CITY OF Grand Junction COLORADO

Purchasing Division

ADDENDUM NO. 2

DATE: **August 16, 2018**
FROM: **City of Grand Junction Purchasing Division**
TO: **All Offerors**
RE: **Lewis Wash Bridge Replacement (Re-Bid) IFB-4548-18-DH**

Offerors responding to the above referenced solicitation are hereby instructed that the requirements have been clarified, modified, superseded and supplemented as to this date as hereinafter described.

Please make note of the following clarifications:

1. See attached geotechnical report.

The original solicitation for the project noted above is amended as noted.

All other conditions of subject remain the same.

Respectfully,

Duane Hoff Jr., Senior Buyer
City of Grand Junction, Colorado

Huddleston-Berry
Engineering & Testing, LLC

GEOLOGIC HAZARDS AND GEOTECHNICAL INVESTIGATION
GRJ-F.5-30.8 BRIDGE OVER LEWIS WASH
GRAND JUNCTION, COLORADO
PROJECT#00208-0062

CITY OF GRAND JUNCTION
250 NORTH 5TH STREET
GRAND JUNCTION, COLORADO 81501

JUNE 30, 2015

Huddleston-Berry Engineering and Testing, LLC
640 White Avenue, Unit B
Grand Junction, Colorado 81501

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

A geologic hazards and geotechnical investigation was conducted for the GRJ-F.5-30.8 Bridge over Lewis wash in Grand Junction , Colorado. The project location is shown on Figure 1 – Site Location Map. The purpose of the investigation was to evaluate the surface and subsurface conditions at the site with respect to geologic hazards, foundation design, pavement design, and earthwork for the proposed construction. This summary has been prepared to include the information required by civil engineers, structural engineers, and contractors involved in the project.

<u>Subsurface Conditions (p. 2)</u>

The subsurface investigation consisted of two borings, drilled on June 8th, 2015. The locations of the borings are shown on Figure 2 – Site Plan. The borings generally encountered pavements above native lean clay soils. The clay soils were underlain by gravel soils and shale bedrock. Groundwater was encountered in the borings at depths of between 18.5 and 19.0 feet at the time of the investigation.

<u>Geologic Hazards (p. 3)</u>

The primary geologic hazard at the site is the presence of moisture sensitive soils. However, flooding of Lewis wash could also impact the site.

<u>Summary of Recommendations</u>

- *Recommended Foundation Alternative* – Shallow Foundations. (p. 4)
- *Nominal Bearing Resistance at Strength Limit State* – q_{ult} = 450*Effective footing width + 3175 psf. (p. 4)
- *Reduction Factor* – 0.45. (p. 4)
- *Nominal Bearing Resistance at Service Limit State* – See Appendix D.

<u>Other Foundation Criteria</u>

- *Seismic Site Class* – Site Class D (p. 5)

<u>Summary of Pavement Recommendations (p. 6)</u>

It is recommended that new pavements match the existing pavement section of 6.0-inches of asphalt pavement above 18.0-inches of CDOT Class 6 base course.

TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 Scope 1
1.2 Site Location and Description 1
1.3 Proposed Construction 1
2.0 GEOLOGIC SETTING 2
2.1 Soils 2
2.2 Geology 2
2.3 Groundwater 2
3.0 SUBSURFACE INVESTIGATION 2
4.0 LABORATORY TESTING 3
5.0 GEOLOGIC INTERPRETATION 3
5.1 Geologic Hazards 3
5.2 Geologic Constraints 3
5.3 Water Resources 3
5.4 Mineral Resources 3
6.0 CONCLUSIONS 3
7.0 RECOMMENDATIONS 4
7.1 Foundations 4
7.2 Lateral Earth Pressures 5
7.3 Corrosion of Steel and Concrete 5
7.4 Seismic Site Classification 5
7.5 Excavations 5
7.6 Pavements 6
8.0 GENERAL 7

