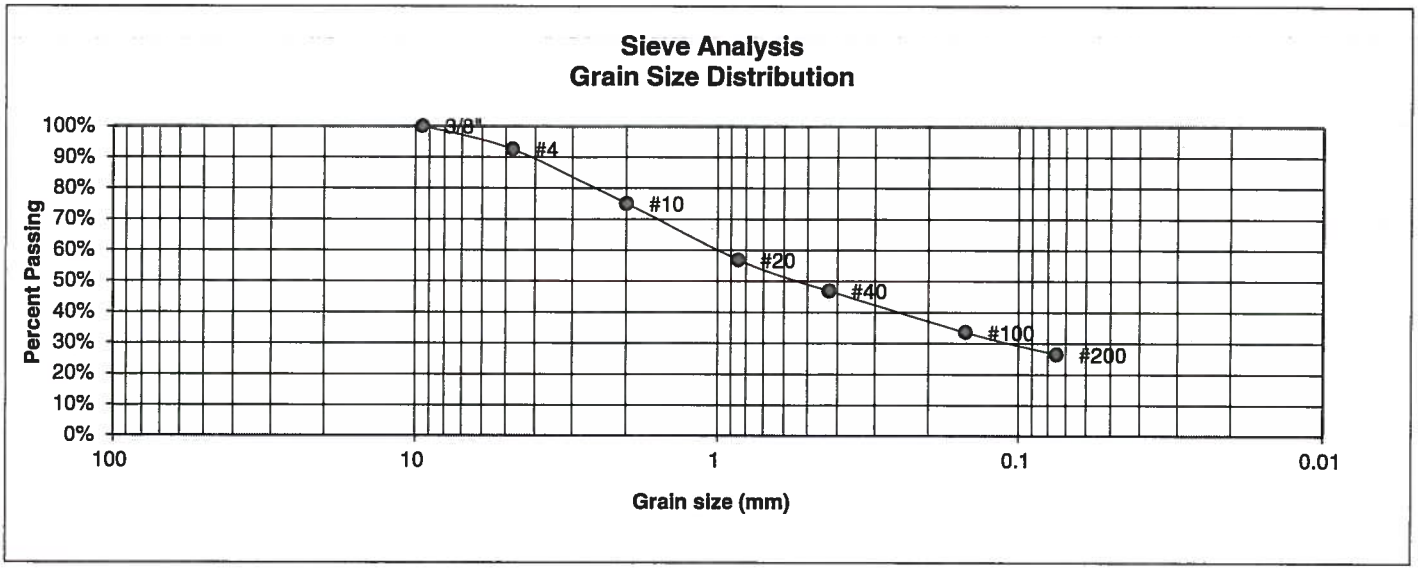
LABORATORY TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | DJ | 2/6/23 |

JOB NO.: 230008
FIG NO.: B-1

| | | | |
|---|---|---|---|
| UNIFIED CLASSIFICATION | SC | CLIENT | CLASSIC COMMUNITIES |
| SOIL TYPE # | 1 | PROJECT | HIGHWAY 105 & JACKSON CREEK |
| TEST BORING # | 1 | JOB NO. | 230008 |
| DEPTH (FT) | 0-3 | 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 | 92.5% |
| 10 | 75.0% |
| 20 | 56.8% |
| 40 | 46.9% |
| 100 | 33.6% |
| 200 | 26.5% |

| Atterberg Limits | |
|---|---|
| Plastic Limit | 16 |
| Liquid Limit | 25 |
| Plastic Index | 9 |

| Swell | |
|---|---|
| Moisture at start | |
| Moisture at finish | |
| Moisture increase | |
| Initial dry density (pcf) | |
| Swell (psf) | |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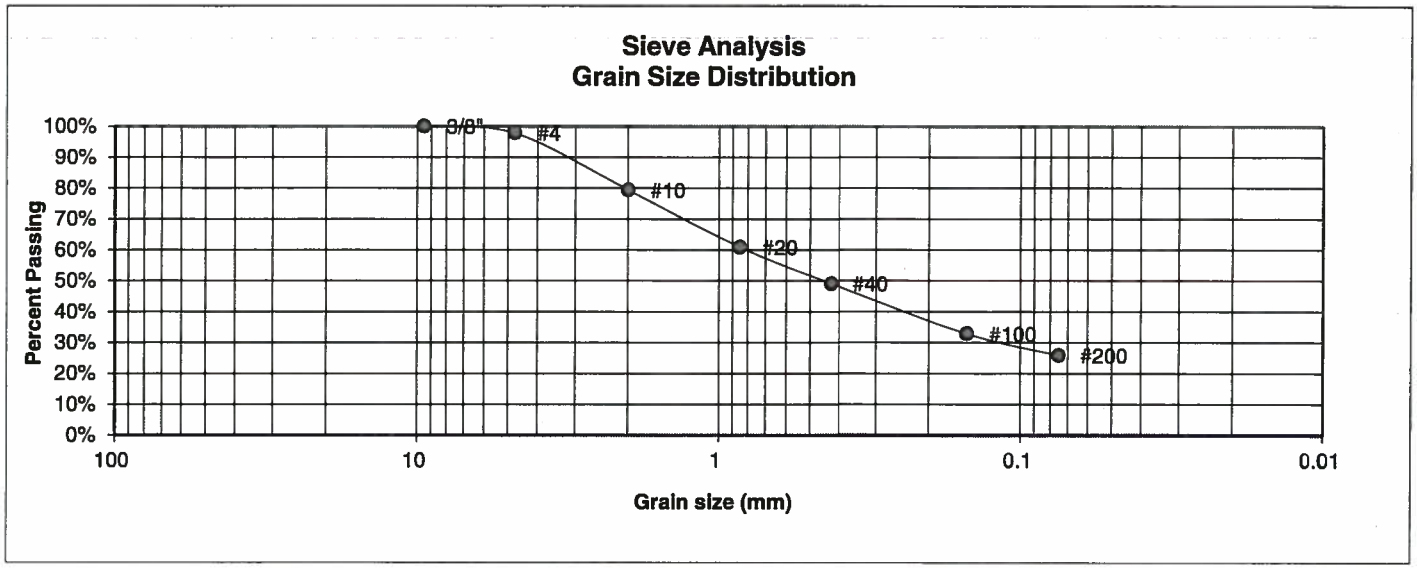
LABORATORY TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | DS | 2/6/23 |

JOB NO.: 230008
FIG NO.: B-2

| | | | |
|---|---|---|---|
| UNIFIED CLASSIFICATION | SC | CLIENT | CLASSIC COMMUNITIES |
| SOIL TYPE # | 1 | PROJECT | HIGHWAY 105 & JACKSON CREEK |
| TEST BORING # | 1 | JOB NO. | 230008 |
| DEPTH (FT) | 1-2 | TEST BY | BL |
| AASHTO CLASSIFICATION | A-2-6 | GROUP INDEX | 0 |




| U.S. Sieve # | Percent Finer |
|---|---|
| 3" | |
| 1 1/2" | |
| 3/4" | |
| 1/2" | |
| 3/8" | 100.0% |
| 4 | 97.8% |
| 10 | 79.4% |
| 20 | 60.9% |
| 40 | 49.1% |
| 100 | 32.8% |
| 200 | 25.8% |

| Atterberg Limits | |
|---|---|
| Plastic Limit | 19 |
| Liquid Limit | 31 |
| Plastic Index | 12 |

