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**PAVEMENT DESIGN REPORT  
VOLLMER ROAD NORTH  
EL PASO COUNTY, COLORADO**

Prepared for:  
**Classic Communities  
2138 Flying Horse Club North  
Colorado Springs, Colorado 80921**

Attn: Austin Lenz

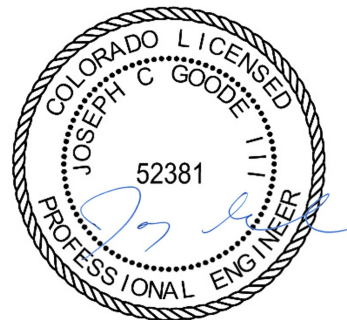
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Respectfully Submitted,

ENTECH ENGINEERING, INC.

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Entech Job No. 231519

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## **1 Introduction**

Entech Engineering, Inc. (Entech) completed a subsurface exploration program, laboratory testing, and pavement design recommendations for a segment of Vollmer Road in northern El Paso County, Colorado. This report describes the subsurface exploration program conducted for the proposed roadway improvements and provides pavement section alternatives and construction recommendations. Entech participated in this project as a subconsultant to Classic Communities. The contents of this report, including the pavement design recommendations, are subject to the limitations and assumptions presented in Section 7.

This revised report supersedes previous versions of the report.

## **2 Project and Site Description**

The proposed improvements to Vollmer Road consist of approximately 1 mile of roadway widening and improvements from approximately 500 feet northeast of Glider Loop to Poco Road (Figure 1). Improvements will include widening of the existing roadway and a new pavement section. The extent of the improvements will include a 2-inch mill and overlay to tie in with the existing roadway.

The existing topography along Vollmer Road includes vacant pasture land and land being developed for future residential lots. The roadway is currently paved with asphalt and is without curbs and gutters. We understand that the proposed roadway surface will remain asphalt. Based on the development plans the improvements include two travel lanes in each direction, a striped median, and curb and gutter installation. Vollmer Road will be designated as an urban minor arterial.

## **3 Subsurface Explorations and Laboratory Testing**

### **3.1 Subsurface Exploration Program**

Subsurface conditions at the project site were explored by 11 test borings, designated TB-1 through TB-11, drilled on November 1, 2023. The locations of the test borings are shown on the Site and Exploration Plan (Figure 2). The borings were drilled to depths of 5 to 10 feet below the existing ground surface (bgs). The drilling was performed using a truck-mounted, continuous flight auger drill rig supplied and operated by Entech. Descriptive boring logs providing the lithologies

of the subsurface conditions encountered during drilling are presented in Appendix A. Groundwater levels were measured in each open borehole at the conclusion of drilling.

Soil and bedrock samples were obtained from the borings utilizing the Standard Penetration Test (ASTM D1586) using a split-barrel California sampler. Results of the Standard Penetration Test (SPT) are included on the boring logs in terms of N-values expressed in blows per foot (bpf). Soil and bedrock samples recovered from the borings were visually classified and recorded on the boring logs. The soil classifications were later verified utilizing laboratory testing and grouped by soil type. The soil type numbers are included on the boring logs. It should be understood that the soil descriptions shown on the boring logs may vary between boring locations and sample depths. It should also be noted that the lines of stratigraphic separation shown on the boring logs represent approximate boundaries between soil types and the actual stratigraphic transitions may be more gradual or variable with location.

### **3.2 Geotechnical Index and Engineering Property Testing**

Water content testing (ASTM D2216) was performed on the samples recovered from the borings, and the results are shown on the boring logs. Grain-Size Analysis (ASTM D422) and Atterberg Limits testing (ASTM D4318) were performed on selected samples to assist in classifying the materials encountered in the borings.

For pavement design, a modified proctor (ASTM D1557) and California Bearing Ratio (CBR) test (ASTM D1883) were completed. Soluble sulfate testing was performed on select soil samples to evaluate the potential for below-grade degradation of concrete due to sulfate attack. The laboratory testing results are presented in Appendix B and summarized in Table B-1.

Strength testing was performed on two sets of soil/cement composite samples. Testing was performed on soil samples prepared with 2% and 4% Portland Cement Type 1/2. A compression strength of 160 pounds per square inch (psi) is recommended for cement-stabilized subgrade. The 5-day average strength value of the 2% mix was 206 psi. The 5-day average strength value of the 4% mix was 233 psi. A 4% mix is recommended based on the laboratory test results. A summary of the testing results is attached in Appendix B, Table B-2.

## **4 Subgrade Conditions**

Two primary soil types and one bedrock type were encountered in the test borings drilled for the subsurface investigation. Each soil type was classified in accordance with the Unified Soil

Classification System (USCS) and the American Association of State Highway and Transportation Officials (AASHTO) soil classification system using the laboratory testing results and the observations made during drilling.

#### **4.1 Subsurface Conditions**

Subsurface conditions along the proposed roadways consisted of loose to dense silty to clayey sand fill and sand with silt or clay fill (Soil Type 1), native medium dense to dense silty sand to sand with silt (Soil Type 2). Very weak to extremely weak, moderately to highly weathered sandstone was encountered at depths of 4 to 7 feet bgs in five of the test borings. When classified as a soil, the sandstone classified as very dense, silty sand to sand with silt (Soil Type 3). The test borings were drilled through 3 to 7 inches of existing hot mix asphalt (HMA) and 1 to 3 inches of aggregate base course (ABC). Soil types and corresponding AASHTO soil classifications are listed as follows:

- Soil Type 1: A-2-4, A-1-b, A-2-6, and A-6 (used for CBR testing and pavement design)
- Soil Type 2: A-2-4 and A-1-b
- Soil Type 3: A-1-b

Laboratory test results are presented in Appendix B and are summarized in Table B-1.

#### **4.2 Groundwater**

Groundwater was not encountered in the test borings. Groundwater fluctuations are possible and will depend on seasonal variations, local precipitation, runoff, and other factors. We do not anticipate groundwater to affect the proposed roadway construction.

### **5 Pavement Design Recommendations**

Pavement design recommendations were made in accordance with the *El Paso County Engineering Criteria Manual*.

#### **5.1 Subgrade Conditions**

California Bearing Ratio (CBR) testing was performed on a representative sample of the subgrade clayey sand fill (Soil Type 1, A-2-4) from TB-7 to determine the support characteristic of the subgrade soils for the roadway section. The results of the CBR testing are presented in Appendix B and summarized in Exhibit 1.

**Exhibit 1: Subsurface Laboratory Testing Summary**

| Design Parameter             | Value                |
|------------------------------|----------------------|
| Soil Type                    | 1 - Clayey Sand Fill |
| CBR at 95%                   | 53.27                |
| Design CBR                   | 10                   |
| Liquid Limit                 | 26                   |
| Plasticity Index             | 10                   |
| Percent Passing 200          | 27.5                 |
| AASHTO Classification        | A-2-4                |
| Unified Soils Classification | SC                   |

**5.2 Swell Mitigation**

El Paso County recommendations require swell mitigation of expansive soils criteria for soils with swell testing results greater than 2% under a 150 pounds per square foot (psf) surcharge. Based on the granular nature of the site materials encountered, mitigation for expansive soils is not required. Localized areas of higher clay contents such as the A-6 material encountered in boring TB-11 may be encountered during subgrade preparation. Overexcavation of cohesive soils is recommended to provide proper subgrade support as discussed in Section 6.1.1.

**5.3 Traffic Loading**

Traffic data is not available for the Vollmer Road widening alignment; however, the roadway is classified as an urban minor arterial. *The El Paso County Engineering Criteria Manual, Table D-2, Minimum Pavement Sections*, provides default 18-kip equivalent single axle loading (ESAL) based street classifications. For design, a default ESAL value of 1,971,000 was used for the urban minor arterial designation.

**5.4 Pavement Design**

The pavement sections were determined utilizing the *El Paso County Engineering Criteria Manual, Appendix D, Pavement Design Criteria and Report*, the CBR testing, and default ESAL values. Design parameters used in the pavement analysis are presented in Exhibit 2.

**Exhibit 2: Pavement Design Parameters**

| Design Parameter                    | Value      |
|-------------------------------------|------------|
| Reliability                         | 85%        |
| Standard Deviation                  | 0.45       |
| Serviceability Loss ( $\Delta$ psi) | 2.0        |
| Design CBR                          | 10.0       |
| Resilient Modulus                   | 15,000 psi |
| Structural Coefficients             |            |
| Hot Mix Asphalt                     | 0.44       |
| Cement Treated Subgrade             | 0.11       |

Pavement sections recommended for roads are summarized in Exhibit 3. The pavement design calculations are presented in Appendix C.

**Exhibit 3: Recommended Pavement Sections**

| Pavement Area        | Roadway Designation  | Design ESAL | Alternative <sup>1</sup>               |
|----------------------|----------------------|-------------|--|
| Vollmer Road (North) | Urban Minor Arterial | 1,971,000   | 1. 5.0 inches HMA over 8.0 inches ABC  |
|                      |                      |             | 2. 5.0 inches HMA over 10.0 inches CTS |

ABC = Aggregate Base Course; CTS = cement-treated subgrade; ESAL = equivalent single axle loads; HMA = Hot Mix Asphalt

Notes:

1. All pavement alternatives meet the minimum sections required per *El Paso County Pavement Design Criteria, Table D-2, Minimum Pavement Sections.*

**6 Construction Recommendations**

Pavement design recommendations provided herein are contingent on good construction practices, and poor construction techniques may result in poor performance. Our analyses assumed that this project will be constructed according to the *El Paso County Engineering Criteria Manual* and the *Pikes Peak Region Asphalt Paving Specifications*.

**6.1 Earthwork Recommendations for Pavement Subgrade**

Proper subgrade preparation is required for adequate pavement performance. Paving areas should be cleared of all deleterious materials including but not limited to existing pavements, utility poles, and fence poles. Surface vegetation, if any, should be removed by stripping, with the depth to be field determined.

### **6.1.1 Overexcavation**

Where encountered, cohesive soils (AASHTO A-6, TB-11) should be removed to a depth 18 inches and replaced with granular fill (Section 6.1.4) to provide uniform subgrade support. The extent of any cohesive material overexcavation should be field determined.

### **6.1.2 Subgrade Preparation – Aggregate Base Course Alternatives**

If pavement section alternatives are selected utilizing aggregate base course (ABC), the final subgrade surface should be scarified to a depth of 12 inches, moisture conditioned within +/-2% over the optimum water content, and recompacted to 95% of its maximum Modified Proctor dry density, ASTM D1557.

Any A-6 material identified during scarification should be removed to a depth of 18 inches and be replaced with granular fill as discussed in Section 6.1.1.

The compacted surface below pavements should be proof-rolled with a fully loaded, tandem-axle, 10-yard dump truck or equivalent. Any areas that are delineated to be soft, loose, or yielding during proof-rolling should be removed and reconditioned or replaced.

### **6.1.3 Cement-treated Subgrade**

For pavement section alternatives utilizing cement-treated subgrade (CTS), the subgrade shall be stabilized prior to placement of the asphalt by the addition of cement to a depth of 10 inches. The amount of cement applied shall be a minimum of 4% (by weight) of the subgrade's maximum dry density as determined by the Modified Proctor Test (ASTM D1557) for granular soils or by the Standard Proctor Test (ASTM D698) for cohesive soils. The cement should be spread evenly on the subgrade surface and be thoroughly mixed into the subgrade over a 10-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 10 inches of subgrade should be thoroughly moisture conditioned to the soil's optimum water content or as much as 2% 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% of the subgrade maximum dry density as determined by the Modified Proctor Test (ASTM D1557) or by the Standard Proctor Test (ASTM D698). 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 or Type 1L 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 degrees F. Cement-treated subgrades should be maintained at a temperature of 40 degrees 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 qualified geotechnical engineer. The geotechnical 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, microfracturing of the stabilized subgrade may be required. Soil strengths in excess of 275 psi require microfracturing.

#### **6.1.4 Fill Placement and Compaction**

Granular fill placed as part of the pavement subgrade shall consist of non-expansive, granular soil, free of organic matter, unsuitable materials, debris, and cobbles greater than 3 inches in diameter. Additionally, any granular fill placed as part of the roadway subgrade should have a minimum CBR of 10. All granular fill placed within the pavement subgrade should be compacted to a minimum of 95% of its maximum Modified Proctor Dry Density (ASTM D1557) at +/-2% of optimum moisture content. Fill material should be placed in horizontal lifts such that each finished lift has a compacted thickness of 6 inches or less. Entech should approve any imported fill to be used within the pavement subgrade area prior to delivery to the site.

#### **6.2 Aggregate Base Course**

ABC materials shall conform to the *El Paso County Standard Specifications Manual, Table D-6, Aggregate Base Course Materials*. ABC materials should be compacted to a minimum of 95% of its maximum Modified Proctor Dry Density (ASTM D1557) at +/-2% of optimum moisture content

#### **6.3 Concrete Degradation Due to Sulfate Attack**

Sulfate solubility testing was conducted on several samples recovered from the test borings to evaluate the potential for sulfate attack on concrete. The test results indicated less than 0.01%

soluble sulfate (by weight). The test results indicate the sulfate component of the in-place soils presents a negligible exposure threat to concrete placed below the site grade.

Type II or Type 1L cement is recommended for concrete on the site. To further avoid concrete degradation during construction, it is recommended that concrete not be placed on frozen or wet ground. Care should be taken to prevent the accumulation or ponding of water in the foundation excavation prior to the placement of concrete. If standing water is present in the foundation excavation, it should be removed by ditching to sumps and pumping the water away from the foundation area prior to concrete placement. If concrete is placed during periods of cold temperatures, the concrete must be kept from freezing. This may require covering the concrete with insulated blankets and adding heat to prohibit freezing.

#### **6.4 Construction Observation**

Subgrade preparation for pavement structures should be observed by Entech in order to verify that (1) no anomalies are present, (2) materials similar to those described in this report have been encountered or placed, and (3) no soft spots, expansive or organic soil, or debris are present in the pavement subgrade prior to paving.

### **7 Closure**

The subsurface investigation, geotechnical evaluation, and recommendations presented in this report are intended for use by Classic Communities with application to the Vollmer Road North paving project in El Paso County, Colorado. In conducting the subsurface exploration program, laboratory testing, engineering evaluation, and reporting, Entech Engineering, Inc. endeavored to work in accordance with generally accepted professional geotechnical and geologic practices and principles consistent with the level of care and skill ordinarily exercised by members of the geotechnical profession currently practicing in the same locality and under similar conditions. No other warranty, expressed or implied, is made. During final design and/or construction, if conditions are encountered that appear different from those described in this report, Entech Engineering, Inc. requests to be notified so that the evaluation and recommendations presented herein can be reviewed and modified as appropriate.

If there are any questions regarding the information provided herein, or if Entech Engineering, Inc. can be of further assistance, please do not hesitate to contact us.