FIGURES

Figure 1 – Site Location Map
Figure 2 – Site Plan

APPENDICES

Appendix A – UDSA NRCS Soil Survey Data
Appendix B – Typed Boring Logs
Appendix C – Laboratory Testing Results
Appendix D – Nominal Bearing Resistance at the Service Limit State
Appendix E – ESAL Calculations

1.0 INTRODUCTION

As part of extensive infrastructure improvements in Western Colorado, the City of Grand Junction proposes to replace the GRJ-F.5-30.8 Bridge over Lewis wash. As part of the design development process, Huddleston-Berry Engineering and Testing, LLC (HBET) was retained by the City of Grand Junction to conduct a geologic hazards and geotechnical investigation at the site.

1.1 Scope

As discussed above, a geologic hazards and geotechnical investigation was conducted for the GRJ-F.5-30.8 Bridge over Lewis wash in Grand Junction, Colorado. The scope of the investigation included the following components:

- Conducting a subsurface investigation to evaluate the subsurface conditions at the site.
- Collecting soil samples and conducting laboratory testing to determine the engineering properties of the soils at the site.
- Providing recommendations for foundation type and subgrade preparation.
- Providing recommendations for bearing capacity.
- Providing recommendations for lateral earth pressure.
- Providing recommendations for drainage, grading, and general earthwork.
- Providing recommendations for pavements.
- Evaluating potential geologic hazards at the site.

The investigation and report were completed by a Colorado registered professional engineer in accordance with generally accepted geotechnical and geological engineering practices. This report has been prepared for the exclusive use of the City of Grand Junction.

1.2 Site Location and Description

The site is located on F ½ Road, west of Allegheny Drive. The project location is shown on Figure 1 – Site Location Map.

At the time of the investigation, F½ Road consisted of one lane in each direction. The roadway grade was fairly level. The predominant land use in the vicinity of the bridge was residential.

1.3 Proposed Construction

The proposed construction is anticipated to include replacement of the existing twin concrete box culvert with a new twin concrete box culvert.

2.0 GEOLOGIC SETTING

2.1 Soils

Soils data was obtained from the USDA Natural Resource Conservation Service Web Soil Survey. The data indicates that the soils at the site consist of Oxyaquic Torrifluvents, 0 to 2 percent slopes and Turley clay loam, 0 to 2 percent slopes. Soil survey data, including descriptions of the soil units, is included in Appendix A.

Road construction in the site soils is described as being very limited due to low strength and/or flooding. Excavation in the site soils is described as being somewhat limited due to depth to saturated zone, flooding, dust, and/or unstable excavation walls. The site soils are indicated to have a low potential for frost action, high risk of corrosion of uncoated steel, and low to high risk of corrosion of concrete.

2.2 Geology

According to the *Geologic Map of Colorado* by Ogden Tweto (1979), the site is underlain by Mancos shale bedrock. The Mancos shale unit is thick in the Grand Valley and has a low to moderate potential for expansion.

2.3 Groundwater

Groundwater was encountered in the borings at depths of between 18.5 and 19.0 feet at the time of the investigation. However, the actual groundwater elevation likely matches the water elevation in Lewis Wash.

3.0 SUBSURFACE INVESTIGATION

The subsurface investigation was conducted on June 8th, 2015 and consisted of two borings. Borings B-1 and B-2 were drilled to depths of 24.0 and 24.5 feet below the existing ground surface, respectively. The locations of the borings are shown on Figure 2 – Site Plan. The borings were located in the field relative to existing site features. Typed boring logs are included in Appendix B. Samples of the native soils were collected during Standard Penetration Testing (SPT) and using bulk sampling methods at the locations shown on the logs.