| Swell | |
|---|---|
| Moisture at start | |
| Moisture at finish | |
| Moisture increase | |
| Initial dry density (pcf) | |
| Swell (psf) | |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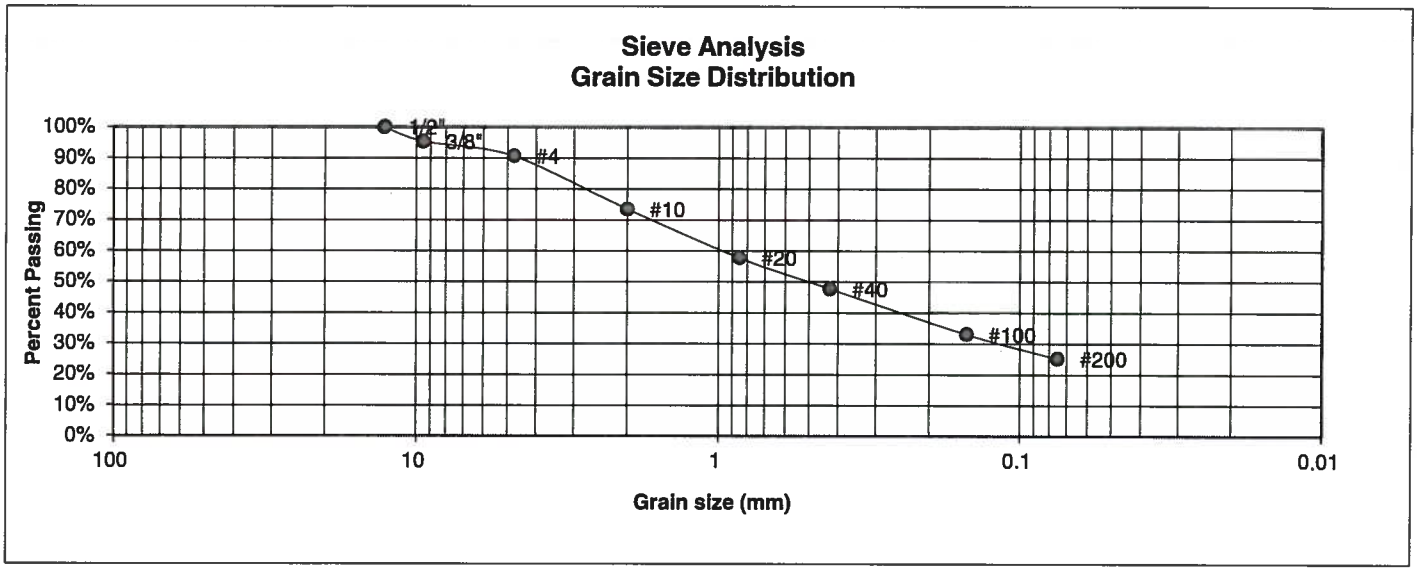
LABORATORY TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | DS | 2/6/23 |

JOB NO.: 230008
FIG NO.: B-3

| | | | |
|---|---|---|---|
| UNIFIED CLASSIFICATION | SC | CLIENT | CLASSIC COMMUNITIES |
| SOIL TYPE # | 1 | PROJECT | HIGHWAY 105 & JACKSON CREEK |
| TEST BORING # | 2 | JOB NO. | 230008 |
| DEPTH (FT) | 1-2 | TEST BY | BL |
| AASHTO CLASSIFICATION | A-2-4 | GROUP INDEX | 0 |




| U.S. Sieve # | Percent Finer |
|---|---|
| 3" | |
| 1 1/2" | |
| 3/4" | |
| 1/2" | 100.0% |
| 3/8" | 95.3% |
| 4 | 90.6% |
| 10 | 73.5% |
| 20 | 57.8% |
| 40 | 47.7% |
| 100 | 33.0% |
| 200 | 25.2% |

| Atterberg Limits | |
|---|---|
| Plastic Limit | 17 |
| Liquid Limit | 25 |
| Plastic Index | 8 |

| Swell | |
|---|---|
| Moisture at start | |
| Moisture at finish | |
| Moisture increase | |
| Initial dry density (pcf) | |
| Swell (psf) | |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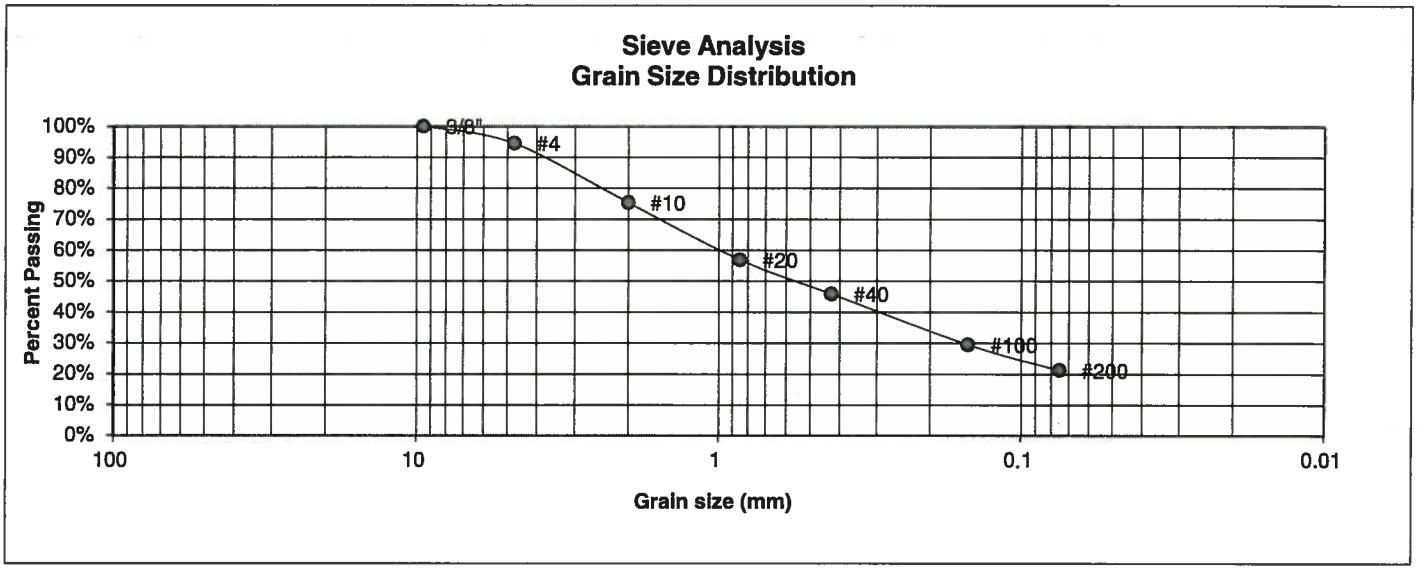
LABORATORY TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | DS | 2/6/23 |

JOB NO.: 230008
FIG NO.: B-4

| | | | |
|---|---|---|---|
| UNIFIED CLASSIFICATION | SM | CLIENT | CLASSIC COMMUNITIES |
| SOIL TYPE # | 1 | PROJECT | HIGHWAY 105 & JACKSON CREEK |
| TEST BORING # | 3 | JOB NO. | 230008 |
| DEPTH (FT) | 1-2 | 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 | 94.5% |
| 10 | 75.3% |
| 20 | 56.9% |
| 40 | 45.9% |
| 100 | 29.5% |
| 200 | 21.2% |