**VICINITY MAP**  
VOLLMER ROAD NORTH  
CLASSIC COMMUNITIES

JOB NO.  
231519

**FIG. 1**

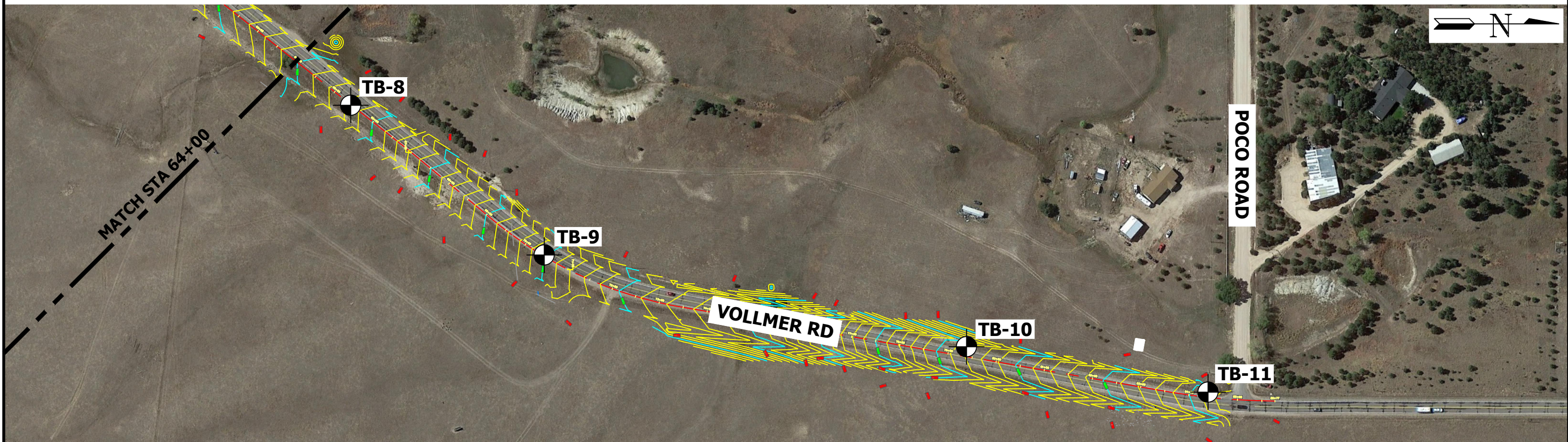
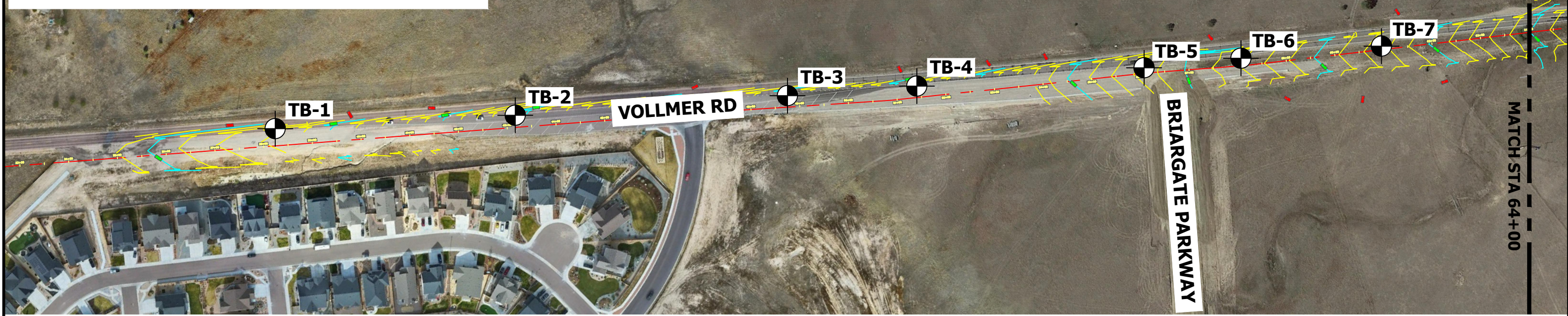
**VOLLMER ROAD**

URBAN (MINOR ARTERIAL) ROADWAY CLASSIFICATION

DESIGN 18-KIP ESAL=1,971,000

SOIL TYPE 1 (AASHTO A-2-4)

PAVEMENT SECTION: 5" HMA OVER 8" ABC



 TB- APPROXIMATE TEST BORING LOCATION AND NUMBER



**SITE AND EXPLORATION PLAN**

VOLLMER ROAD NORTH  
CLASSIC COMMUNITIES

JOB NO.  
231519

**FIG. 2**



## **APPENDIX A: Test Boring Logs**

TEST BORING 1  
DATE DRILLED 11/1/2023

TEST BORING 2  
DATE DRILLED 11/1/2023

REMARKS

REMARKS

DRY TO 10', 11/1/23

DRY TO 5', 11/1/23

3" ASPHALT, 2" BASE COURSE  
FILL 0-6', SAND, WITH SILT,  
BROWN, MEDIUM DENSE, MOIST

3" ASPHALT, 2" BASE COURSE  
FILL 0-5', SAND, WITH SILT TO  
SILTY, BROWN, MEDIUM DENSE  
to LOOSE, MOIST

SANDSTONE, VERY WEAK, TAN,  
MODERATELY WEATHERED  
(SAND, WITH SILT, VERY DENSE,  
MOIST)

| Depth (ft) | Symbol   | Samples | Blows per foot | Watercontent % | Soil Type |
|------------|----------|---------|----------------|----------------|-----------|
| 0-6'       | [Symbol] |         | 21             | 4.3            | 1         |
| 6-11'      | [Symbol] |         | 11             | 5.9            | 1         |
| 11-16.6'   | [Symbol] |         | 50<br>6"       | 6.8            | 3         |

| Depth (ft) | Symbol   | Samples | Blows per foot | Watercontent % | Soil Type |
|------------|----------|---------|----------------|----------------|-----------|
| 0-5'       | [Symbol] |         | 15             | 6.0            | 1         |
| 5-8'       | [Symbol] |         | 8              | 7.8            | 1         |



**TEST BORING LOGS**

VOLLMER ROAD NORTH  
CLASSIC COMMUNITIES

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**FIG. A-1**

TEST BORING 3  
 DATE DRILLED 11/1/2023

TEST BORING 4  
 DATE DRILLED 11/1/2023

REMARKS

REMARKS

DRY TO 5', 11/1/23

5" ASPHALT, 1" BASE COURSE  
 FILL 0-5', SAND, SILTY, BROWN,  
 DENSE to LOOSE, MOIST

| Depth (ft) | Symbol   | Samples | Blows per foot | Watercontent % | Soil Type |
|------------|----------|---------|----------------|----------------|-----------|
| 0-5        | [Symbol] |         | 31             | 8.6            | 1         |
| 5          | [Symbol] |         | 7              | 8.0            | 1         |
| 10         | [Symbol] |         |                |                |           |
| 15         | [Symbol] |         |                |                |           |
| 20         | [Symbol] |         |                |                |           |

DRY TO 10', 11/1/23

5" ASPHALT, 2" BASE COURSE  
 FILL 0-4', SAND, SILTY, BROWN,  
 MEDIUM DENSE, MOIST  
  
 SAND, SILTY, GRAY, MEDIUM  
 DENSE, MOIST  
 SANDSTONE, EXTREMELY WEAK,  
 TAN, MODERATELY WEATHERED  
 (SAND, WITH SILT, VERY DENSE,  
 MOIST)

| Depth (ft) | Symbol   | Samples | Blows per foot | Watercontent % | Soil Type |
|------------|----------|---------|----------------|----------------|-----------|
| 0-4        | [Symbol] |         | 25             | 9.4            | 1         |
| 4-5        | [Symbol] |         | 10             | 10.8           | 2         |
| 5-10       | [Symbol] |         | 50<br>8"       | 11.7           | 3         |
| 10         | [Symbol] |         |                |                |           |
| 15         | [Symbol] |         |                |                |           |
| 20         | [Symbol] |         |                |                |           |



**TEST BORING LOGS**

VOLLMER ROAD NORTH  
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**FIG. A-2**

TEST BORING 5  
 DATE DRILLED 11/1/2023

TEST BORING 6  
 DATE DRILLED 11/1/2023

REMARKS

REMARKS

DRY TO 5', 11/1/23

7" ASPHALT, 1" BASE COURSE

FILL 0-5', SAND, SILTY TO CLAYEY,  
 BROWN, DENSE to MEDIUM  
 DENSE, MOIST

| Depth (ft) | Symbol   | Samples | Blows per foot | Watercontent % | Soil Type |
|------------|----------|---------|----------------|----------------|-----------|
| 0-5        | [Symbol] |         | 36             | 7.6            | 1         |
| 5          | [Symbol] |         | 16             | 11.4           | 1         |
| 10         |          |         |                |                |           |
| 15         |          |         |                |                |           |
| 20         |          |         |                |                |           |

DRY TO 5', 11/1/23

6" ASPHALT, 1" ROAD BASE

FILL 0-4', SAND, SILTY, BROWN,  
 MEDIUM DENSE, MOIST

SANDSTONE, EXTREMELY WEAK,  
 TAN, HIGHLY WEATHERED (SAND,  
 SILTY, VERY DENSE, MOIST)

| Depth (ft) | Symbol   | Samples | Blows per foot | Watercontent % | Soil Type |
|------------|----------|---------|----------------|----------------|-----------|
| 0-4        | [Symbol] |         | 23             | 12.4           | 1         |
| 4-5        | [Symbol] |         | 50<br>11"      | 11.1           | 3         |
| 5          |          |         |                |                |           |
| 10         |          |         |                |                |           |
| 15         |          |         |                |                |           |
| 20         |          |         |                |                |           |



**TEST BORING LOGS**

VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

JOB NO.  
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**FIG. A-3**



TEST BORING 7  
 DATE DRILLED 11/1/2023

TEST BORING 8  
 DATE DRILLED 11/1/2023

REMARKS

REMARKS

DRY TO 10', 11/1/23

6" ASPHALT, 3" BASE COURSE  
 FILL 0-6', SAND, WITH SILT TO  
 CLAY, MEDIUM DENSE, MOIST

SANDSTONE, VERY WEAK, TAN,  
 MODERATELY WEATHERED  
 (SAND, WITH SILT, VERY DENSE,

| Depth (ft) | Symbol   | Samples | Blows per foot | Watercontent % | Soil Type |
|------------|----------|---------|----------------|----------------|-----------|
| 0-6'       | [Symbol] |         | 19             | 6.0            | 1         |
| 5'         | [Symbol] |         | 15             | 11.5           | 1         |
| 10'        | [Symbol] |         | 50<br>7"       | 13.1           | 3         |

DRY TO 5', 11/1/23

6" ASPHALT, 3" BASE COURSE  
 FILL 0-5', SAND, WITH SILT,  
 BROWN, MEDIUM DENSE, MOIST

| Depth (ft) | Symbol   | Samples | Blows per foot | Watercontent % | Soil Type |
|------------|----------|---------|----------------|----------------|-----------|
| 0-5'       | [Symbol] |         | 23             | 5.2            | 1         |
| 5'         | [Symbol] |         | 18             | 4.3            | 1         |



**TEST BORING LOGS**

VOLLMER ROAD NORTH  
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**FIG. A-4**

TEST BORING 9  
DATE DRILLED 11/1/2023

TEST BORING 10  
DATE DRILLED 11/1/2023

REMARKS

REMARKS

DRY TO 5', 11/1/23

6" ASPHALT, 3" BASE COURSE  
FILL 0-4', SAND, SILTY, BROWN,  
MEDIUM DENSE, MOIST

SAND, SILTY, TAN, MEDIUM  
DENSE, MOIST

| Depth (ft) | Symbol   | Samples | Blows per foot | Watercontent % | Soil Type |
|------------|----------|---------|----------------|----------------|-----------|
| 0-4        | [Symbol] |         | 11             | 12.8           | 1         |
| 4-5        | [Symbol] |         | 27             | 7.9            | 2         |
| 5-10       | [Symbol] |         |                |                |           |
| 10-15      | [Symbol] |         |                |                |           |
| 15-20      | [Symbol] |         |                |                |           |

DRY TO 10', 11/1/23

6" ASPHALT, 3" BASE COURSE  
FILL 0-4', SAND, CLAYEY, BROWN,  
MEDIUM DENSE, MOIST

SAND, WITH SILT, TAN, DENSE,  
MOIST  
SANDSTONE, VERY WEAK, TAN,  
MODERATELY WEATHERED  
(SAND, WITH SILT, VERY DENSE,

| Depth (ft) | Symbol   | Samples | Blows per foot | Watercontent % | Soil Type |
|------------|----------|---------|----------------|----------------|-----------|
| 0-4        | [Symbol] |         | 13             | 10.2           | 1         |
| 4-5        | [Symbol] |         | 44             | 6.4            | 2         |
| 5-10       | [Symbol] |         |                |                |           |
| 10-15      | [Symbol] |         | 50<br>7"       | 9.8            | 3         |
| 15-20      | [Symbol] |         |                |                |           |



**TEST BORING LOGS**

VOLLMER ROAD NORTH  
CLASSIC COMMUNITIES

JOB NO.  
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**FIG. A-5**

TEST BORING 11  
 DATE DRILLED 11/1/2023

REMARKS

DRY TO 5', 11/1/23

6" ASPHALT, 3" BASE COURSE  
 FILL 0-5', SAND, CLAYEY, BROWN,  
 MEDIUM, MOIST

| Depth (ft) | Symbol            | Samples | Blows per foot | Watercontent % | Soil Type |
|------------|-------------------|---------|----------------|----------------|-----------|
| 0-6        | Asphalt/Aggregate |         | 11             | 7.3            | 1         |
| 6-5        | Sand/Clayey       |         | 20             | 6.3            | 1         |
| 5-20       | Soil Profile      |         |                |                |           |



TEST BORING LOGS

VOLLMER ROAD NORTH  
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FIG. A-6