As indicated on the logs, the subsurface conditions at the site were slightly variable. However, the borings generally encountered 6.0-inches of asphalt pavement above granular base course to a depth of 2.0 feet. Below the base course, brown, moist, soft to medium stiff sandy lean clay extended to depths of between 17.0 and 20.0 feet. The clay was underlain by tan to brown, moist to wet, medium dense sandy gravel to a depth of 22.0 feet. Below the gravel, brown, soft, moderately weathered shale bedrock extended to the bottoms of the borings. As discussed previously, groundwater was encountered in the borings at depths of between 18.5 and 19.0 feet at the time of the investigation.

4.0 LABORATORY TESTING

Selected native soil samples collected from the borings were tested in the Huddleston-Berry Engineering and Testing LLC geotechnical laboratory for natural moisture and density, grain size analysis, swell/consolidation, maximum dry density and optimum moisture (Proctor), Atterberg limits, California Bearing Ratio (CBR), and water soluble sulfates. In addition, a sample of the streambed material was tested for grain-size analysis for use in scour computations. The laboratory testing results are included in Appendix C.

The laboratory testing results indicate that the native clay soils are moderately plastic. In addition, the native clay soils were shown to be slightly collapsible at their existing density with up to approximately 1.3% collapse measured in the laboratory. However, the CBR results indicate that the native clay soils may expand as much as 0.9% when compacted and introduced to excess moisture. Water soluble sulfates were detected in the site soils in a concentration of 0.4%.

5.0 GEOLOGIC INTERPRETATION

5.1 Geologic Hazards

The primary geologic hazard at the site is the presence of moisture sensitive soils. However, flooding of Lewis wash could also impact the site.

5.2 Geologic Constraints

The primary geologic constraint to construction is the presence of surface water and groundwater associated with Lewis wash. However, the presence of moisture sensitive soils may also impact the construction.

5.3 Water Resources

The primary water feature in the area is Lewis wash.

5.4 Mineral Resources

No significant mineral resources were identified in the project area. Potential mineral resources in Western Colorado generally include gravel, uranium ore, and commercial rock products such as flagstone. No significant gravel, uranium bearing bedrock, or other mineable bedrock units were encountered in the project area at the time of the investigation, nor was any literary or cartographic information discovered that indicate the existence of commercial quality mineral deposits.

6.0 CONCLUSIONS

Based upon the available data sources, field investigation, and nature of the proposed construction, HBET does not believe that there are any geologic conditions which should preclude construction at the site.

7.0 RECOMMENDATIONS

7.1 Foundations

As discussed previously, a new twin concrete box culvert is proposed to carry F½ Road across Lewis wash. Therefore, the structure will be supported by the base of the culvert. Based upon information provided to HBET, the base of the culvert will be approximately 17 to 18 feet below the roadway elevation. Although this is close to the elevation of the gravels encountered in the borings, the blow counts in the gravels indicate that they were not in a dense condition. Therefore, in order to provide uniform support to the culvert, it is recommended that the culvert be constructed above a minimum of 24-inches of structural fill.

In general, based upon their plasticity, the native clay soils are not suitable for reuse as structural fill. Imported structural fill should consist of a granular, non-expansive, non-free draining material such as crusher fines, pit-run, or CDOT Class 6 base course. However, if pit-run is used for structural fill, a minimum of six inches of crusher fines or Class 6 base course should be placed on top of the pit run to prevent large point stresses on the bottoms of the footings due to large particles in the pit-run.

Prior to placement of structural fill, it is recommended that the bottom of the foundation excavation be scarified to a depth of 6 to 8 inches, moisture conditioned, and compacted to a minimum of 95% of the standard Proctor maximum dry density, within ± 2% of the optimum moisture content as determined in accordance with ASTM D698. However, due to the presence of surface water and/or groundwater, soft soil conditions may be encountered and compaction of the subgrade may be difficult. It may be necessary to utilize geotextile and/or geogrid in conjunction with up to 24-inches of additional granular fill to stabilize the subgrade. HBET should be contacted to provide specific recommendations for subgrade stabilization based upon the actual conditions in the bottom of the foundation excavation.