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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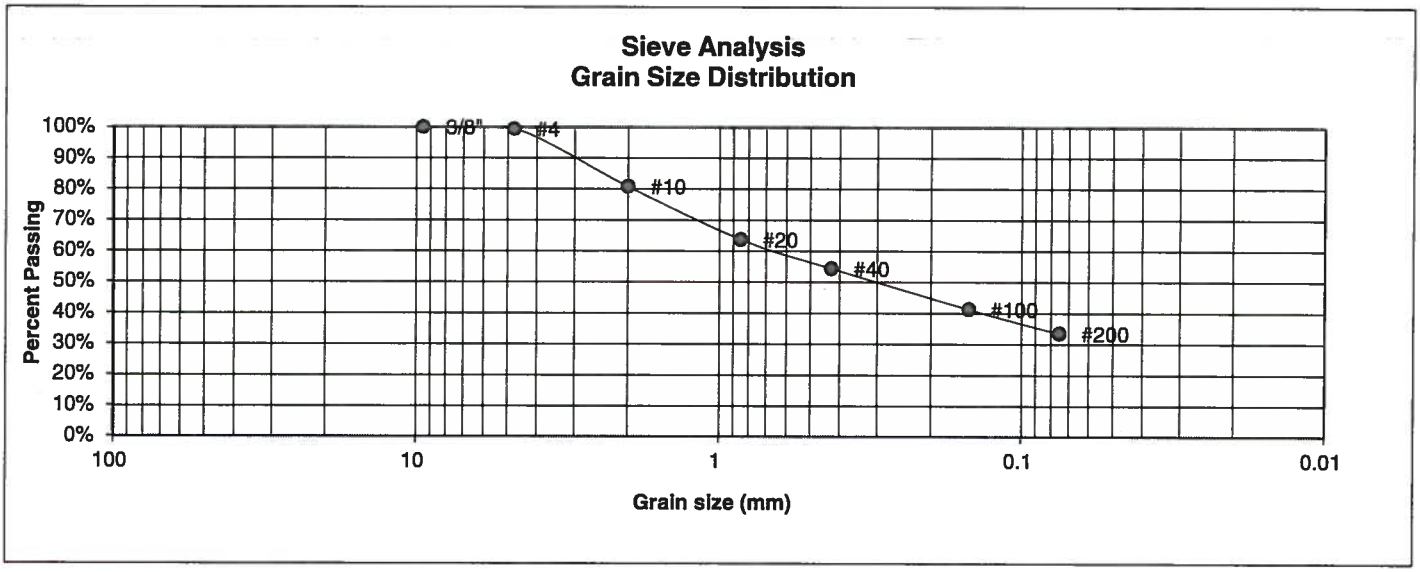
LABORATORY TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | DS | 2/6/23 |

JOB NO.: 230008
FIG NO.: B-5

| | | | |
|---|---|---|---|
| UNIFIED CLASSIFICATION | SM | CLIENT | CLASSIC COMMUNITIES |
| SOIL TYPE # | 1 | PROJECT | HIGHWAY 105 & JACKSON CREEK |
| TEST BORING # | 4 | JOB NO. | 230008 |
| DEPTH (FT) | 1-2 | 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 | 99.4% |
| 10 | 80.8% |
| 20 | 63.7% |
| 40 | 54.4% |
| 100 | 41.2% |
| 200 | 33.5% |

| Atterberg Limits | |
|---|---|
| Plastic Limit | 28 |
| Liquid Limit | 36 |
| Plastic Index | 8 |

| Swell | |
|---|---|
| Moisture at start | |
| Moisture at finish | |
| Moisture increase | |
| Initial dry density (pcf) | |
| Swell (psf) | |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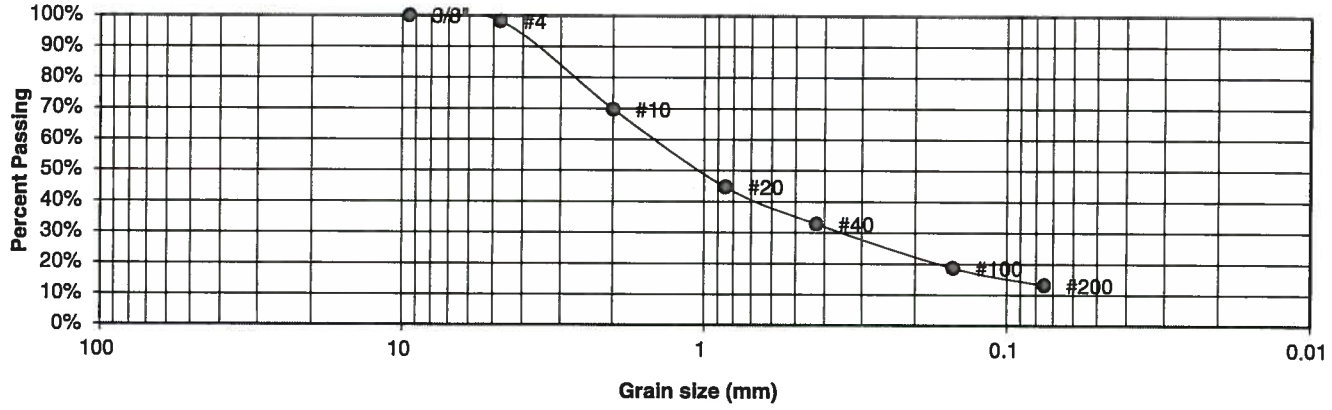
LABORATORY TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | DS | 2/6/23 |

JOB NO.: 230008
FIG NO.: B-6

| | | | |
|---|---|---|---|
| UNIFIED CLASSIFICATION | SM | CLIENT | CLASSIC COMMUNITIES |
| SOIL TYPE # | 2 | PROJECT | HIGHWAY 105 & JACKSON CREEK |
| TEST BORING # | 1 | JOB NO. | 230008 |
| DEPTH (FT) | 10 | TEST BY | BL |
| AASHTO CLASSIFICATION | A-1-b | GROUP INDEX | 0 |

**Sieve Analysis**
**Grain Size Distribution**




| U.S. Sieve # | Percent Finer |
|---|---|
| 3" | |
| 1 1/2" | |
| 3/4" | |
| 1/2" | |
| 3/8" | 100.0% |
| 4 | 98.1% |
| 10 | 69.7% |
| 20 | 44.7% |
| 40 | 32.8% |
| 100 | 18.6% |
| 200 | 13.1% |

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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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

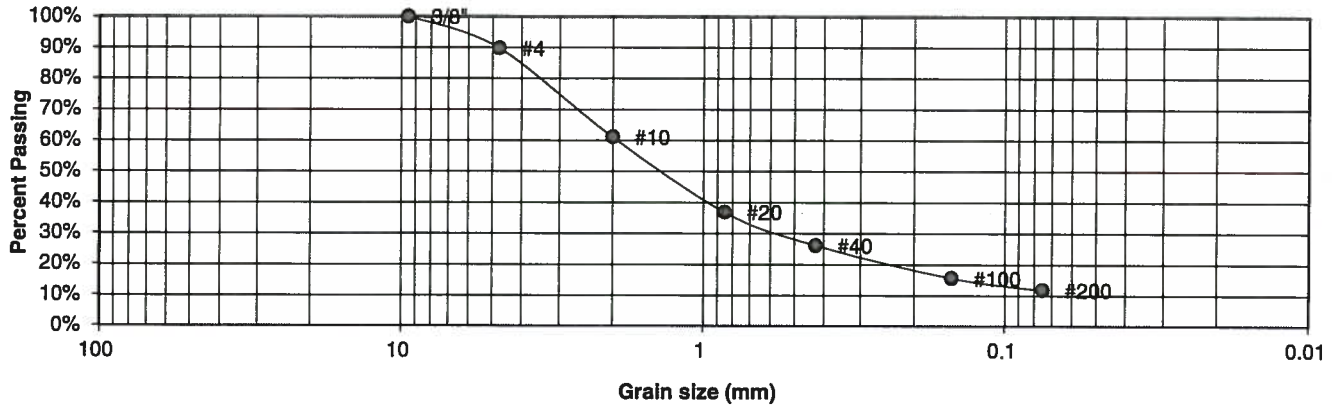

LABORATORY TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | DS | 2/6/23 |

JOB NO.: 230008
FIG NO.: B-7

| | | | |
|---|---|---|---|
| UNIFIED CLASSIFICATION | SM-SW | CLIENT | CLASSIC COMMUNITIES |
| SOIL TYPE # | 3 | PROJECT | HIGHWAY 105 & JACKSON CREEK |
| TEST BORING # | 2 | JOB NO. | 230008 |
| DEPTH (FT) | 10 | TEST BY | BL |
| AASHTO CLASSIFICATION | A-1-b | GROUP INDEX | 0 |