## **APPENDIX B: Laboratory Test Results**

**TABLE B-1  
SUMMARY OF LABORATORY TEST RESULTS**

| SOIL TYPE | TEST BORING NO. | DEPTH (FT) | PASSING NO. 200 SIEVE (%) | MOISTURE (%) | LIQUID LIMIT | PLASTIC LIMIT | PLASTIC INDEX | SULFATE (WT %) | AASHTO CLASS. | USCS  | SOIL DESCRIPTION            |
|-----------|-----------------|------------|---------------------------|--------------|--------------|---------------|---------------|----------------|---------------|-------|-----------------------------|
| 1, CBR    | 7               | 0-3        | 27.5                      | 8.7          | 26           | 16            | 10            |                | A-2-4         | SC    | FILL, SAND, CLAYEY          |
| 1         | 1               | 1-2        | 10.7                      | 4.4          | NV           | NP            | NP            |                | A-1-b         | SM    | FILL, SAND, WITH SILT       |
| 1         | 2               | 1-2        | 11.6                      | 6.2          | NV           | NP            | NP            |                | A-1-b         | SM    | FILL, SAND, WITH SILT       |
| 1         | 3               | 1-2        | 29.3                      | 9.7          | NV           | NP            | NP            | <0.01          | A-2-4         | SM    | FILL, SAND, SILTY           |
| 1         | 4               | 1-2        | 30.4                      | 11.3         | NV           | NP            | NP            |                | A-2-4         | SM    | FILL, SAND, SILTY           |
| 1         | 5               | 1-2        | 14.0                      | 7.7          | NV           | NP            | NP            |                | A-1-b         | SM    | FILL, SAND, SILTY           |
| 1         | 6               | 1-2        | 30.2                      | 15.2         | NV           | NP            | NP            | <0.01          | A-2-4         | SM    | FILL, SAND, SILTY           |
| 1         | 7               | 1-2        | 9.3                       | 6.8          |              |               |               |                | A-2-6         | SC    | FILL, SAND, WITH CLAY       |
| 1         | 8               | 1-2        | 11.7                      | 5.1          | NV           | NP            | NP            |                | A-1-b         | SW-SM | FILL, SAND, WITH SILT       |
| 1         | 9               | 1-2        | 29.9                      | 13.0         | NV           | NP            | NP            |                | A-2-4         | SM    | FILL, SAND, SILTY           |
| 1         | 10              | 1-2        | 31.9                      | 11.6         | 29           | 21            | 8             | <0.01          | A-2-4         | SC    | FILL, SAND, CLAYEY          |
| 1         | 11              | 1-2        | 36.7                      | 15.5         | 35           | 21            | 14            |                | A-6           | SC    | FILL, SAND, CLAYEY          |
| 1         | 1               | 0-3        | 24.5                      | 6.8          |              |               |               |                | A-2-4         | SM    | FILL, SAND, SILTY           |
| 2         | 9               | 5          | 29.2                      | 10.0         | NV           | NP            | NP            |                | A-2-4         | SM    | SAND, SILTY                 |
| 2         | 10              | 5          | 9.3                       | 6.8          | NV           | NP            | NP            |                | A-1-b         | SW-SM | SAND, WITH SILT             |
| 3         | 1               | 10         | 10.3                      | 8.1          | NV           | NP            | NP            | <0.01          | A-1-b         | SW-SM | SANDSTONE (SAND, WITH SILT) |
| 3         | 4               | 10         | 10.0                      | 14.3         | NV           | NP            | NP            |                | A-1-b         | SW-SM | SANDSTONE (SAND, WITH SILT) |
| 3         | 6               | 5          | 12.3                      | 12.8         | NV           | NP            | NP            | <0.01          | A-1-b         | SM    | SANDSTONE (SAND, SILTY)     |
| 3         | 7               | 10         | 9.5                       | 12.6         | NV           | NP            | NP            | <0.01          | A-1-b         | SW-SM | SANDSTONE (SAND, WITH SILT) |
| 3         | 10              | 10         | 9.7                       | 10.2         | NV           | NP            | NP            | <0.01          | A-1-b         | SW-SM | SANDSTONE (SAND, WITH SILT) |

**TABLE B-2  
SUMMARY OF CTS TEST RESULTS**

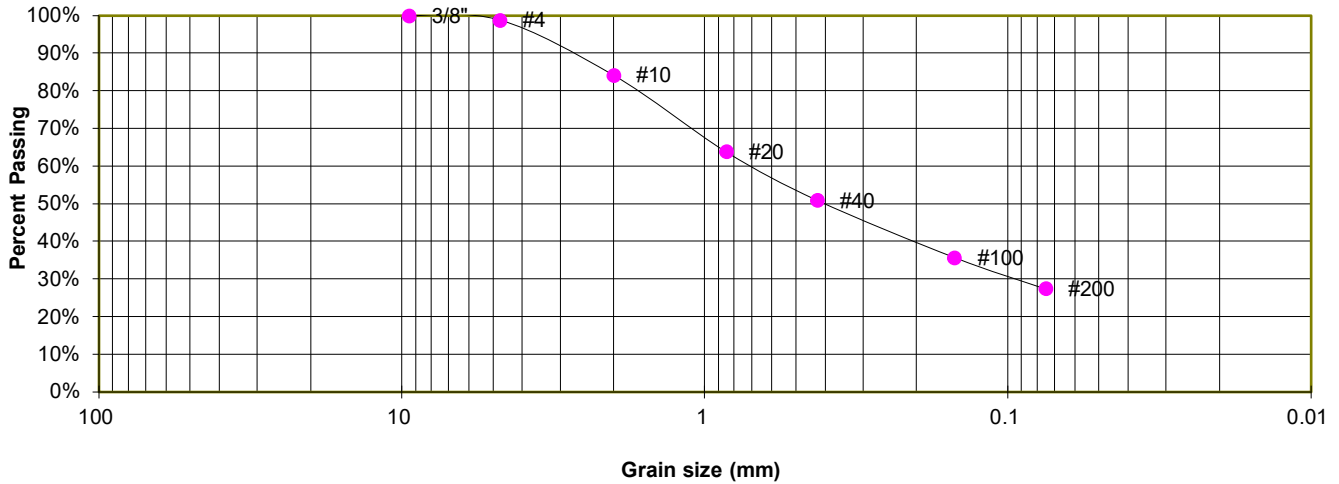
|                 |                             |
|-----------------|-----------------------------|
| FIELD SAMPLE ID | <u>SAND, SILTY</u>          |
| SOIL ADDITIVE   | <u>TYPE I/II CEMENT</u>     |
| CURING METHOD   | <u>100° HUMIDIFIED OVEN</u> |

| <b>ADDITIVE<br/>%</b> | <b>WATER<br/>%</b> | <b>DENSITY<br/>(dry)</b> | <b>AGE<br/>(days)</b> | <b>STRENGTH<br/>(psi)</b> |
|-----------------------|--------------------|--------------------------|-----------------------|---------------------------|
| 2                     | 7.0                | 122.9                    | 5                     | 197                       |
| 2                     | 7.0                | 122.7                    | 5                     | 207                       |
| 2                     | 7.0                | 122.6                    | 5                     | 214                       |
| AVERAGE:              |                    |                          |                       | <b>206</b>                |
| 4                     | 7.0                | 122.8                    | 5                     | 231                       |
| 4                     | 7.0                | 122.5                    | 5                     | 226                       |
| 4                     | 7.0                | 122.6                    | 5                     | 242                       |
| AVERAGE:              |                    |                          |                       | <b>233</b>                |

TEST BORING 7  
 DEPTH (FT) 0-3

SOIL DESCRIPTION FILL, SAND, CLAYEY  
 SOIL TYPE 1, CBR

**Sieve Analysis  
 Grain Size Distribution**



**GRAIN SIZE ANALYSIS**

| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3"           |               |
| 1 1/2"       |               |
| 3/4"         |               |
| 1/2"         |               |
| 3/8"         | 100.0%        |
| 4            | 98.8%         |
| 10           | 84.2%         |
| 20           | 63.8%         |
| 40           | 50.9%         |
| 100          | 35.7%         |
| 200          | 27.5%         |

**ATTERBERG LIMITS**

|               |    |
|---------------|----|
| Plastic Limit | 16 |
| Liquid Limit  | 26 |
| Plastic Index | 10 |

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SC  
 AASHTO CLASSIFICATION: A-2-4  
 AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**

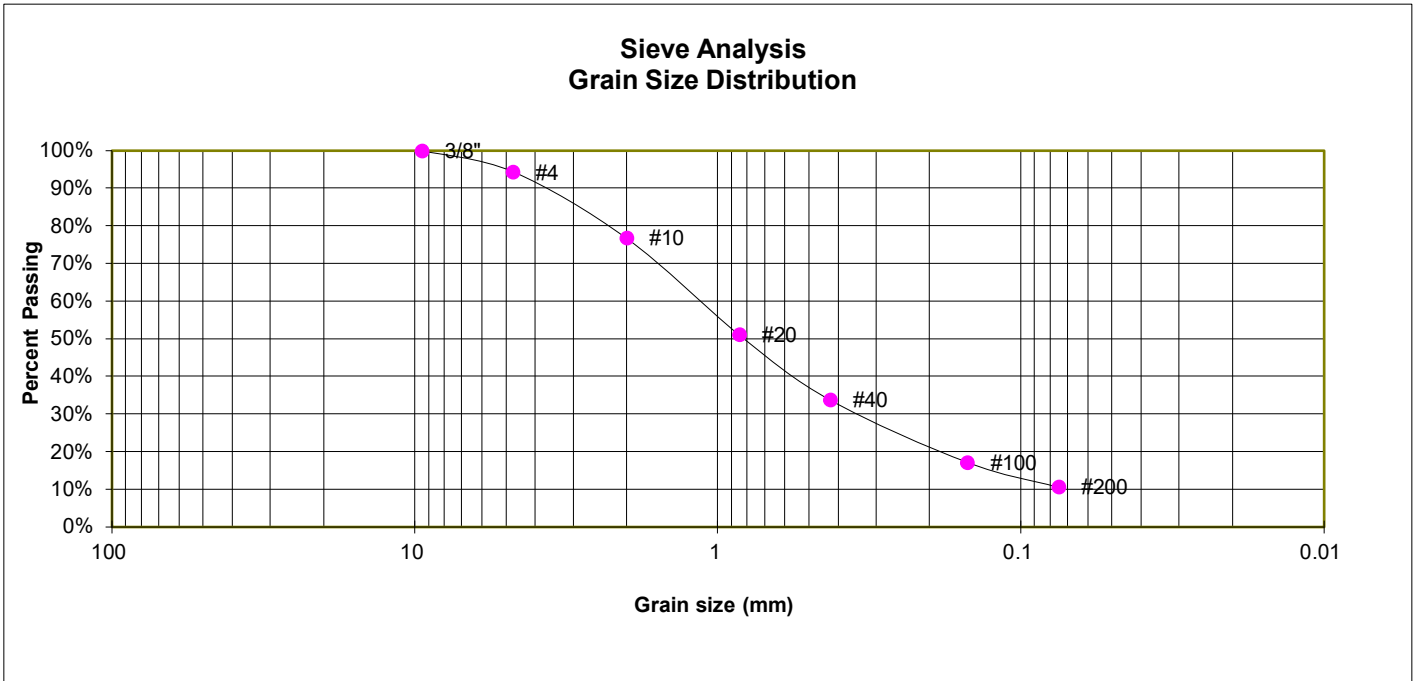
VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

JOB NO.  
 231519

**FIG. B-1**

TEST BORING 1  
 DEPTH (FT) 1-2

SOIL DESCRIPTION FILL, SAND, WITH SILT  
 SOIL TYPE 1



**GRAIN SIZE ANALYSIS**

| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3"           |               |
| 1 1/2"       |               |
| 3/4"         |               |
| 1/2"         |               |
| 3/8"         | 100.0%        |
| 4            | 94.4%         |
| 10           | 76.7%         |
| 20           | 51.1%         |
| 40           | 33.7%         |
| 100          | 17.2%         |
| 200          | 10.7%         |

**ATTERBERG LIMITS**

|               |    |
|---------------|----|
| Plastic Limit | NP |
| Liquid Limit  | NV |
| Plastic Index | NP |

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SM  
 AASHTO CLASSIFICATION: A-1-b  
 AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**

VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

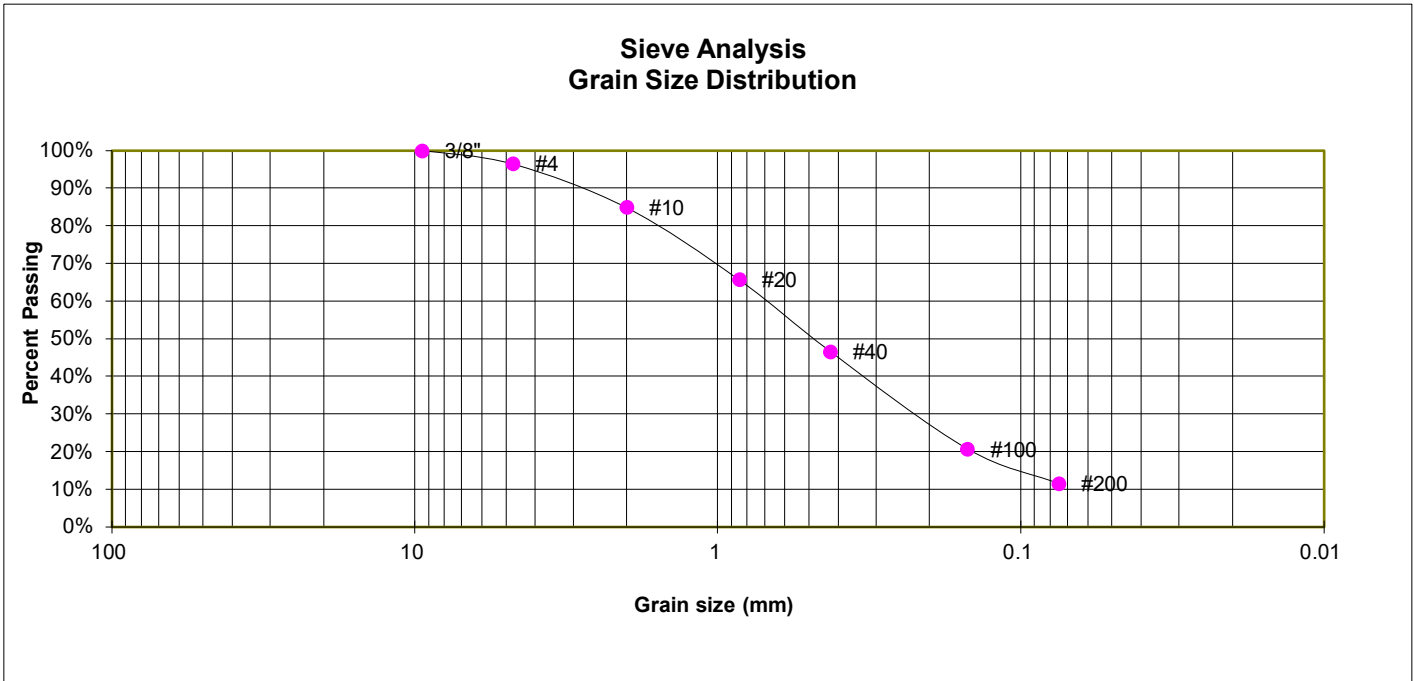
JOB NO.  
 231519

**FIG. B-2**



TEST BORING 2  
 DEPTH (FT) 1-2

SOIL DESCRIPTION FILL, SAND, WITH SILT  
 SOIL TYPE 1



**GRAIN SIZE ANALYSIS**

| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3"           |               |
| 1 1/2"       |               |
| 3/4"         |               |
| 1/2"         |               |
| 3/8"         | 100.0%        |
| 4            | 96.5%         |
| 10           | 84.9%         |
| 20           | 65.7%         |
| 40           | 46.5%         |
| 100          | 20.7%         |
| 200          | 11.6%         |

**ATTERBERG LIMITS**

|               |    |
|---------------|----|
| Plastic Limit | NP |
| Liquid Limit  | NV |
| Plastic Index | NP |

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SM  
 AASHTO CLASSIFICATION: A-1-b  
 AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**

VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

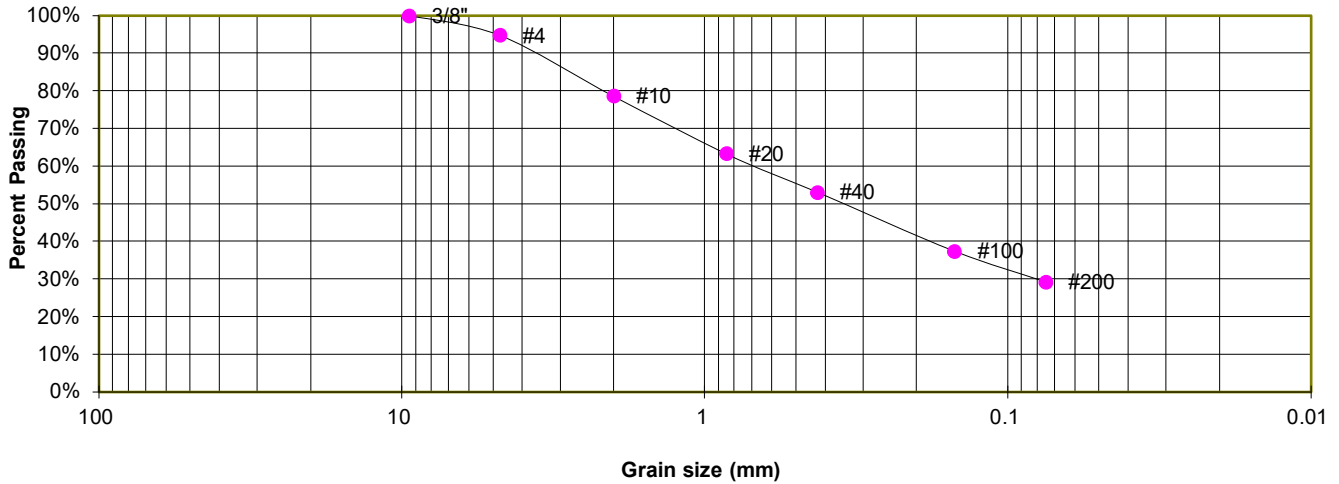
JOB NO.  
 231519

**FIG. B-3**

TEST BORING 3  
 DEPTH (FT) 1-2

SOIL DESCRIPTION FILL, SAND, SILTY  
 SOIL TYPE 1

**Sieve Analysis  
 Grain Size Distribution**



**GRAIN SIZE ANALYSIS**

| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3"           |               |
| 1 1/2"       |               |
| 3/4"         |               |
| 1/2"         |               |
| 3/8"         | 100.0%        |
| 4            | 94.8%         |
| 10           | 78.6%         |
| 20           | 63.4%         |
| 40           | 53.1%         |
| 100          | 37.4%         |
| 200          | 29.3%         |

**ATTERBERG LIMITS**

|               |    |
|---------------|----|
| Plastic Limit | NP |
| Liquid Limit  | NV |
| Plastic Index | NP |

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SM  
 AASHTO CLASSIFICATION: A-2-4  
 AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**

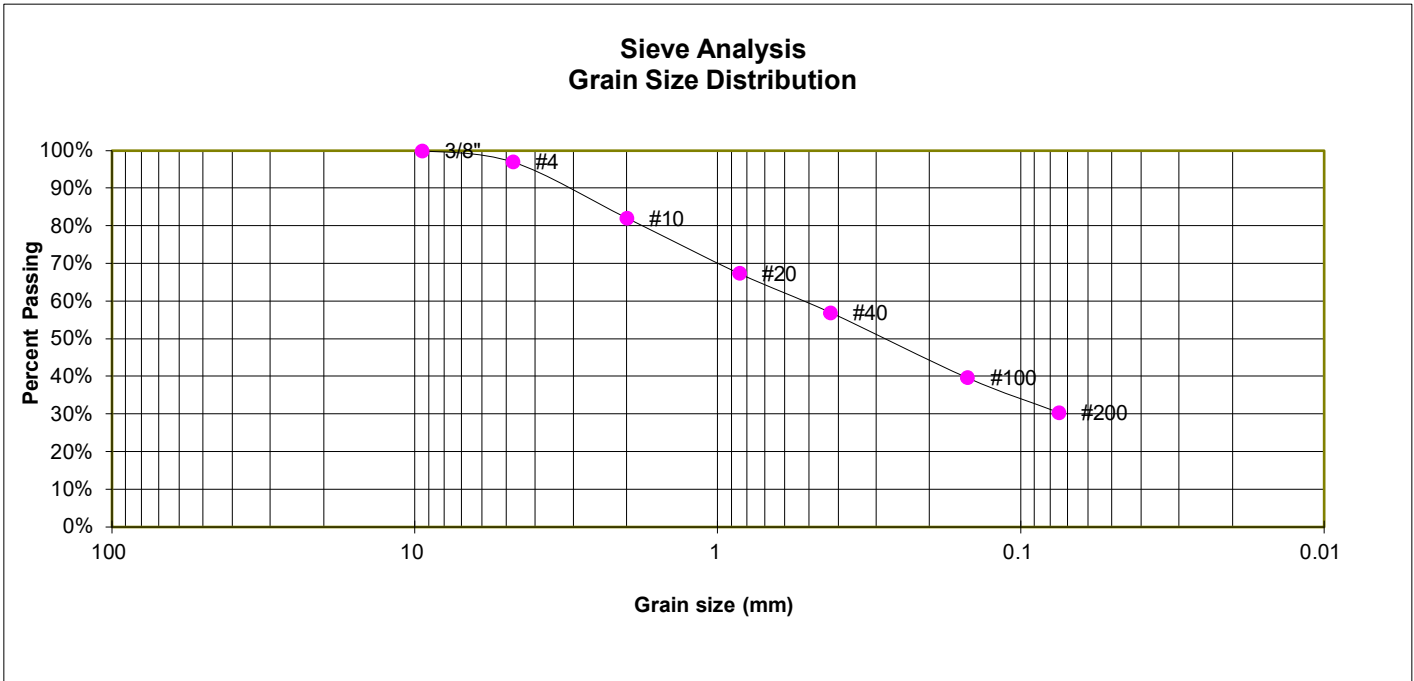
VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

JOB NO.  
 231519

**FIG. B-4**

TEST BORING 4  
 DEPTH (FT) 1-2

SOIL DESCRIPTION FILL, SAND, SILTY  
 SOIL TYPE 1



**GRAIN SIZE ANALYSIS**

| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3"           |               |
| 1 1/2"       |               |
| 3/4"         |               |
| 1/2"         |               |
| 3/8"         | 100.0%        |
| 4            | 97.0%         |
| 10           | 82.1%         |
| 20           | 67.4%         |
| 40           | 57.0%         |
| 100          | 39.7%         |
| 200          | 30.4%         |

**ATTERBERG LIMITS**

|               |    |
|---------------|----|
| Plastic Limit | NP |
| Liquid Limit  | NV |
| Plastic Index | NP |

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SM  
 AASHTO CLASSIFICATION: A-2-4  
 AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**

VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

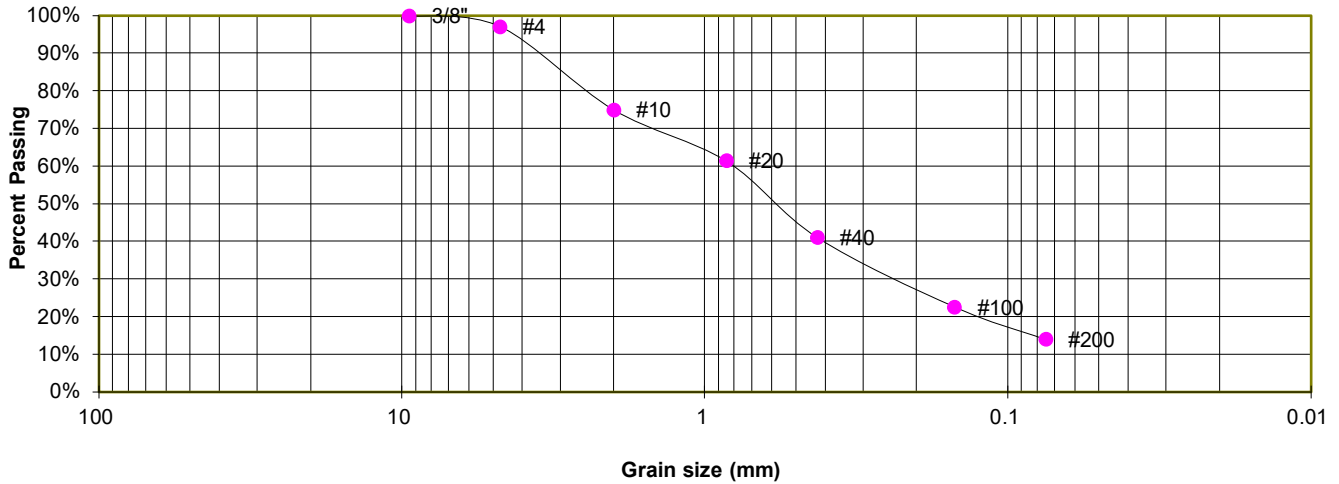
JOB NO.  
 231519

**FIG. B-5**

TEST BORING 5  
 DEPTH (FT) 1-2

SOIL DESCRIPTION FILL, SAND, SILTY  
 SOIL TYPE 1

**Sieve Analysis  
 Grain Size Distribution**



**GRAIN SIZE ANALYSIS**

| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3"           |               |
| 1 1/2"       |               |
| 3/4"         |               |
| 1/2"         |               |
| 3/8"         | 100.0%        |
| 4            | 97.1%         |
| 10           | 75.0%         |
| 20           | 61.4%         |
| 40           | 41.0%         |
| 100          | 22.6%         |
| 200          | 14.0%         |

**ATTERBERG LIMITS**

|               |    |
|---------------|----|
| Plastic Limit | NP |
| Liquid Limit  | NV |
| Plastic Index | NP |

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SM  
 AASHTO CLASSIFICATION: A-1-b  
 AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**

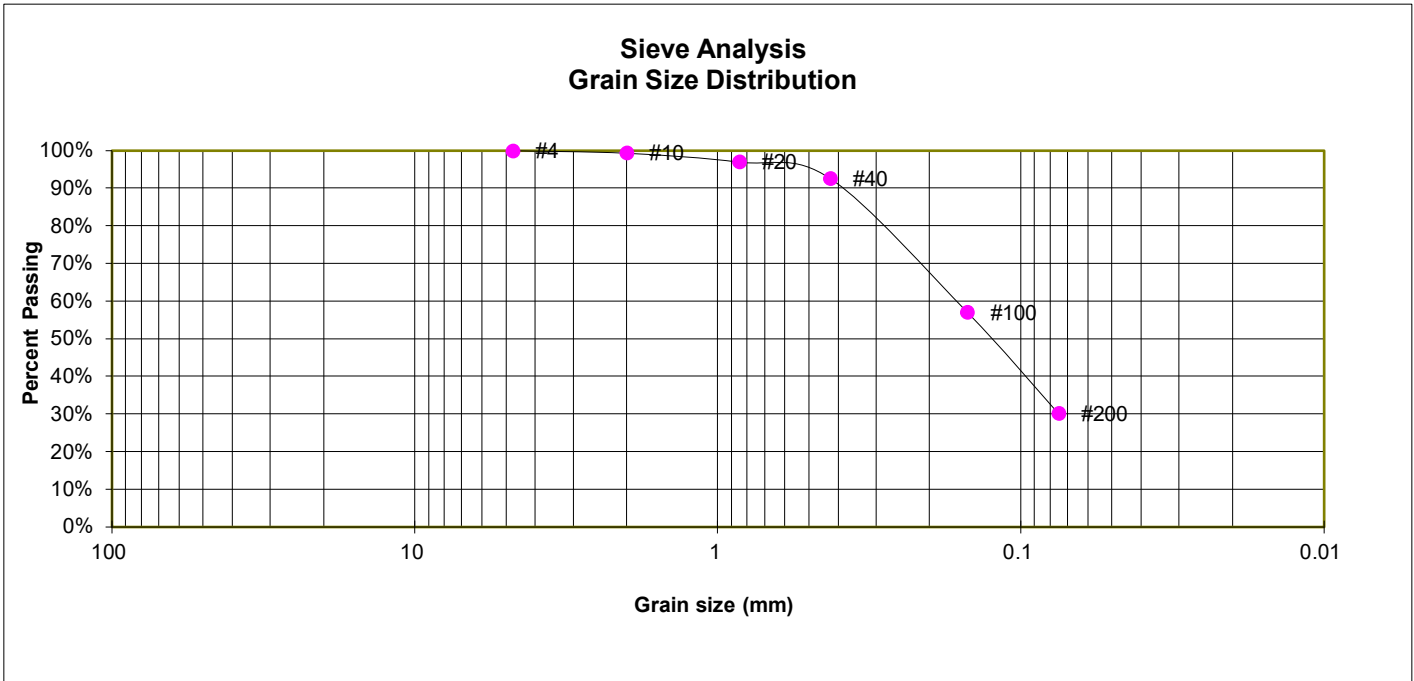
VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

JOB NO.  
 231519

**FIG. B-6**

TEST BORING 6  
 DEPTH (FT) 1-2

SOIL DESCRIPTION FILL, SAND, SILTY  
 SOIL TYPE 1



**GRAIN SIZE ANALYSIS**

| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3"           |               |
| 1 1/2"       |               |
| 3/4"         |               |
| 1/2"         |               |
| 3/8"         |               |
| 4            | 100.0%        |
| 10           | 99.3%         |
| 20           | 97.0%         |
| 40           | 92.6%         |
| 100          | 57.0%         |
| 200          | 30.2%         |

**ATTERBERG LIMITS**

|               |    |
|---------------|----|
| Plastic Limit | NP |
| Liquid Limit  | NV |
| Plastic Index | NP |

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SM  
 AASHTO CLASSIFICATION: A-2-4  
 AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**

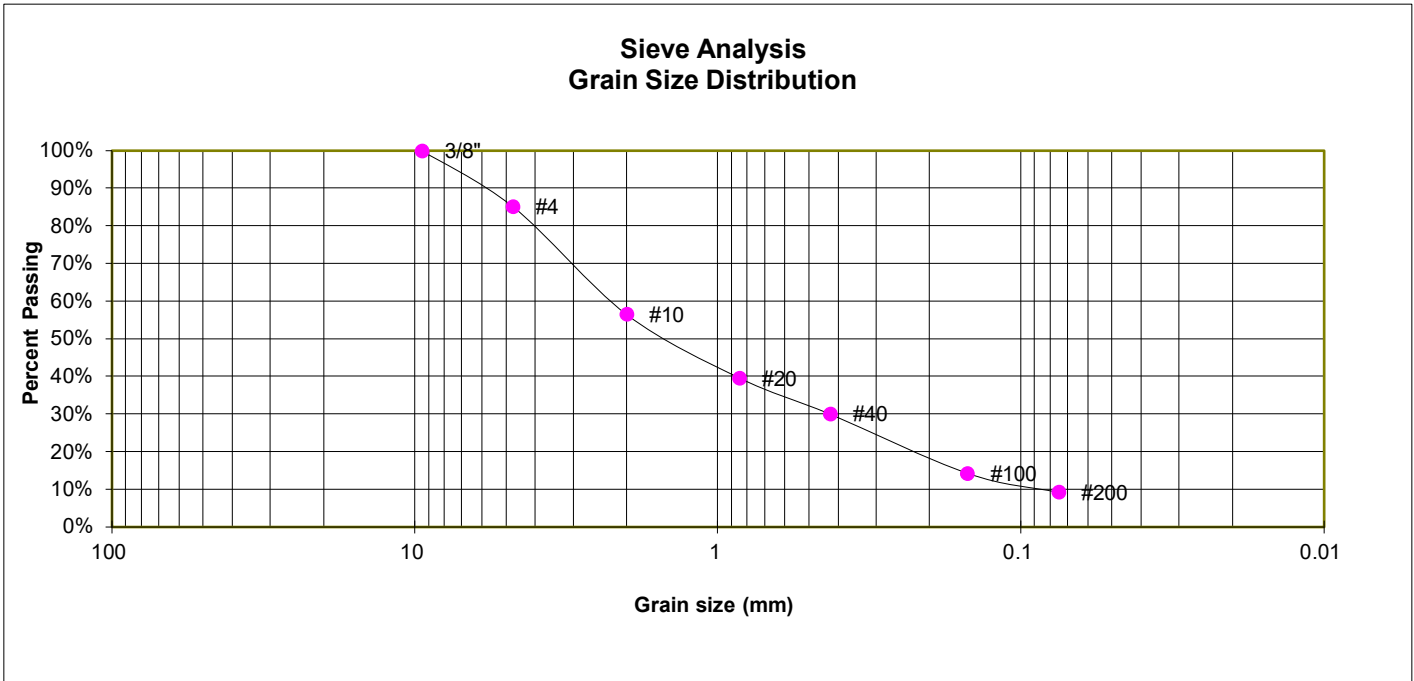
VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