Structural fill should extend laterally beyond the edges of the foundation a distance equal to the thickness of structural fill. Structural fill should be moisture conditioned, placed in maximum 8-inch loose lifts, and compacted to a minimum of 95% of the standard Proctor maximum dry density for fine grained soils and modified Proctor maximum dry density for coarse grained soils, within ± 2% of the optimum moisture content as determined in accordance with ASTM D698 and D1557C, respectively. Pit-run materials should be proofrolled to the Engineer's satisfaction.

For subgrade preparation as recommended and structural fill consisting of imported granular materials, a nominal bearing resistance for the strength limit state of q_{ult} = 450*Effective footing width + 3175 psf may be used. A resistance factor of 0.45 is recommended. Nominal bearing resistance for the service limit state should be in accordance with the attached plot of Bearing Stress versus Effective Footing Width for a maximum total settlement of 1.0-inch included in Appendix D. Foundations subject to frost should be at least 24-inches below the finished grade.

7.2 Lateral Earth Pressures

Any earth retaining structures should be designed to resist lateral earth pressures. HBET recommends that the structures be designed using the following earth pressure coefficients:

Native Lean Clay Soils
- $K_a = 0.39$
- $K_p = 2.56$

Class 1 Structural Backfill
- $K_a = 0.33$
- $K_p = 3.00$

The earth pressure coefficients above assume horizontal backslope and should be increased where the backslope is not level. Computed lateral earth pressures on the structures should consider surcharge loading from F½ Road.

7.3 Corrosion of Steel and Concrete

Based upon information provided in the USDA NRCS Web Soil Survey, the soils at the site have a high risk of corrosion of uncoated steel. Therefore, it is recommended that the structural engineer consider corrosion in design of steel structural elements or utilities.

With regard to soil corrosivity to concrete, as discussed previously, water soluble sulfates were detected in the site soils in a concentration of 0.4%. This concentration represents a severe degree of potential sulfate attack on concrete exposed to the native soils. As a result, Type V cement is generally recommended in accordance with the International Building Code (IBC). However, Type V cement can be difficult to obtain in Western Colorado. Where Type V cement is unavailable, Type I-II sulfate resistant cement is recommended.

7.4 Seismic Site Classification

Based upon the results of the subsurface investigation, the site generally classifies as Seismic Site Class D for a stiff soil profile.

7.5 Excavations

Excavations in the soils at the site may stand for short periods of time but should not be considered to be stable. Trenching and excavations should be sloped back, shored, or shielded for worker protection in accordance with applicable OSHA standards. The native soils generally classify as Type C soil with regard to OSHA's *Construction Standards for Excavations*. In general, for Type C soils, the maximum allowable slope in temporary cuts is 1.5H:1V. However, at or near the water table, the soils will tend to slough and sheeting or shoring may be required.

In addition, it is important to note that the soil classification is based solely on the boring data. Some of the native clay soils may actually classify as Type B soils. It is recommended that HBET be contacted during construction to further evaluate the native soils where significant excavations are proposed.

7.6 Pavements

The proposed construction is anticipated to include new pavements at the approaches to the new structure. As discussed previously, the native pavement subgrade materials consist primarily of lean clay soils. The design CBR of the native clay soils was determined in the laboratory to be approximately 2.0. This corresponds to a Resilient Modulus of 3,000 psi.

Based upon the subgrade conditions and anticipated traffic loading, pavement section alternatives were developed in accordance with the *Guideline for the Design and Use of Asphalt Pavements for Colorado Roadways* by the Colorado Asphalt Pavement Association and CDOT *Pavement Design Manual*. ESAL calculations are included in Appendix E.

As discussed previously, the existing pavement section includes approximately 6.0-inches of asphalt pavement above 18.0-inches of granular base course. This section is adequate for traffic loading well in excess of the design traffic loading. As a result, for consistency, it is recommended that new pavements match the existing pavement section.