**Sieve Analysis**
**Grain Size Distribution**




| U.S. Sieve # | Percent Finer |
|---|---|
| 3" | |
| 1 1/2" | |
| 3/4" | |
| 1/2" | |
| 3/8" | 100.0% |
| 4 | 89.8% |
| 10 | 61.1% |
| 20 | 36.9% |
| 40 | 26.2% |
| 100 | 15.6% |
| 200 | 11.8% |

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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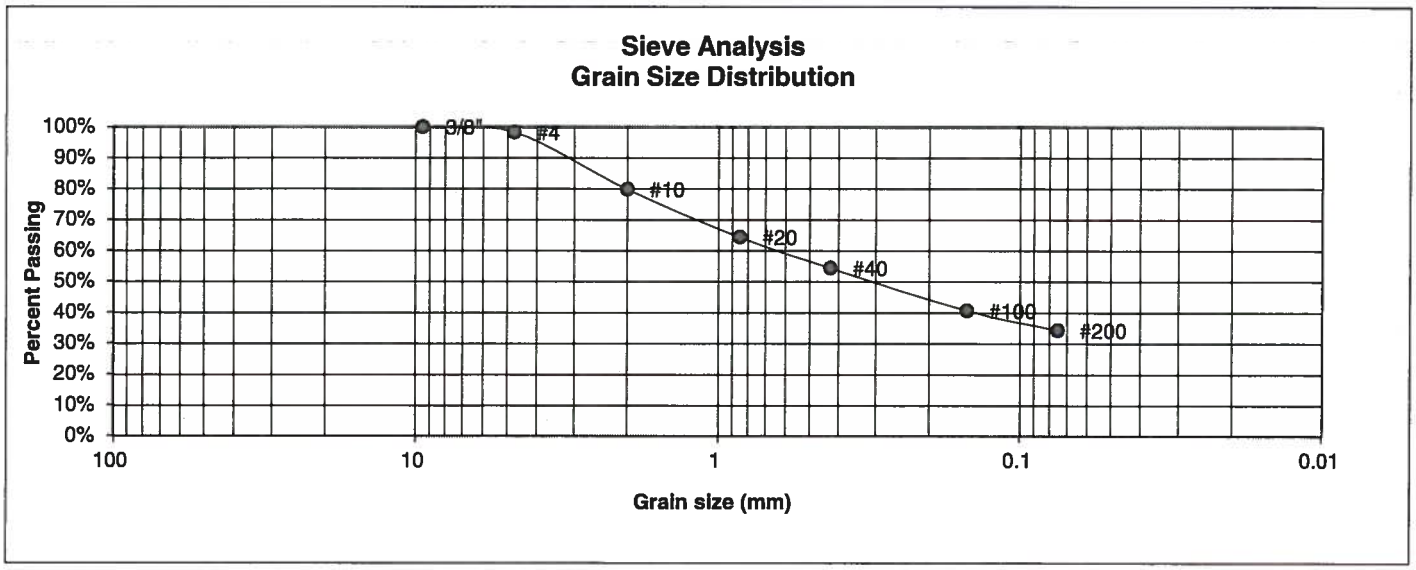
LABORATORY TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | DS | 2/6/23 |

JOB NO.: 230008
FIG NO.: B-8

| | | | |
|---|---|---|---|
| UNIFIED CLASSIFICATION | SC | CLIENT | CLASSIC COMMUNITIES |
| SOIL TYPE # | 3 | PROJECT | HIGHWAY 105 & JACKSON CREEK |
| TEST BORING # | 4 | JOB NO. | 230008 |
| DEPTH (FT) | 5 | TEST BY | BL |
| AASHTO CLASSIFICATION | A-2-6 | GROUP INDEX | 2 |




| U.S. Sieve # | Percent Finer |
|---|---|
| 3" | |
| 1 1/2" | |
| 3/4" | |
| 1/2" | |
| 3/8" | 100.0% |
| 4 | 98.3% |
| 10 | 79.8% |
| 20 | 64.4% |
| 40 | 54.5% |
| 100 | 40.7% |
| 200 | 34.4% |

| Atterberg Limits | |
|---|---|
| Plastic Limit | 24 |
| Liquid Limit | 43 |
| Plastic Index | 19 |

| Swell | |
|---|---|
| Moisture at start | |
| Moisture at finish | |
| Moisture increase | |
| Initial dry density (pcf) | |
| Swell (psf) | |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LABORATORY TEST RESULTS

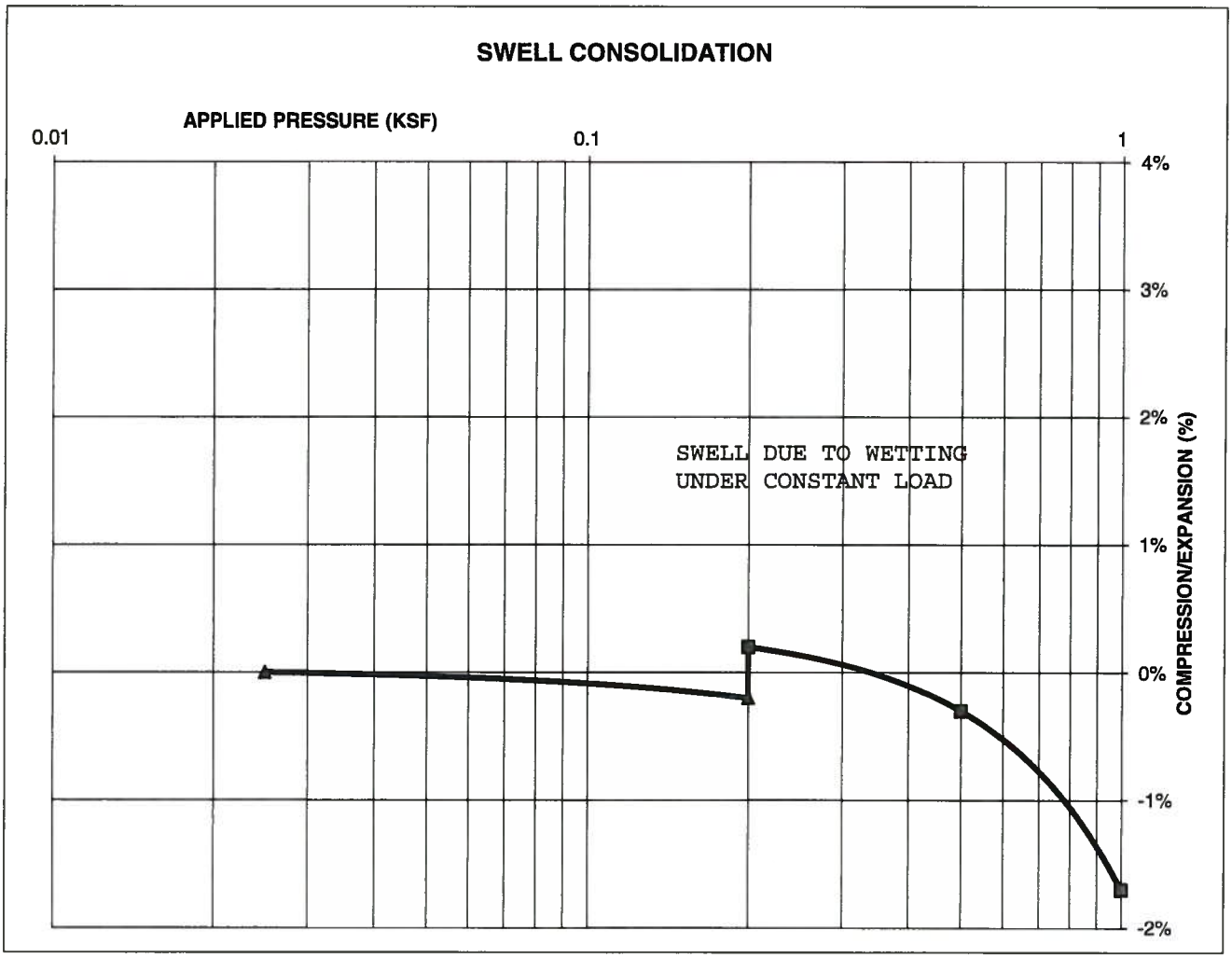
| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | DS | 2/6/23 |