JOB NO.  
 231519

**FIG. B-7**

TEST BORING 7  
 DEPTH (FT) 1-2

SOIL DESCRIPTION FILL, SAND, WITH CLAY  
 SOIL TYPE 1



**GRAIN SIZE ANALYSIS**

| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3"           |               |
| 1 1/2"       |               |
| 3/4"         |               |
| 1/2"         |               |
| 3/8"         | 100.0%        |
| 4            | 85.1%         |
| 10           | 56.5%         |
| 20           | 39.6%         |
| 40           | 30.0%         |
| 100          | 14.2%         |
| 200          | 9.3%          |

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SC  
 AASHTO CLASSIFICATION: A-2-6  
 AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**

VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

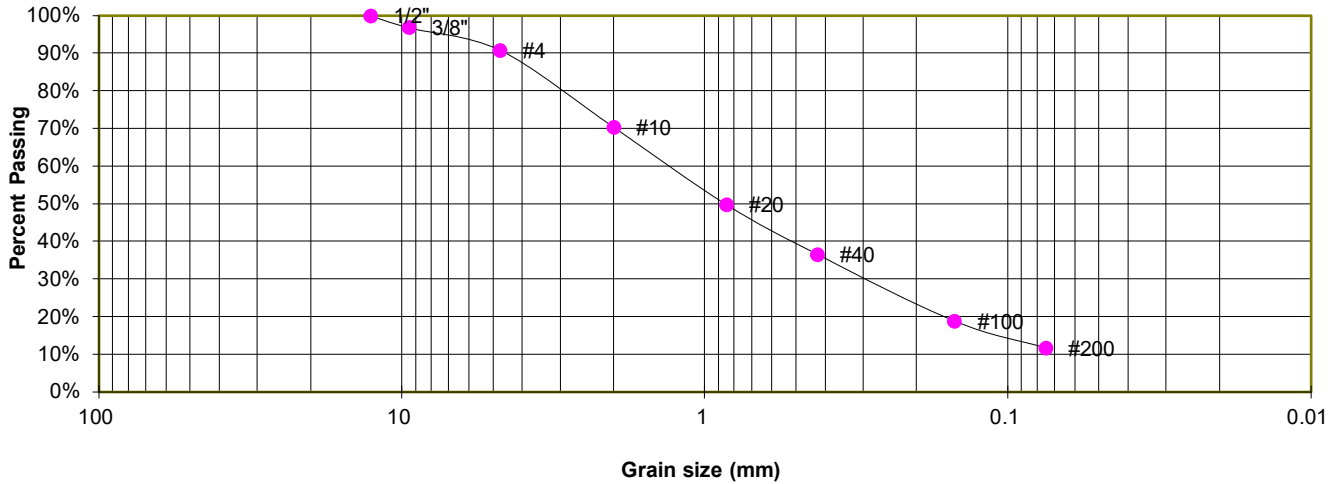
JOB NO.  
 231519

**FIG. B-8**

TEST BORING 8  
 DEPTH (FT) 1-2

SOIL DESCRIPTION FILL, SAND, WITH SILT  
 SOIL TYPE 1

**Sieve Analysis  
 Grain Size Distribution**



**GRAIN SIZE ANALYSIS**

| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3"           |               |
| 1 1/2"       |               |
| 3/4"         |               |
| 1/2"         | 100.0%        |
| 3/8"         | 96.8%         |
| 4            | 90.7%         |
| 10           | 70.4%         |
| 20           | 49.8%         |
| 40           | 36.6%         |
| 100          | 18.9%         |
| 200          | 11.7%         |

**ATTERBERG LIMITS**

|               |    |
|---------------|----|
| Plastic Limit | NP |
| Liquid Limit  | NV |
| Plastic Index | NP |

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SW-SM  
 AASHTO CLASSIFICATION: A-1-b  
 AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**

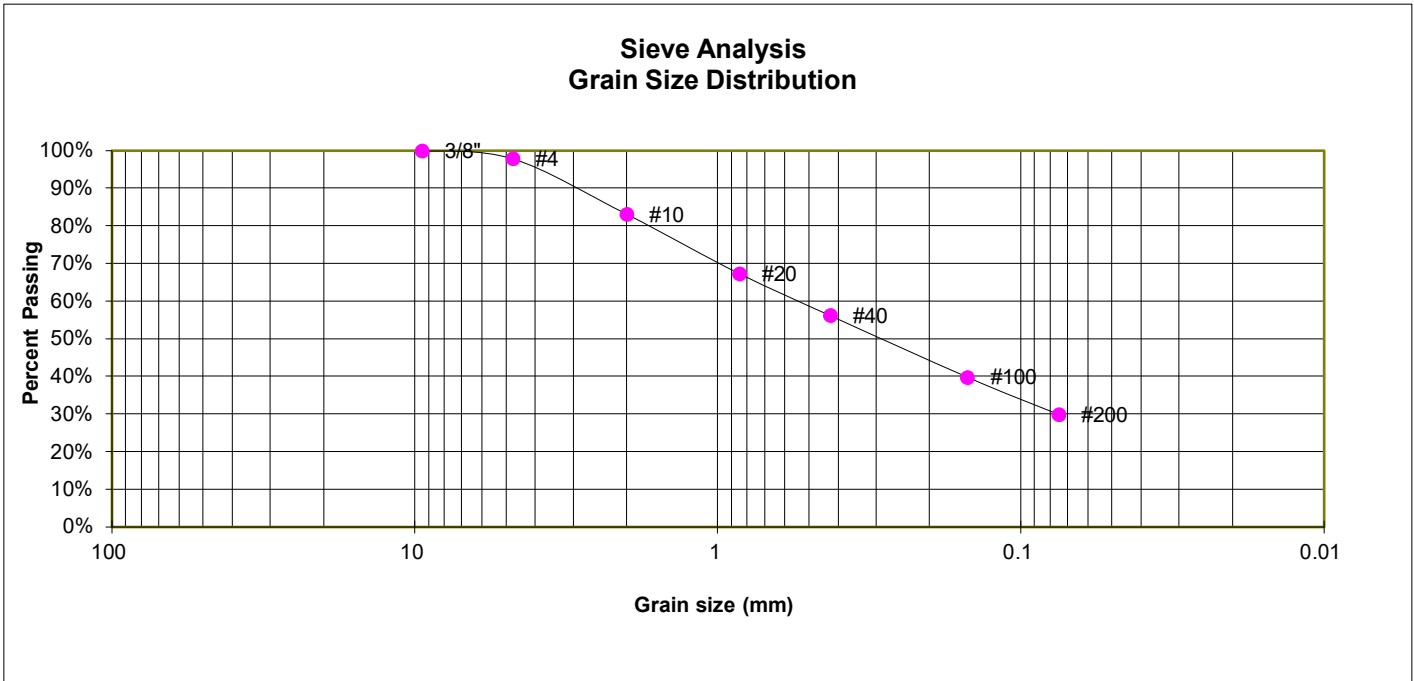
VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

JOB NO.  
 231519

**FIG. B-9**

TEST BORING 9  
 DEPTH (FT) 1-2

SOIL DESCRIPTION FILL, SAND, SILTY  
 SOIL TYPE 1



**GRAIN SIZE ANALYSIS**

| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3"           |               |
| 1 1/2"       |               |
| 3/4"         |               |
| 1/2"         |               |
| 3/8"         | 100.0%        |
| 4            | 97.9%         |
| 10           | 83.1%         |
| 20           | 67.4%         |
| 40           | 56.2%         |
| 100          | 39.8%         |
| 200          | 29.9%         |

**ATTERBERG LIMITS**

|               |    |
|---------------|----|
| Plastic Limit | NP |
| Liquid Limit  | NV |
| Plastic Index | NP |

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SM  
 AASHTO CLASSIFICATION: A-2-4  
 AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**

VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

JOB NO.  
 231519

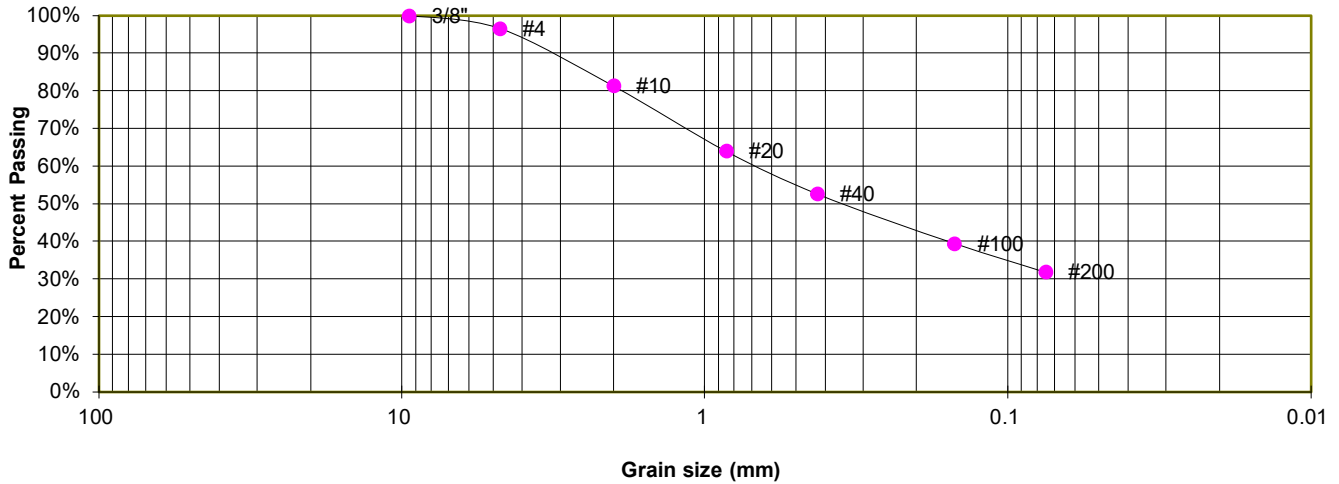
**FIG. B-10**



TEST BORING 10  
DEPTH (FT) 1-2

SOIL DESCRIPTION FILL, SAND, CLAYEY  
SOIL TYPE 1

**Sieve Analysis  
Grain Size Distribution**



**GRAIN SIZE ANALYSIS**

| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3"           |               |
| 1 1/2"       |               |
| 3/4"         |               |
| 1/2"         |               |
| 3/8"         | 100.0%        |
| 4            | 96.5%         |
| 10           | 81.4%         |
| 20           | 64.0%         |
| 40           | 52.7%         |
| 100          | 39.5%         |
| 200          | 31.9%         |

**ATTERBERG LIMITS**

|               |    |
|---------------|----|
| Plastic Limit | 21 |
| Liquid Limit  | 29 |
| Plastic Index | 8  |

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SC  
AASHTO CLASSIFICATION: A-2-4  
AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**

VOLLMER ROAD NORTH  
CLASSIC COMMUNITIES

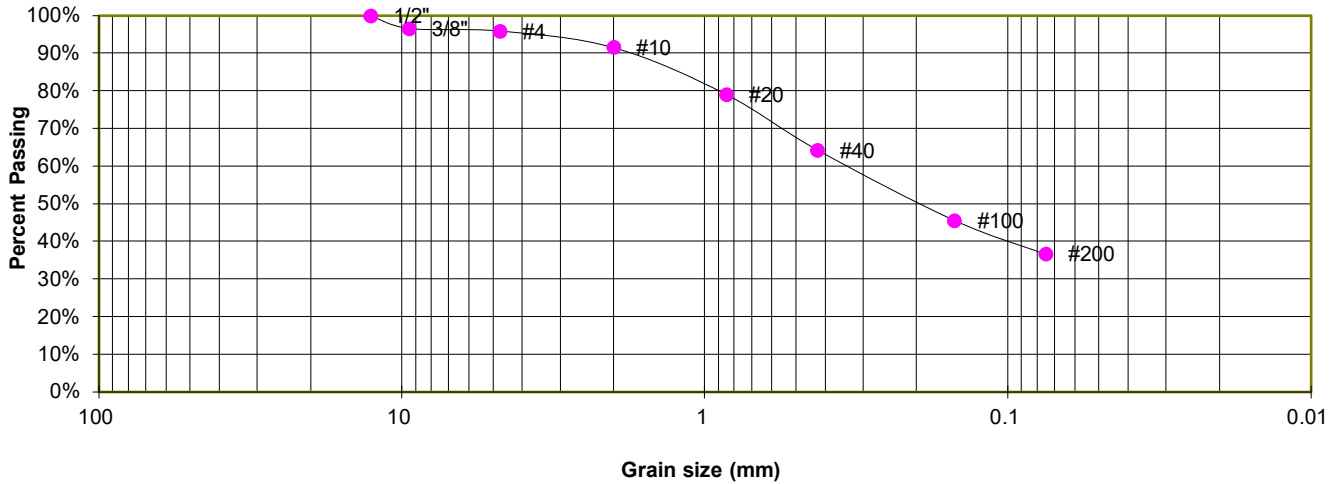
JOB NO.  
231519

**FIG. B-11**

TEST BORING 11  
 DEPTH (FT) 1-2

SOIL DESCRIPTION FILL, SAND, CLAYEY  
 SOIL TYPE 1

**Sieve Analysis  
 Grain Size Distribution**



**GRAIN SIZE ANALYSIS**

| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3"           |               |
| 1 1/2"       |               |
| 3/4"         |               |
| 1/2"         | 100.0%        |
| 3/8"         | 96.6%         |
| 4            | 95.9%         |
| 10           | 91.6%         |
| 20           | 79.1%         |
| 40           | 64.3%         |
| 100          | 45.6%         |
| 200          | 36.7%         |

**ATTERBERG LIMITS**

|               |    |
|---------------|----|
| Plastic Limit | 21 |
| Liquid Limit  | 35 |
| Plastic Index | 14 |

**SOIL CLASSIFICATION**

|                        |     |
|------------------------|-----|
| USCS CLASSIFICATION:   | SC  |
| AASHTO CLASSIFICATION: | A-6 |
| AASHTO GROUP INDEX:    | 1   |