Prior to pavement placement, areas to be paved should be stripped of all topsoil, uncontrolled fill, or other unsuitable materials. It is recommended that the subgrade soils be scarified to a depth of 12-inches; moisture conditioned, and recompacted to a minimum of 95% of the standard Proctor maximum dry density, within 0 to -2% of optimum moisture content as determined by AASHTO T-99.

Aggregate base course and subbase course should be placed in maximum 9-inch loose lifts, moisture conditioned, and compacted to a minimum of 95% and 93% of the maximum dry density, respectively, at -2% to +3% of optimum moisture content as determined by AASHTO T-180. In addition to density testing, base course should be proofrolled to verify subgrade stability.

It is recommended that Hot-Mix Asphaltic (HMA) pavement conform to CDOT grading SX or S specifications and consist of an approved 75 gyration Superpave method mix design. HMA pavement should be compacted to between 92% and 96% of the maximum theoretical density. An end point stress of 50 psi should be used.

The long-term performance of the pavements is dependent on positive drainage away from the pavements. Ditches, culverts, and inlet structures in the vicinity of paved areas must be maintained to prevent ponding of water on the pavement.

8.0 GENERAL

The recommendations included above are based upon the results of the subsurface investigation and on our local experience. These conclusions and recommendations are valid only for the proposed construction.

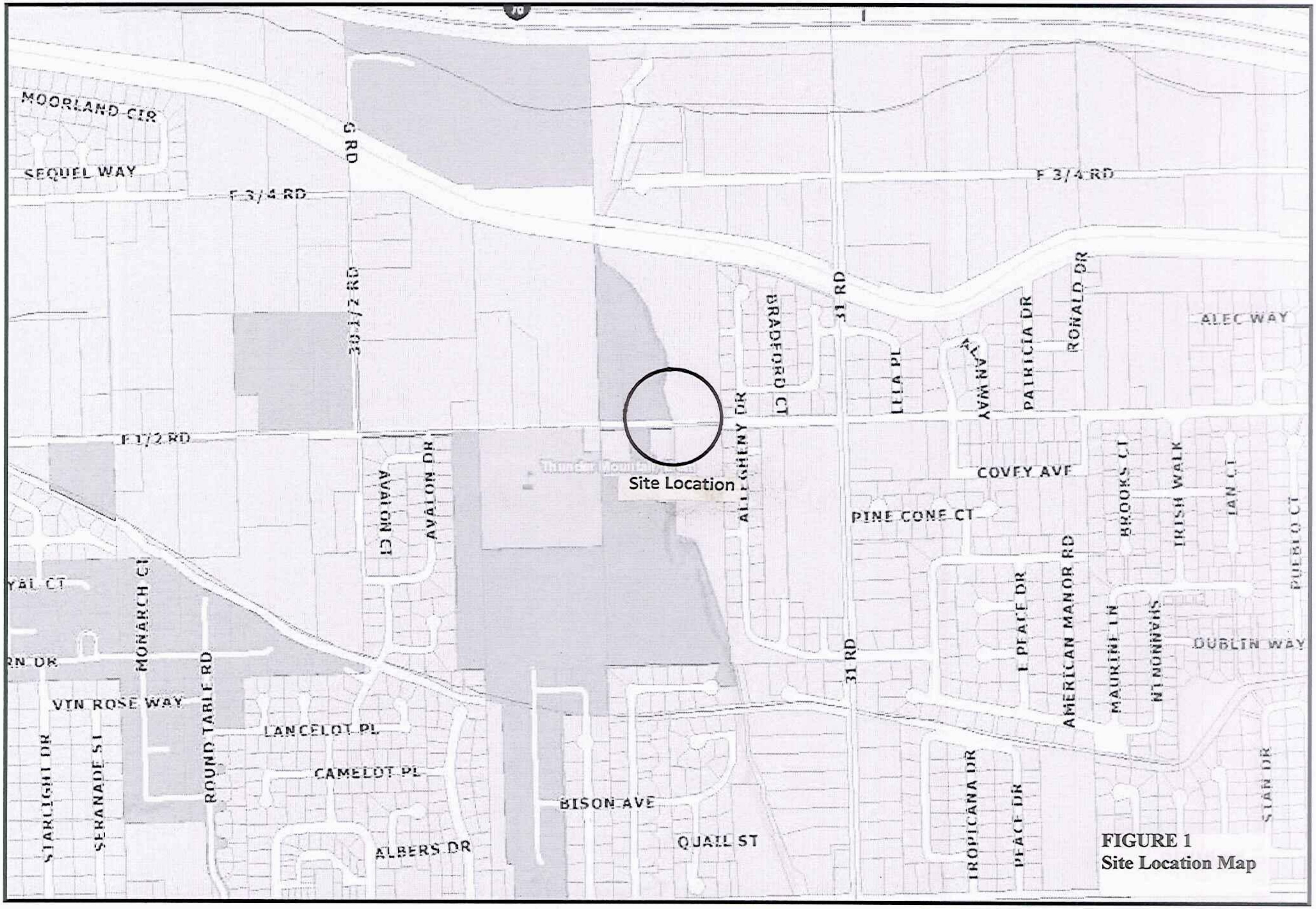
As discussed previously, the subsurface conditions at the site were variable. However, the precise nature and extent of subsurface variability may not become evident until construction. Therefore, it is recommended that a representative of HBET be retained to provide engineering oversight and construction materials testing services during the construction. This is to verify compliance with the recommendations included in this report or permit identification of significant variations in the subsurface conditions which may require modification of the recommendations.