JOB NO.: 230008
FIG NO.: B-9

***CONSOLIDATION TEST RESULTS***

| | | | |
|---|---|---|---|
| TEST BORING # | 2 | DEPTH(ft) | 0-3 |
| DESCRIPTION | SC | SOIL TYPE | 1 |
| NATURAL UNIT DRY WEIGHT (PCF) | | | 124 |
| NATURAL MOISTURE CONTENT | | | 12.3% |
| SWELL/CONSOLIDATION (%) | | | 0.4% |

JOB NO. 230008
CLIENT CLASSIC COMMUNITIES
PROJECT HIGHWAY 105 & JACKSON CREEK

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SWELL CONSOLIDATION
TEST RESULTS

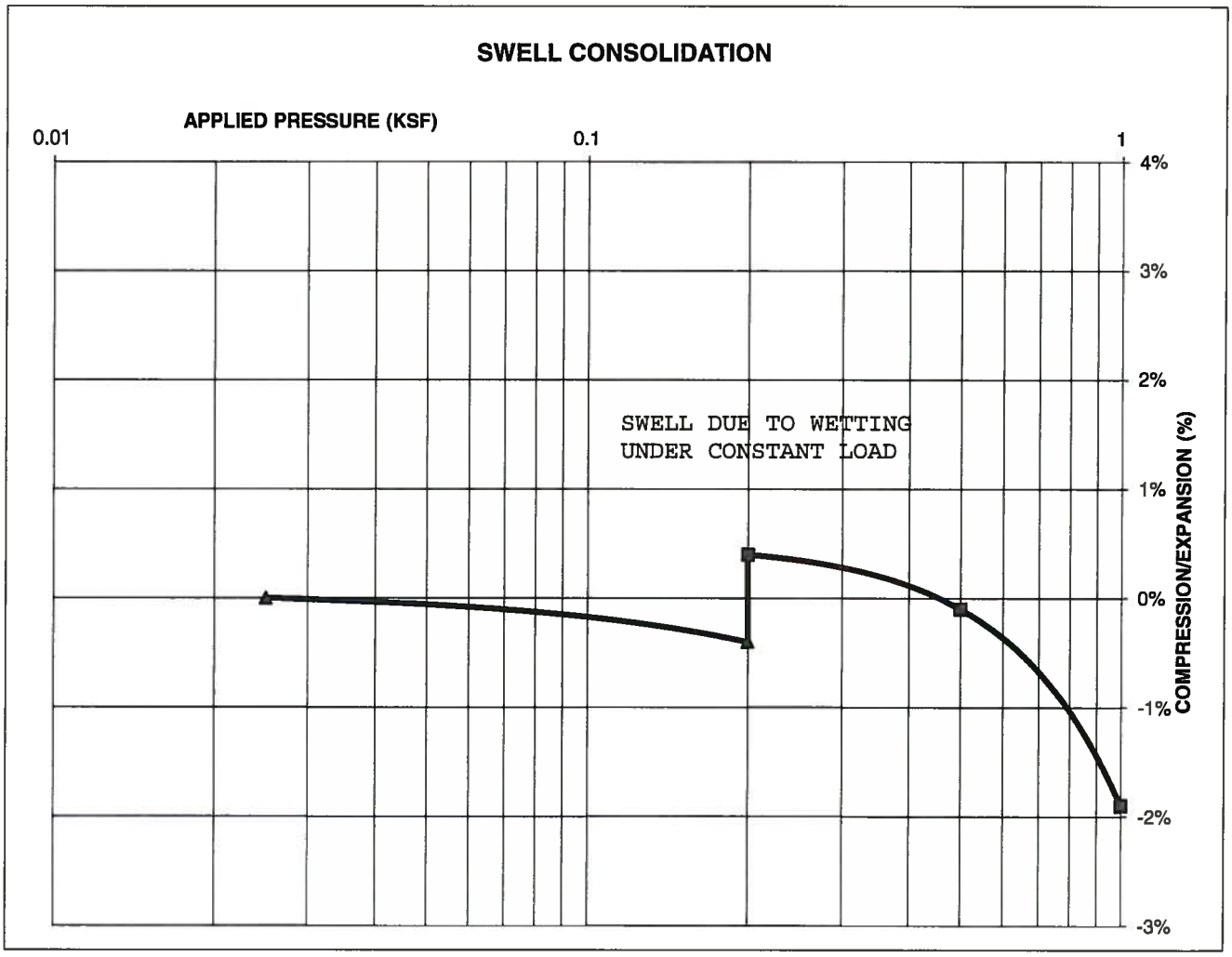
| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | DS | 2/6/23 |

JOB NO.: 230008
FIG NO.: B-16

***CONSOLIDATION TEST RESULTS***

| | | | |
|---|---|---|---|
| TEST BORING # | 1 | DEPTH(ft) | 1-2 |
| DESCRIPTION | SC | SOIL TYPE | 1 |
| NATURAL UNIT DRY WEIGHT (PCF) | | | 114 |
| NATURAL MOISTURE CONTENT | | | 10.6% |
| SWELL/CONSOLIDATION (%) | | | 0.8% |

JOB NO. 230008
CLIENT CLASSIC COMMUNITIES
PROJECT HIGHWAY 105 & JACKSON CREEK

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SWELL CONSOLIDATION
TEST RESULTS