**LABORATORY TEST RESULTS**

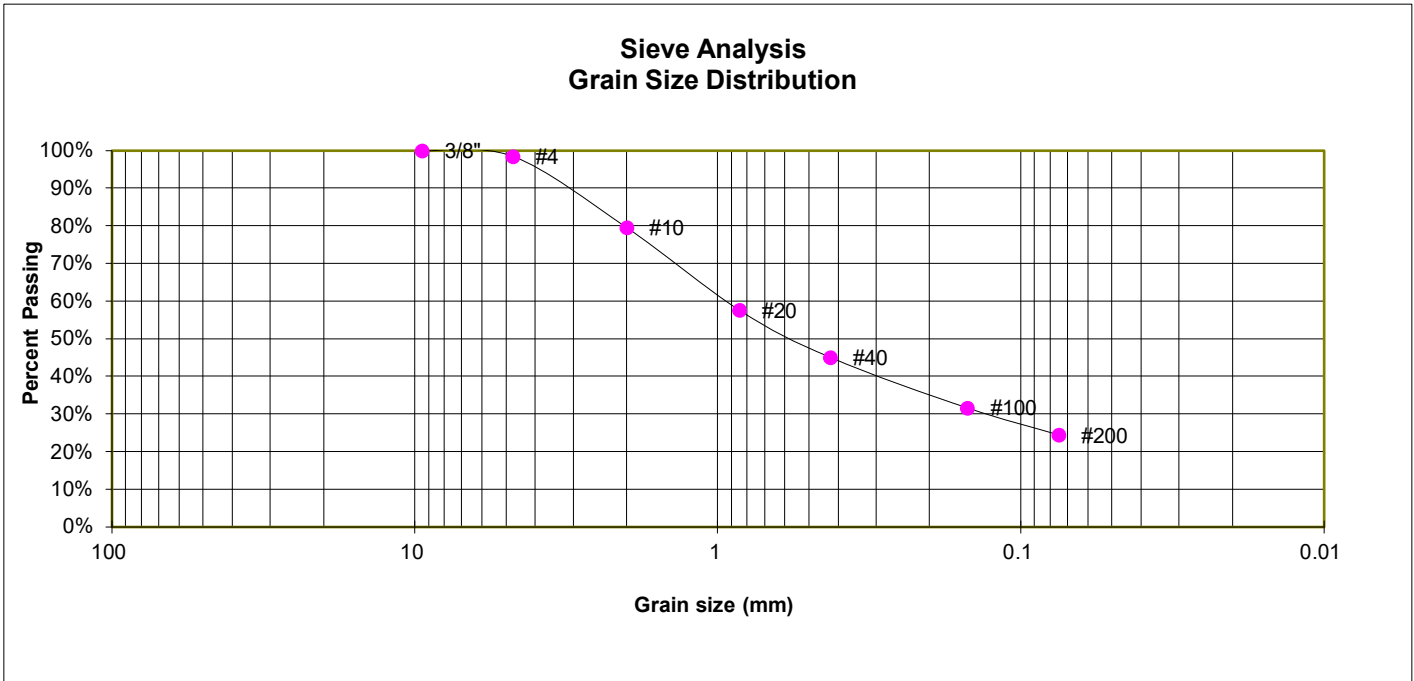
VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

JOB NO.  
 231519

**FIG. B-12**

TEST BORING 1  
 DEPTH (FT) 0-3

SOIL DESCRIPTION FILL, SAND, SILTY  
 SOIL TYPE 1



**GRAIN SIZE ANALYSIS**

| U.S.<br>Sieve # | Percent<br>Finer |
|-----------------|------------------|
| 3"              |                  |
| 1 1/2"          |                  |
| 3/4"            |                  |
| 1/2"            |                  |
| 3/8"            | 100.0%           |
| 4               | 98.4%            |
| 10              | 79.6%            |
| 20              | 57.7%            |
| 40              | 45.0%            |
| 100             | 31.7%            |
| 200             | 24.5%            |

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SM  
 AASHTO CLASSIFICATION: A-2-4



**LABORATORY TEST RESULTS**

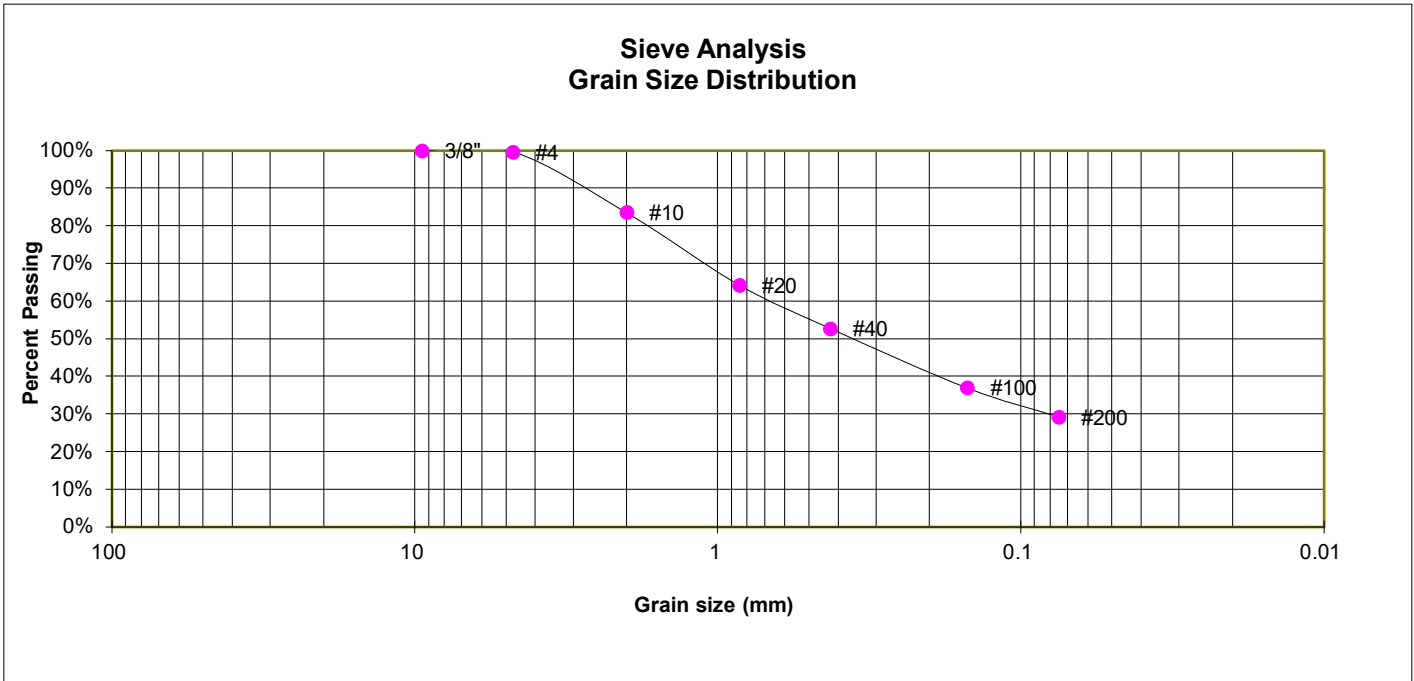
VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

JOB NO.  
 231519

**FIG. B-13**

TEST BORING 9  
 DEPTH (FT) 5

SOIL DESCRIPTION SAND, SILTY  
 SOIL TYPE 2



**GRAIN SIZE ANALYSIS**

| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3"           |               |
| 1 1/2"       |               |
| 3/4"         |               |
| 1/2"         |               |
| 3/8"         | 100.0%        |
| 4            | 99.6%         |
| 10           | 83.6%         |
| 20           | 64.3%         |
| 40           | 52.7%         |
| 100          | 37.0%         |
| 200          | 29.2%         |

**ATTERBERG LIMITS**

|               |    |
|---------------|----|
| Plastic Limit | NP |
| Liquid Limit  | NV |
| Plastic Index | NP |

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SM  
 AASHTO CLASSIFICATION: A-2-4  
 AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**

VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

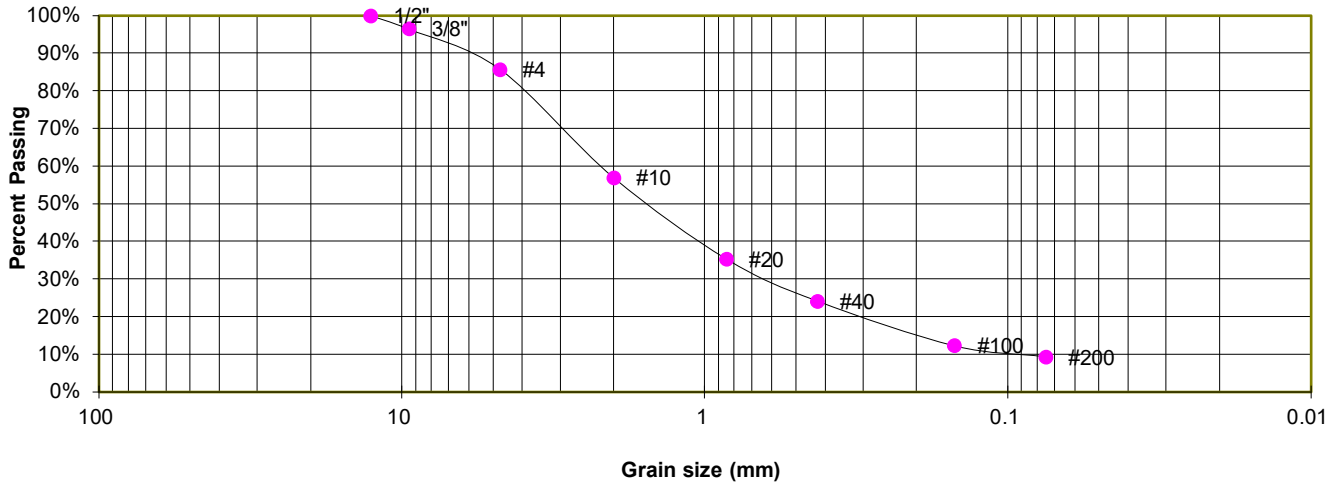
JOB NO.  
 231519

**FIG. B-14**

TEST BORING 10  
 DEPTH (FT) 5

SOIL DESCRIPTION SAND, WITH SILT  
 SOIL TYPE 2

**Sieve Analysis  
 Grain Size Distribution**



**GRAIN SIZE ANALYSIS**

| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3"           |               |
| 1 1/2"       |               |
| 3/4"         |               |
| 1/2"         | 100.0%        |
| 3/8"         | 96.5%         |
| 4            | 85.7%         |
| 10           | 57.0%         |
| 20           | 35.4%         |
| 40           | 24.1%         |
| 100          | 12.4%         |
| 200          | 9.3%          |

**ATTERBERG LIMITS**

|               |    |
|---------------|----|
| Plastic Limit | NP |
| Liquid Limit  | NV |
| Plastic Index | NP |

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SW-SM  
 AASHTO CLASSIFICATION: A-1-b  
 AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**

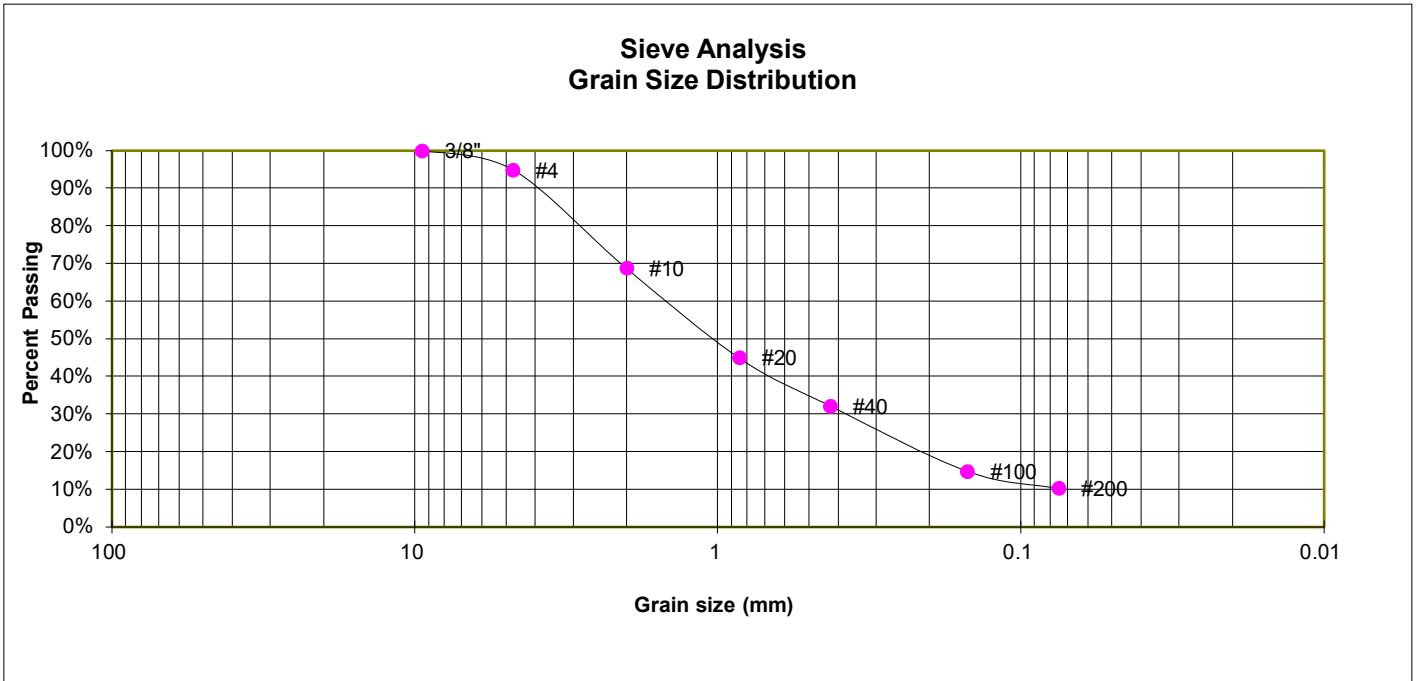
VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

JOB NO.  
 231519

**FIG. B-15**

TEST BORING 1  
 DEPTH (FT) 10

SOIL DESCRIPTION SANDSTONE (SAND, WITH SILT)  
 SOIL TYPE 3



**GRAIN SIZE ANALYSIS**

| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3"           |               |
| 1 1/2"       |               |
| 3/4"         |               |
| 1/2"         |               |
| 3/8"         | 100.0%        |
| 4            | 94.8%         |
| 10           | 68.8%         |
| 20           | 44.9%         |
| 40           | 32.1%         |
| 100          | 14.8%         |
| 200          | 10.3%         |

**ATTERBERG LIMITS**

|               |    |
|---------------|----|
| Plastic Limit | NP |
| Liquid Limit  | NV |
| Plastic Index | NP |

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SW-SM  
 AASHTO CLASSIFICATION: A-1-b  
 AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**