Huddleston-Berry Engineering and Testing, LLC is pleased to be of service to your project. Please contact us if you have any questions or comments regarding the contents of this report.

Respectfully Submitted:
Huddleston-Berry Engineering and Testing, LLC

Michael A. Berry, P.E.
Vice President of Engineering

FIGURES



Mesa County Map

The Geographic Information System (GIS) and its components are designed as a source of reference for answering inquiries, for planning and for modeling. GIS is not intended or does not replace legal description information in the chain of title and other information contained in official government records such as the County Clerk and Recorders office or the courts. In addition, the representations of location in this GIS cannot be substitute for actual legal surveys.
The information contained herein is believed accurate and suitable for the limited uses, and subject to the limitations, set forth above. Mesa County makes no warranty as to the accuracy or suitability of any information contained herein. Users assume all risk and responsibility for any and all damages, including consequential damages, which may flow from the user's use of this information.

0 0.05 0.1 0.2 mi

0 0.075 0.15 0.3 km

Print Date: June 22, 2015

Mesa County, Colorado
GIS/IT Department

City of Grand Junction

N

0 0.0175 0.035 Miles

Printed: 6/22/2015

1 inch = 67 feet

City of Grand Junction Colorado Geographic Information System

APPENDIX A
Soil Survey Data

Map Scale: 1:340 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 5, 10, 20, 30

Feet: 0, 15, 30, 60, 90

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Mesa County Area, Colorado
Survey Area Data: Version 5, Sep 22, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 22, 2010—Sep 2, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Mesa County Area, Colorado (CO680)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Rs	Oxyaquic Torrifluvents, 0 to 2 percent slopes	0.4	65.0%
Tr	Turley clay loam, 0 to 2 percent slopes	0.2	35.0%
Totals for Area of Interest		**0.6**	**100.0%**

Map Unit Description

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this report, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. All the soils of a series have major horizons that are similar in composition, thickness, and arrangement. Soils of a given series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Additional information about the map units described in this report is available in other soil reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the soil reports define some of the properties included in the map unit descriptions.