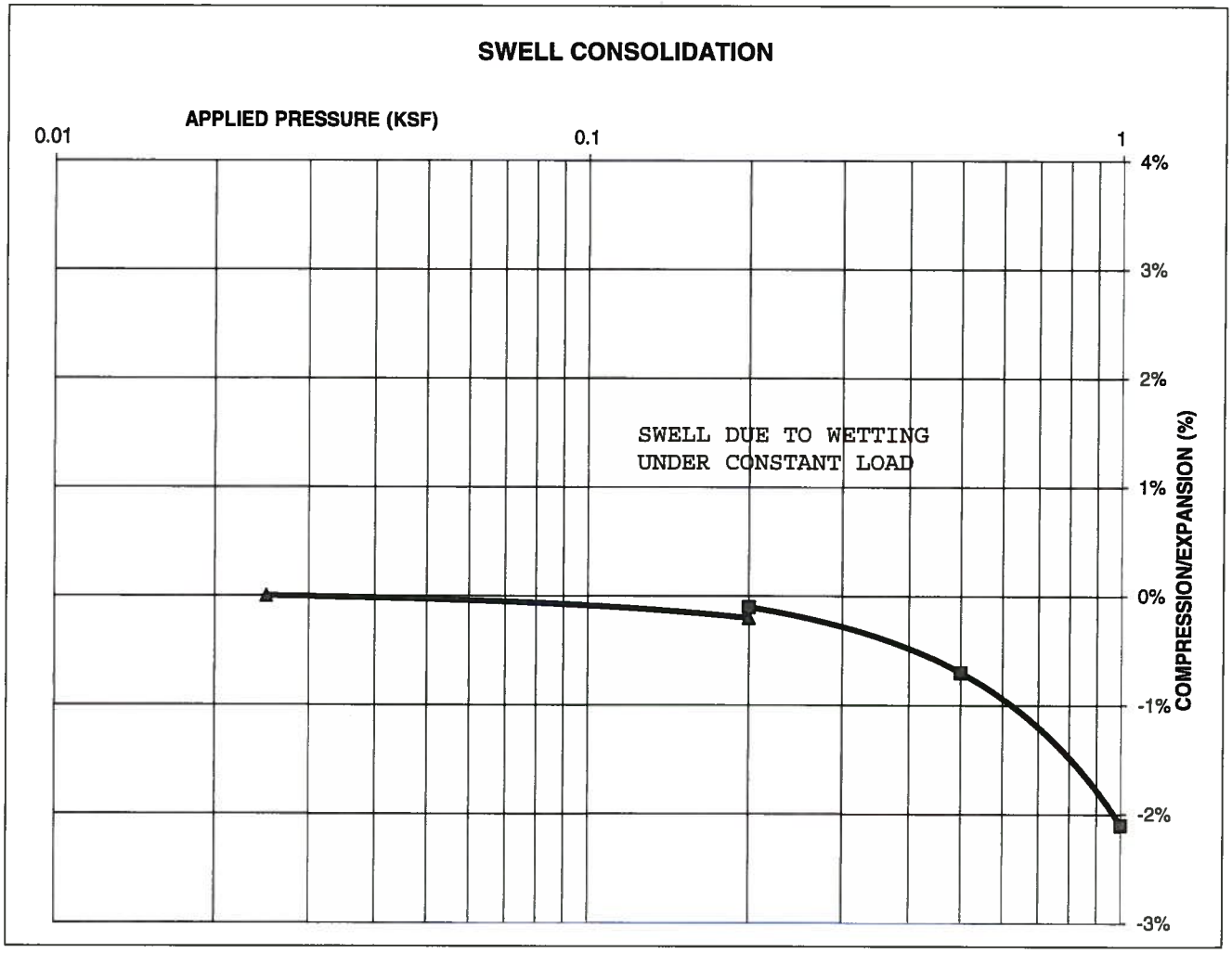
| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | DS | 2/6/23 |

JOB NO.: 230008
FIG NO.: B-11

***CONSOLIDATION TEST RESULTS***

| | | | |
|---|---|---|---|
| TEST BORING # | 4 | DEPTH(ft) | 5 |
| DESCRIPTION | SC | SOIL TYPE | 3 |
| NATURAL UNIT DRY WEIGHT (PCF) | | | 112 |
| NATURAL MOISTURE CONTENT | | | 11.5% |
| SWELL/CONSOLIDATION (%) | | | 0.1% |

JOB NO. 230008
CLIENT CLASSIC COMMUNITIES
PROJECT HIGHWAY 105 & JACKSON CREEK





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SWELL CONSOLIDATION
TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | DS | 2/6/23 |

JOB NO.: 230008
FIG NO.: B-12

| | | | |
|---|---|---|---|
| CLIENT | CLASSIC COMMUNITIES | JOB NO. | 230008 |
| PROJECT | HIGHWAY 105 & JACKSON CREEK | DATE | 2/2/2023 |
| LOCATION | HIGHWAY 105 & JACKSON CREEK | TEST BY | BL |

| BORING NUMBER | DEPTH, (ft) | SOIL TYPE NUMBER | UNIFIED CLASSIFICATION | WATER SOLUBLE SULFATE, (wt%) |
|---|---|---|---|---|
| TB-1 | 1-2 | 1 | SC | 0.00 |
| TB-4 | 1-2 | 1 | SM | <0.01 |
| TB-1 | 10 | 2 | SM | <0.01 |
| TB-4 | 5 | 3 | SC | 0.00 |
| | | | | |
| | | | | |
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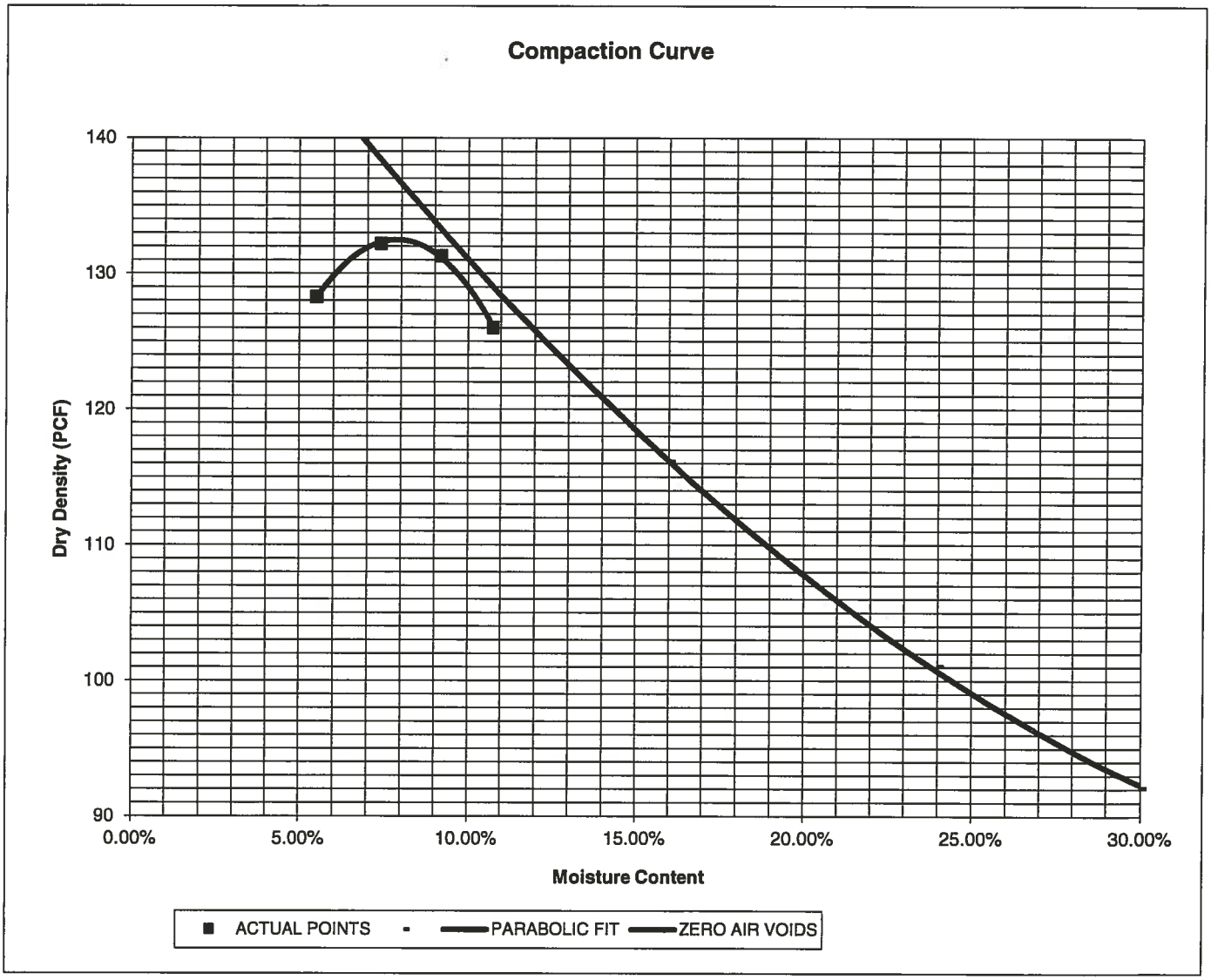
**LABORATORY TEST**
**SULFATE RESULTS**