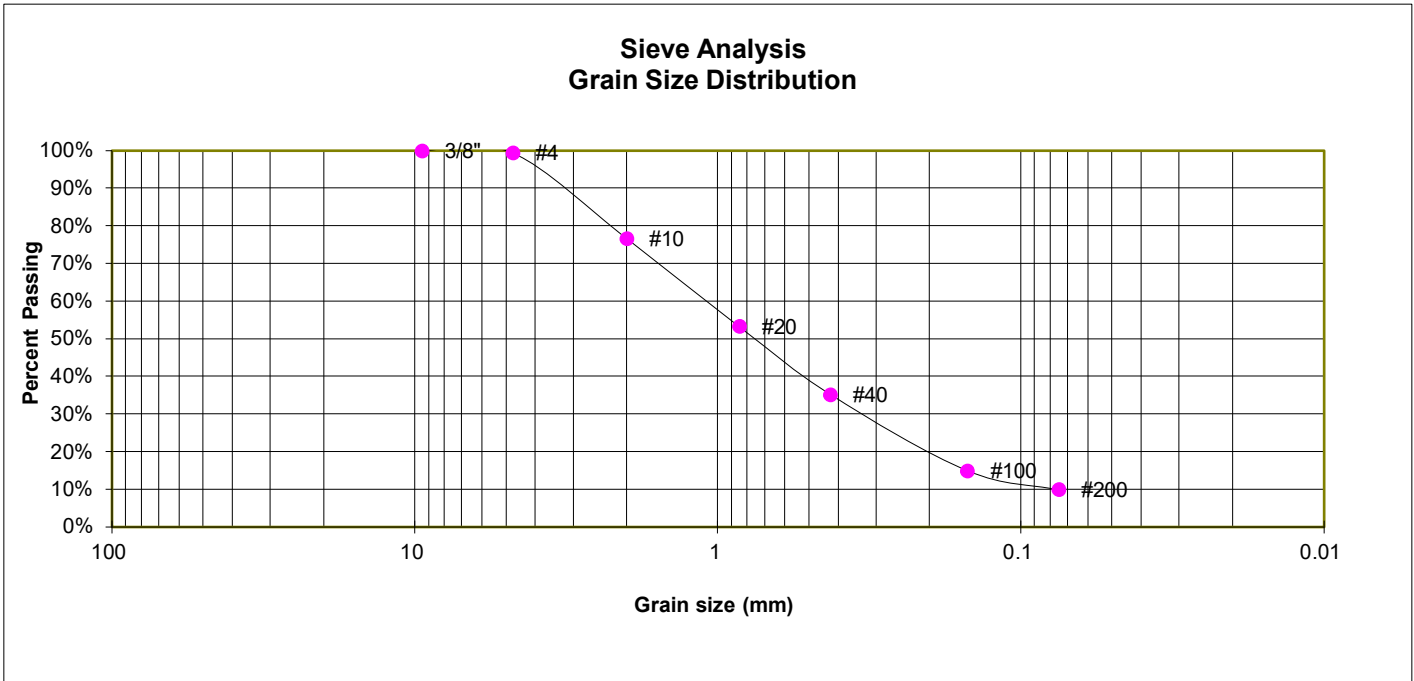
VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

JOB NO.  
 231519

**FIG. B-16**

TEST BORING 4  
 DEPTH (FT) 10

SOIL DESCRIPTION SANDSTONE (SAND, WITH SILT)  
 SOIL TYPE 3



**GRAIN SIZE ANALYSIS**

| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3"           |               |
| 1 1/2"       |               |
| 3/4"         |               |
| 1/2"         |               |
| 3/8"         | 100.0%        |
| 4            | 99.4%         |
| 10           | 76.6%         |
| 20           | 53.3%         |
| 40           | 35.2%         |
| 100          | 14.9%         |
| 200          | 10.0%         |

**ATTERBERG LIMITS**

|               |    |
|---------------|----|
| Plastic Limit | NP |
| Liquid Limit  | NV |
| Plastic Index | NP |

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SW-SM  
 AASHTO CLASSIFICATION: A-1-b  
 AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**

VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

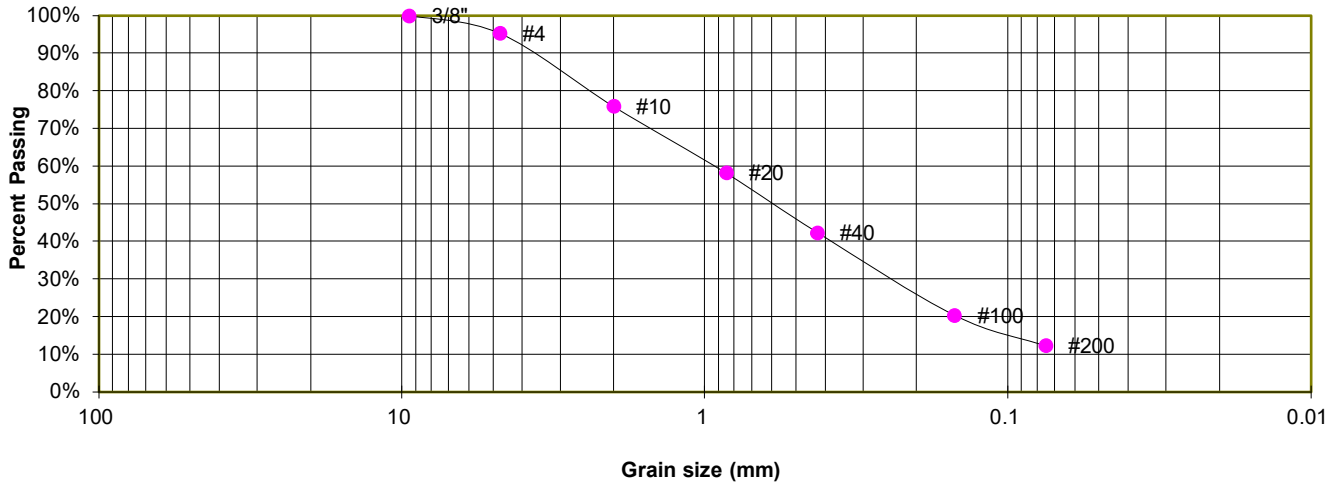
JOB NO.  
 231519

**FIG. B-17**

TEST BORING 6  
 DEPTH (FT) 5

SOIL DESCRIPTION SANDSTONE (SAND, SILTY)  
 SOIL TYPE 3

**Sieve Analysis  
 Grain Size Distribution**



**GRAIN SIZE ANALYSIS**

| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3"           |               |
| 1 1/2"       |               |
| 3/4"         |               |
| 1/2"         |               |
| 3/8"         | 100.0%        |
| 4            | 95.3%         |
| 10           | 75.9%         |
| 20           | 58.3%         |
| 40           | 42.4%         |
| 100          | 20.4%         |
| 200          | 12.3%         |

**ATTERBERG LIMITS**

|               |    |
|---------------|----|
| Plastic Limit | NP |
| Liquid Limit  | NV |
| Plastic Index | NP |

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SM  
 AASHTO CLASSIFICATION: A-1-b  
 AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**

VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

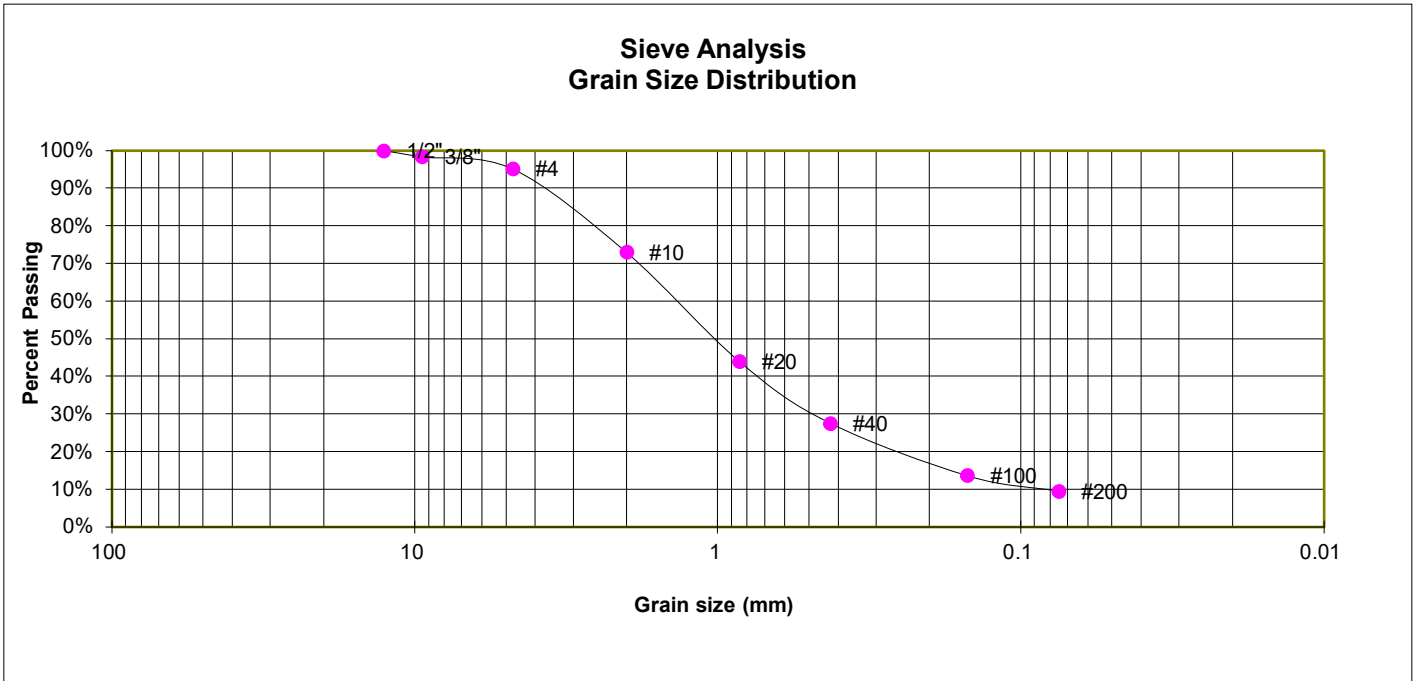
JOB NO.  
 231519

**FIG. B-18**



TEST BORING 7  
 DEPTH (FT) 10

SOIL DESCRIPTION SANDSTONE (SAND, WITH SILT)  
 SOIL TYPE 3



**GRAIN SIZE ANALYSIS**

| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3"           |               |
| 1 1/2"       |               |
| 3/4"         |               |
| 1/2"         | 100.0%        |
| 3/8"         | 98.4%         |
| 4            | 95.1%         |
| 10           | 73.0%         |
| 20           | 44.0%         |
| 40           | 27.5%         |
| 100          | 13.7%         |
| 200          | 9.5%          |

**ATTERBERG LIMITS**

|               |    |
|---------------|----|
| Plastic Limit | NP |
| Liquid Limit  | NV |
| Plastic Index | NP |

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SW-SM  
 AASHTO CLASSIFICATION: A-1-b  
 AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**

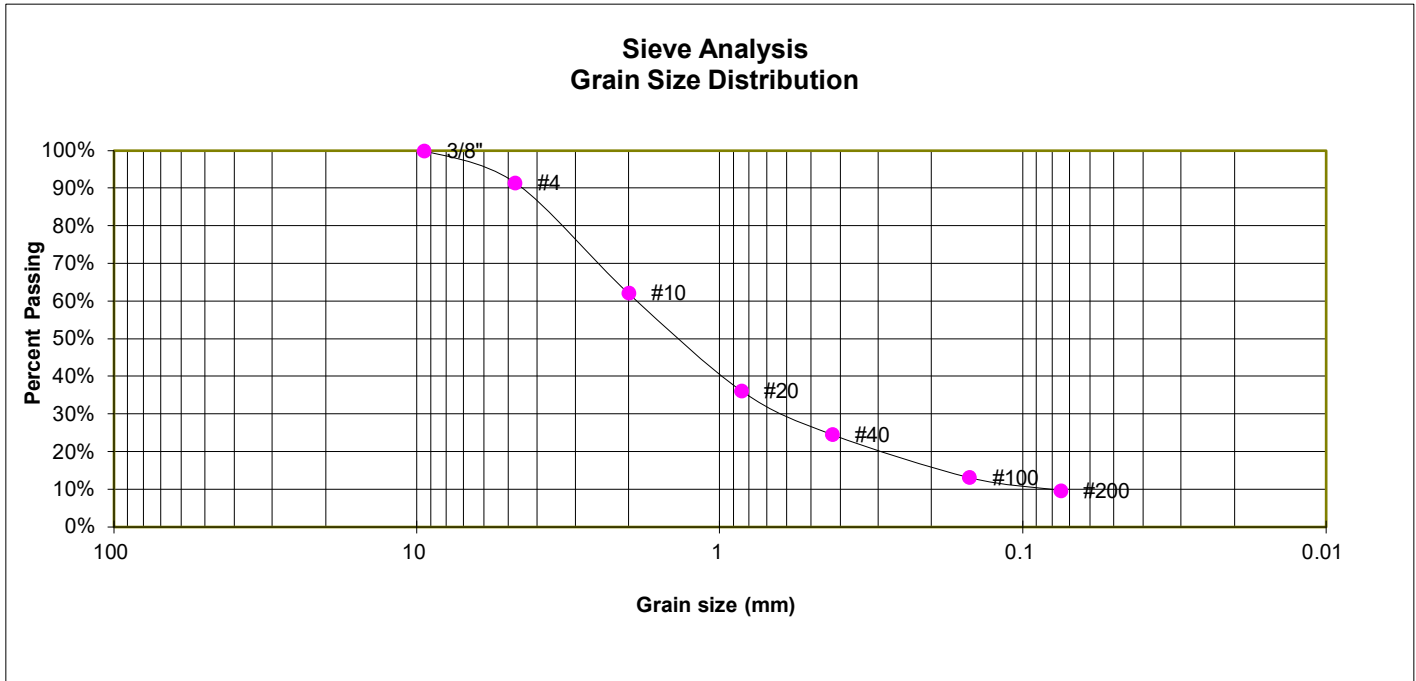
VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

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 231519

**FIG. B-19**

TEST BORING 10  
 DEPTH (FT) 10

SOIL DESCRIPTION SANDSTONE (SAND, WITH SILT)  
 SOIL TYPE 3



**GRAIN SIZE ANALYSIS**

| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3"           |               |
| 1 1/2"       |               |
| 3/4"         |               |
| 1/2"         |               |
| 3/8"         | 100.0%        |
| 4            | 91.5%         |
| 10           | 62.2%         |
| 20           | 36.2%         |
| 40           | 24.6%         |
| 100          | 13.2%         |
| 200          | 9.7%          |

**ATTERBERG LIMITS**

|               |    |
|---------------|----|
| Plastic Limit | NP |
| Liquid Limit  | NV |
| Plastic Index | NP |

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SW-SM  
 AASHTO CLASSIFICATION: A-1-b  
 AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**