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | DS | 2/6/23 |

JOB NO.: 230008
FIG NO.: B-13

| | | | |
|---|---|---|---|
| PROJECT | HIGHWAY 105 & JACKSON CREEK | CLIENT | CLASSIC COMMUNITIES |
| SAMPLE LOCATION | TB-2 @ 0-3' | JOB NO. | 230008 |
| SOIL DESCRIPTION | FILL, SAND, CLAYEY, BROWN | DATE | 02/02/23 |

| | | | |
|---|---|---|---|
| IDENTIFICATION | SC | COMPACTION TEST # | 1 |
| TEST DESIGNATION / METHOD | ASTM D-1557-A | TEST BY | BC |
| MAXIMUM DRY DENSITY (PCF) | 132.2 | OPTIMUM MOISTURE | 7.8% |





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**MOISTURE DENSITY RELATION**

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | DS | 2/6/23 |

JOB NO.: 230008
FIG NO.: B-14

## CBR TEST LOAD DATA

JOB NO: 230008
CLIENT: CLASSIC COMMUNITIES
PROJECT: HIGHWAY 105 & JACKSON CREEK
SOIL TYPE: 1

| PISTON DIAMETER (cm) | PISTON AREA ($in^2$) |
|---|---|
| 4.958 | 2.993 |

| PENETRATION DEPTH (INCHES) | *10 BLOWS* MOLD # 1 LOAD(LBS) (LBS) | STRESS (PSI) | *25 BLOWS* MOLD # 2 LOAD(LBS) (LBS) | STRESS (PSI) | *56 BLOWS* MOLD # 3 LOAD(LBS) (LBS) | STRESS (PSI) |
|---|---|---|---|---|---|---|
| 0.000 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| 0.025 | 83 | 27.74 | 125 | 41.77 | 187 | 62.49 |
| 0.050 | 129 | 43.11 | 151 | 50.46 | 224 | 74.85 |
| 0.075 | 144 | 48.12 | 220 | 73.52 | 331 | 110.61 |
| 0.100 | 178 | 59.48 | 334 | 111.61 | 502 | 167.75 |
| 0.125 | 207 | 69.17 | 419 | 140.02 | 628 | 209.86 |
| 0.150 | 239 | 79.87 | 482 | 161.07 | 721 | 240.93 |
| 0.175 | 274 | 91.56 | 578 | 193.15 | 867 | 289.72 |
| 0.200 | 305 | 101.92 | 606 | 202.51 | 908 | 303.42 |
| 0.300 | 367 | 122.64 | 860 | 287.38 | 1288 | 430.41 |
| 0.400 | 410 | 137.01 | 1035 | 345.86 | 1552 | 518.63 |
| 0.500 | 450 | 150.38 | 1236 | 413.03 | 1724 | 576.11 |

## FINAL MOISTURE CONTENT

| | MOLD # 1 | MOLD # 2 | MOLD # 3 |
|---|---|---|---|
| CAN # | 307 | 357 | 315 |
| WT. CAN | 8.48 | 7.81 | 8.13 |
| WT. CAN+WET | 185.95 | 175.7 | 202.28 |
| WT. CAN+DRY | 162.59 | 153.76 | 188.17 |
| WT. H20 | 23.36 | 21.94 | 14.11 |
| WT. DRY SOIL | 154.11 | 145.95 | 180.04 |
| MOISTURE CONTENT | 15.16% | 15.03% | 7.84% |

| | | | |
|---|---|---|---|
| WET DENSITY (PCF) | 125.9 | 130.8 | 134.4 |
| DRY DENSITY (PCF) | 116.8 | 121.3 | 124.7 |

| | | | | |
|---|---|---|---|---|
| BEARING RATIO | | 5.95 | 11.16 | 16.78 |
| 90% OF DRY DENSITY | 119.0 | | | |
| 95% OF DRY DENSITY | 125.6 | | | |

| | | | |
|---|---|---|---|
| BEARING RATIO AT 90% OF MAX | 8.44 | ~ R VALUE | 22 |
| BEARING RATIO AT 95% OF MAX | 18.33 | ~ R VALUE | 65 |

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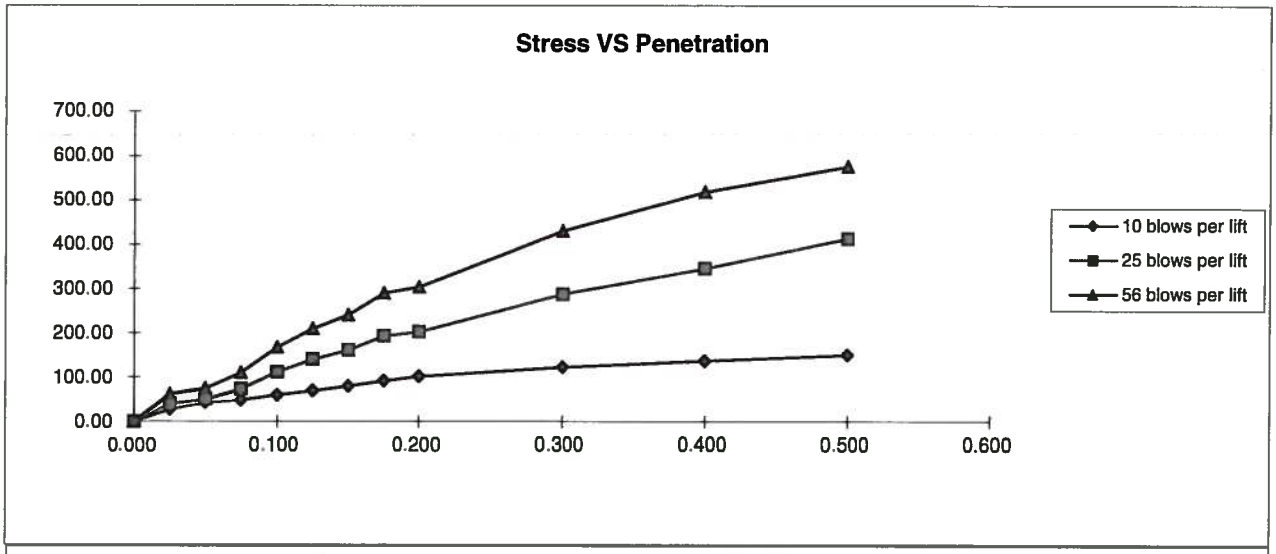
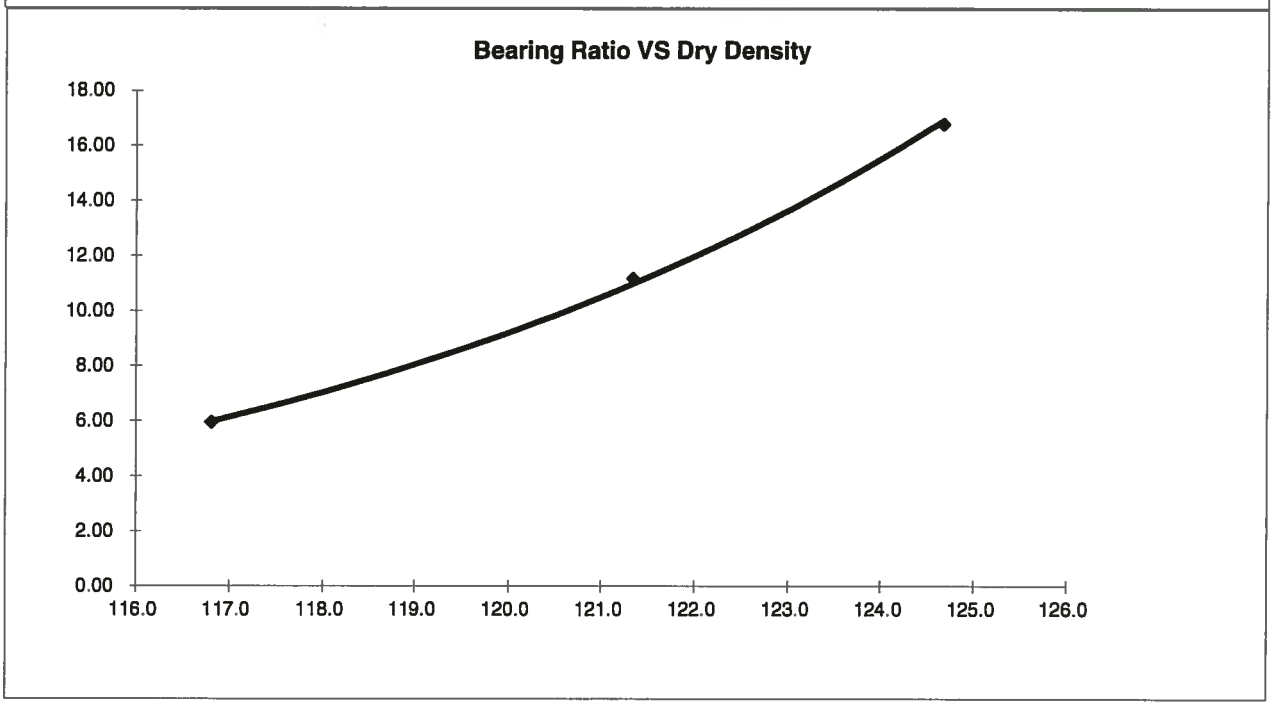
**CBR TEST DATA**

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | DS | 2/6/23 |

JOB NO.: 230008
FIG NO.: B-15




| | | | |
|---|---|---|---|
| BEARING RATIO AT 90% OF MAX | 8.44 | ~ R VALUE | 22.00 |
| BEARING RATIO AT 95% OF MAX | 18.33 | ~ R VALUE | 65.00 |

JOB NO: 230008
SOIL TYPE: 1

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**CALIFORNIA BEARING RATIO**

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | DS | 2/6/23 |

JOB NO.: 230008
FIG NO.: B-16

# APPENDIX C: Pavement Design Calculations

# FLEXIBLE PAVEMENT DESIGN

## DESIGN DATA

CLASSIC COMMUNITIES U.S. STATE HIGHWAY 105
PRINCIPAL ARTERIAL SOIL TYPE 1

| | | |
|---|---|---|
| Equivalent (18 kip) Single Axle Load Applications (ESAL): | ESAL ($W_{18}$) = | 5,256,000 |
| Hveem Stabilometer (R Value) Results: | R = | 50 |
| Standard Deviation | $S_o$ = | 0.45 |
| Loss in Serviceability | Δpsi = | 2.5 |
| Reliability | Reliability = | 90 |
| Reliability (z-statistic) | $Z_R$ = | -1.28 |
| Soil Resilient Modulus | $M_R$ = | 13168 |

Weighted Structural Number (WSN): ➡ WSN = 3.43

## 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 |

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

| Left | Right | Difference |
|---|---|---|
| 6.72 | 6.72 | 0.0 |

Job No. 230008
Fig. No. C-1

# DESIGN CALCULATIONS

AGGREGATE BASE COURSE

## DESIGN DATA

CLASSIC COMMUNITIES U.S. STATE HIGHWAY 105
PRINCIPAL ARTERIAL

| | |
|---|---|
| Equivalent (18 kip) Single Axle Load Applications (ESAL): | ESAL = 5,256,000 |
| Hveem Stabilometer (R Value) Results: | R = 50 |
| Weighted Structural Number (WSN): | WSN = 3.43 |

## 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

$D_1 = (WSN)/C_1$ = 7.8 inches of Full Depth Asphalt
Use 8.0 inches Full Depth

## FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = [ 5 ] inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 11.1 inches of Aggregate
Base Course, use 12.0 inches

## RECOMMENDED ALTERNATIVES

1. 5.0 inches of Asphalt + 12.0 inches of Aggregate Base Course, or
2. 8.0 inches of Asphalt

Job No. 230008
Fig. No. C-2

# FLEXIBLE PAVEMENT DESIGN

## DESIGN DATA

CLASSIC COMMUNITIES U.S. STATE HIGHWAY 105
PRINCIPAL ARTERIAL SOIL TYPE 1

| | | |
|---|---|---|
| Equivalent (18 kip) Single Axle Load Applications (ESAL): | ESAL ($W_{18}$) = | 5,256,000 |
| Hveem Stabilometer (R Value) Results: | R = | 50 |
| Standard Deviation | $S_o$ = | 0.45 |
| Loss in Serviceability | Δpsi = | 2.5 |
| Reliability | Reliability = | 90 |
| Reliability (z-statistic) | $Z_R$ = | -1.28 |
| Soil Resilient Modulus | $M_R$ = | 13168 |

Weighted Structural Number (WSN): → WSN = 3.43

## 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 |

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

| Left | Right | Difference |
|---|---|---|
| 6.72 | 6.72 | 0.0 |

Job No. 230008
Fig. No. C-3

# DESIGN CALCULATIONS

CEMENT SECTIONS

## DESIGN DATA

CLASSIC COMMUNITIES U.S. STATE HIGHWAY 105
PRINCIPAL ARTERIAL SOIL TYPE 1

| | |
|---|---|
| Equivalent (18 kip) Single Axle Load Applications (ESAL): | ESAL = 5,256,000 |
| Hveem Stabilometer (R Value) Results: | R = 50 |
| Weighted Structural Number (WSN): | WSN = 3.43 |

## DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

$C_1$ = 0.44 Strength Coefficient - Hot Bituminous Asphalt
$C_2$ = 0.11 Strength Coefficient - Cement Stabilized Subgrade

$D_1$ = Depth of Asphalt (inches)
$D_2$ = Depth of Cement Stabilized Subgrade (inches)

## FOR ASPHALT + CEMENT STABILIZED SUBGRADE SECTION

Asphalt Thickness (t) = [ 5 ] inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 11.1 inches of Cement Stabilized Subgrade
Cement Stabilized Subgrad 12.0

## RECOMMENDED ALTERNATIVES

1. 5.0 inches of Asphalt + 12.0 inches of Cement Stabilized Subgrade

Job No. 230008
Fig. No. C-4