VOLLMER ROAD NORTH  
 CLASSIC COMMUNITIES

JOB NO.  
 231519

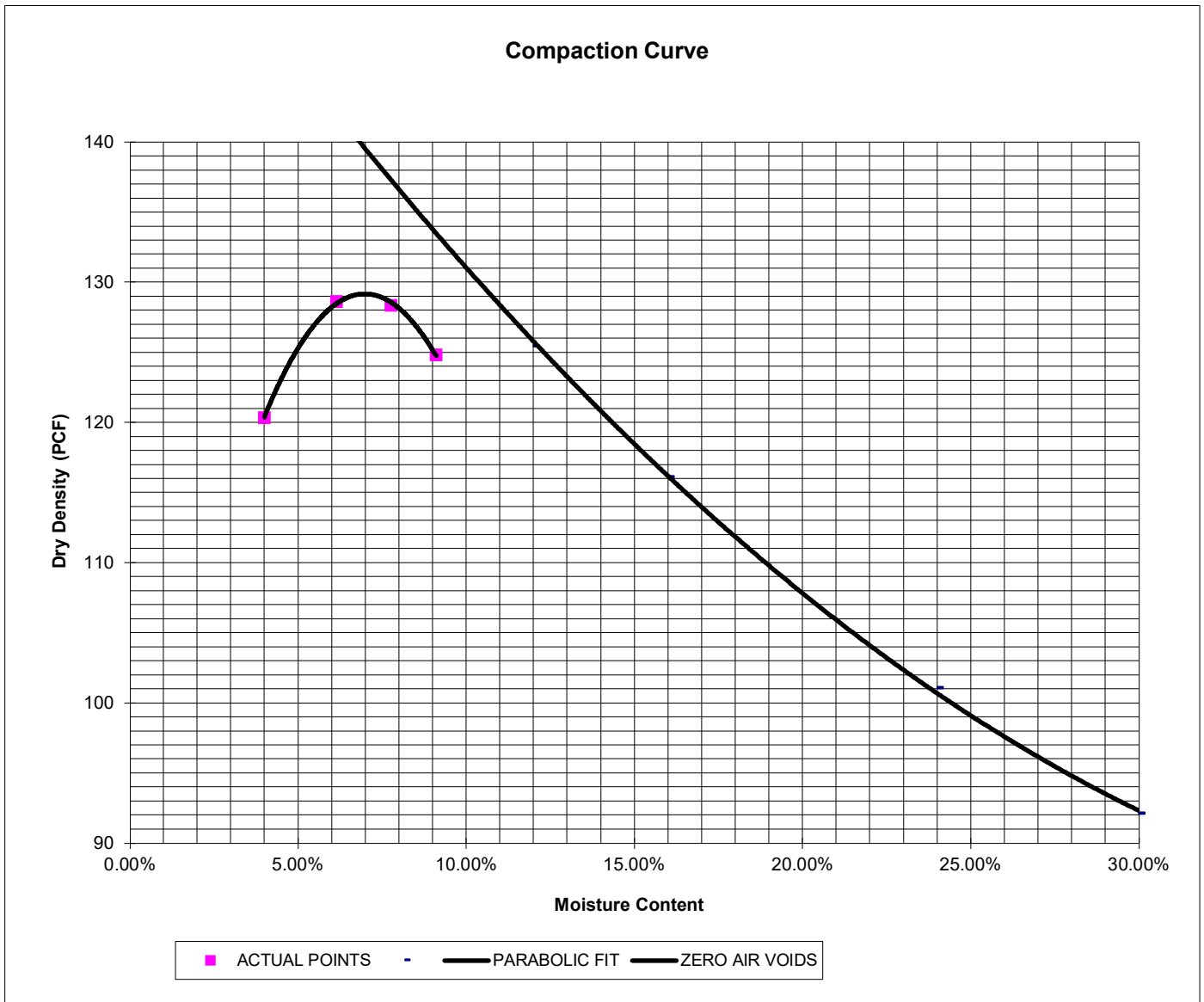
**FIG. B-20**

SAMPLE LOCATION TB-7 @ 0-3'

SOIL DESCRIPTION FILL, SAND, CLAYEY, BROWN  
SOIL TYPE 1

**PROCTOR DATA**

IDENTIFICATION: SC  
PROCTOR TEST #: 1  
TEST BY: DK  
TEST DESIGNATION: ASTM-1557-A  
MAXIMUM DRY DENSITY (PCF): 129.1  
OPTIMUM MOISTURE: 7



**LABORATORY TEST RESULTS**

VOLLMER ROAD NORTH  
CLASSIC COMMUNITIES

JOB NO.  
231519

**FIG. B-21**

SAMPLE LOCATION TB-7 @ 0-3'

SOIL DESCRIPTION FILL, SAND, CLAYEY, BROWN  
SOIL TYPE 1

**CBR TEST LOAD DATA**

Piston Diameter (cm): 4.958

Piston Area (in<sup>2</sup>): 2.993

| Penetration<br>Depth<br>(inches) | 10 BLOWS<br>Mold # 1 |                 | 25 BLOWS<br>Mold # 2 |                 | 56 BLOWS<br>Mold # 3 |                 |
|----------------------------------|----------------------|-----------------|----------------------|-----------------|----------------------|-----------------|
|                                  | Load<br>(lbs)        | Stress<br>(psi) | Load<br>(lbs)        | Stress<br>(psi) | Load<br>(lbs)        | Stress<br>(psi) |
| 0.000                            | 0                    | 0.00            | 0                    | 0.00            | 0                    | 0.00            |
| 0.025                            | 151                  | 50.46           | 208                  | 69.51           | 306                  | 102.26          |
| 0.050                            | 309                  | 103.26          | 450                  | 150.38          | 796                  | 266.00          |
| 0.075                            | 490                  | 163.74          | 723                  | 241.60          | 1389                 | 464.16          |
| 0.100                            | 681                  | 227.57          | 1051                 | 351.21          | 2133                 | 712.78          |
| 0.125                            | 851                  | 284.38          | 1329                 | 444.11          | 2682                 | 896.24          |
| 0.150                            | 1006                 | 336.17          | 1578                 | 527.32          | 3310                 | 1106.10         |
| 0.175                            | 1137                 | 379.95          | 1811                 | 605.18          | 3620                 | 1209.69         |
| 0.200                            | 1251                 | 418.04          | 2048                 | 684.38          | 4190                 | 1400.16         |
| 0.300                            | 1703                 | 569.09          | 2998                 | 1001.83         | 5230                 | 1747.70         |
| 0.400                            | 1881                 | 628.57          | 3506                 | 1171.59         | 6000                 | 2005.01         |
| 0.500                            | 2053                 | 686.05          | 3989                 | 1333.00         |                      |                 |

**MOISTURE AND DENSITY DATA**

|                   | Mold # 1 | Mold # 2 | Mold # 3 |
|-------------------|----------|----------|----------|
| Can #             | 341      | 117      | 352      |
| Wt. Can           | 7.39     | 9.52     | 6.98     |
| Wt. Can+Wet       | 176.67   | 231.7    | 235.23   |
| Wt. Can+Dry       | 158.2    | 210.95   | 216.49   |
| Wt. H2O           | 18.47    | 20.75    | 18.74    |
| Wt. Dry Soil      | 150.81   | 201.43   | 209.51   |
| Moisture Content  | 12.25%   | 10.30%   | 8.94%    |
| Wet Density (PCF) | 123.7    | 127.8    | 134.6    |
| Dry Density (PCF) | 115.6    | 119.5    | 125.8    |
| % Compaction      | 90%      | 93%      | 97%      |
| CBR               | 22.76    | 35.12    | 71.28    |

**PROCTOR DATA**

|                               |       |
|-------------------------------|-------|
| Maximum Dry Density (pcf)     | 129.1 |
| Optimum Moisture              | 7     |
| 90% of Max. Dry Density (pcf) | 116.2 |
| 95% of Max. Dry Density (pcf) | 122.6 |

CBR at 90% of Max. Density = 24.56 ~ R VALUE 71

CBR at 95% of Max. Density = 53.27 ~ R VALUE 76



**LABORATORY TEST RESULTS**

VOLLMER ROAD NORTH  
CLASSIC COMMUNITIES

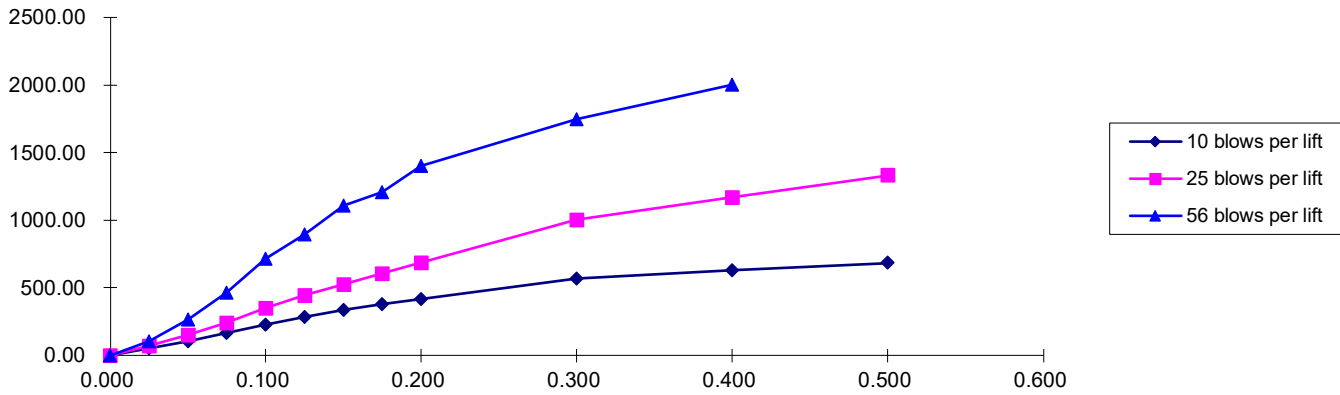
JOB NO.  
231519

**FIG. B-22**

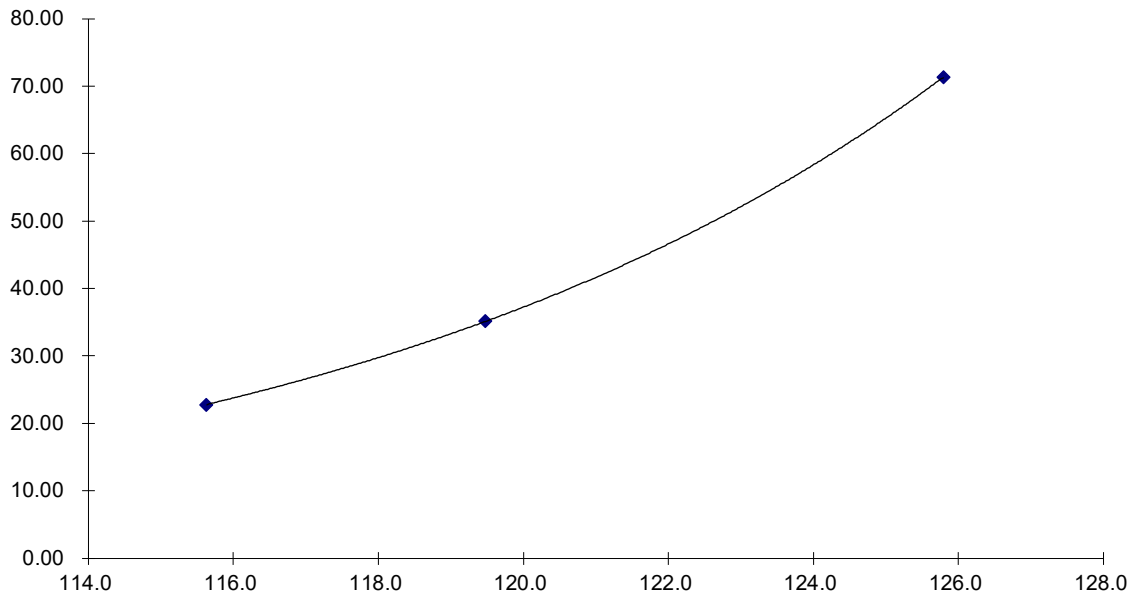
SAMPLE LOCATION TB-7 @ 0-3'  
DEPTH (FT) 0

SOIL DESCRIPTION FILL, SAND, CLAYEY, BROWN  
SOIL TYPE 1

Stress VS Penetration



Bearing Ratio VS Dry Density



LABORATORY TEST RESULTS

VOLLMER ROAD NORTH  
CLASSIC COMMUNITIES

JOB NO.  
231519

FIG. B-23



## **APPENDIX C: Pavement Design Calculations**

## FLEXIBLE PAVEMENT DESIGN

### PROJECT DATA

Project Location Vollmer Road North

Job Number: 231519

Note: Analysis follows design procedures from 1993 AASHTO Guide for Design of Pavement Structures and Appendix D of the El Paso County Pavement Design Criteria and Report

### DESIGN DATA

|   |                     |            |
|---|---------------------|------------|
| Equivalent (18-kip) Single Axle Load Applications (ESAL): | ESAL ( $W_{18}$ ) = | 1,971,000  |
| Design CBR  | CBR =               | 10         |
| Standard Deviation  | $S_o$ =             | 0.45       |
| Loss in Serviceability                                    | $\Delta\psi$ =      | 2.0        |
| Reliability   | Reliability =       | 85         |
| Reliability (z-statistic)                                 | $Z_R$ =             | -1.04      |
| Soil Resilient Modulus                                    | $M_R$ =             | 15,000 psi |

Required Structural Number (SN): ➔ SN = 2.80

### DESIGN EQUATIONS

#### Resilient Modulus

If using CBR:

$$M_R = (\text{CBR}) \times 1,500$$

If using R-Value:

$$M_R = 10^{[(S_1 + 18.72) / 6.24]} \text{ where } S_1 = [(R\text{-value} - 5) / 11.29] + 3$$

#### Required Structural Number

Solves nomograph shown in Figure D-1

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

#### Pavement Section Thickness

$\text{SN}^* = C_1 D_1 + C_2 D_2$  where:

- $C_1$  = Strength Coefficient - HMA
- $C_2$  = Strength Coefficient - ABC
- $D_1$  = Depth of HMA (inches)
- $D_2$  = Depth of ABC (inches)

### RECOMMENED THICKNESSES

| Layer | Material | Coefficient  | Thickness ( $D_i^*$ ) | $\text{SN}_i^*$       | SN   |
|-------|----------|--------------|-----------------------|-----------------------|------|
| 1     | HMA      | $C_1 = 0.44$ | 5.0 inches            | 2.200                 | -    |
| 2     | ABC      | $C_2 = 0.11$ | 8.0 inches            | 0.880                 |      |
|       |          |              |                       | $\text{SN}^* = 3.080$ | 2.80 |

Pavement SN > Required SN, Design is Acceptable

## FLEXIBLE PAVEMENT DESIGN

### PROJECT DATA

Project Location Vollmer Road North

Job Number: 231519

Note: Analysis follows design procedures from 1993 AASHTO Guide for Design of Pavement Structures and Appendix D of the El Paso County Pavement Design Criteria and Report

### DESIGN DATA

|   |                     |            |
|---|---------------------|------------|
| Equivalent (18-kip) Single Axle Load Applications (ESAL): | ESAL ( $W_{18}$ ) = | 1,971,000  |
| Design CBR  | CBR =               | 10         |
| Standard Deviation  | $S_o$ =             | 0.45       |
| Loss in Serviceability                                    | $\Delta\psi$ =      | 2.0        |
| Reliability   | Reliability =       | 85         |
| Reliability (z-statistic)                                 | $Z_R$ =             | -1.04      |
| Soil Resilient Modulus                                    | $M_R$ =             | 15,000 psi |

Required Structural Number (SN): ➔ SN = 2.80

### DESIGN EQUATIONS

#### Resilient Modulus

If using CBR:

$$M_R = (\text{CBR}) \times 1,500$$

If using R-Value:

$$M_R = 10^{[(S_1 + 18.72) / 6.24]} \text{ where } S_1 = [(R\text{-value} - 5) / 11.29] + 3$$

#### Required Structural Number

Solves nomograph shown in Figure D-1

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

#### Pavement Section Thickness

$\text{SN}^* = C_1 D_1 + C_2 D_2$  where:

- $C_1$  = Strength Coefficient - HMA
- $C_2$  = Strength Coefficient - CTS
- $D_1$  = Depth of HMA (inches)
- $D_2$  = Depth of CTS (inches)

### RECOMMENED THICKNESSES

| Layer | Material | Coefficient  | Thickness ( $D_i^*$ ) | $\text{SN}_i^*$       | SN   |
|-------|----------|--------------|-----------------------|-----------------------|------|
| 1     | HMA      | $C_1 = 0.44$ | 5.0 inches            | 2.200                 | -    |
| 2     | CTS      | $C_2 = 0.11$ | 10.0 inches           | 1.100                 |      |
|       |          |              |                       | $\text{SN}^* = 3.300$ | 2.80 |

Pavement SN > Required SN, Design is Acceptable