Report—Map Unit Description

Mesa County Area, Colorado

Rs—Oxyaquic Torrifluvents, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: k0d6
Elevation: 4,500 to 4,900 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 150 to 190 days
Farmland classification: Not prime farmland

Map Unit Composition

Oxyaquic torrifluvents and similar soils: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Oxyaquic Torrifluvents

Setting

Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sandstone and shale

Typical profile

Az - 0 to 2 inches: sandy loam
Cyz - 2 to 8 inches: very fine sandy loam
Cz1 - 8 to 22 inches: stratified loamy sand to sandy clay loam
Cz2 - 22 to 60 inches: very gravelly sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: About 30 to 60 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Gypsum, maximum in profile: 5 percent
Salinity, maximum in profile: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)
Available water storage in profile: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: A
Ecological site: Saltdesert Overflow (R034XY407CO)

Tr—Turley clay loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: k0d8
Elevation: 4,500 to 4,800 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 150 to 190 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Turley and similar soils: 90 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Turley

Setting

Landform: Fan remnants
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sandstone and shale

Typical profile

Ap - 0 to 10 inches: clay loam
C1 - 10 to 20 inches: fine sandy loam
C2 - 20 to 30 inches: clay loam
C3 - 30 to 60 inches: stratified loam to silty clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Gypsum, maximum in profile: 4 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 10.6 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: C

Data Source Information

Soil Survey Area: Mesa County Area, Colorado
Survey Area Data: Version 5, Sep 22, 2014

Roads and Streets, Shallow Excavations, and Lawns and Landscaping

Soil properties influence the development of building sites, including the selection of the site, the design of the structure, construction, performance after construction, and maintenance. This table shows the degree and kind of soil limitations that affect local roads and streets, shallow excavations, and lawns and landscaping.

The ratings in the table are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect building site development. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or soil material stabilized by lime or cement; and a surface of flexible material (asphalt), rigid material (concrete), or gravel with a binder. The ratings are based on the soil properties that affect the ease of excavation and grading and the traffic-supporting capacity. The properties that affect the ease of excavation and grading are depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, depth to a water table, ponding, flooding, the amount of large stones, and slope. The properties that affect the traffic-supporting capacity are soil strength (as inferred from the AASHTO group index number), subsidence, linear extensibility (shrink-swell potential), the potential for frost action, depth to a water table, and ponding.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for graves, utility lines, open ditches, or other purposes. The ratings are based on the soil properties that influence the ease of digging and the resistance to sloughing. Depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, the amount of large stones, and dense layers influence the ease of digging, filling, and compacting. Depth to the seasonal high water table, flooding, and ponding may restrict the period when excavations can be made. Slope influences the ease of using machinery. Soil texture, depth to the water table, and linear extensibility (shrink-swell potential) influence the resistance to sloughing.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. Irrigation is not considered in the ratings. The ratings are based on the soil properties that affect plant growth and trafficability after vegetation is established. The properties that affect plant growth are reaction; depth to a water table; ponding; depth to bedrock or a cemented pan; the available water capacity in the upper 40 inches; the content of salts, sodium, or calcium carbonate; and sulfidic materials. The properties that affect trafficability are flooding, depth to a water table, ponding, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer.

Information in this table is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil between the surface and a depth of 5 to 7 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this table. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Report—Roads and Streets, Shallow Excavations, and Lawns and Landscaping

[Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the potential limitation. The table shows only the top five limitations for any given soil. The soil may have additional limitations]

Roads and Streets, Shallow Excavations, and Lawns and Landscaping–Mesa County Area, Colorado							
Map symbol and soil name	**Pct. of map unit**	**Local roads and streets**		**Shallow excavations**		**Lawns and landscaping**	
		Rating class and limiting features	**Value**	**Rating class and limiting features**	**Value**	**Rating class and limiting features**	**Value**
Rs—Oxyaquic Torrifluvents, 0 to 2 percent slopes							
Oxyaquic torrifluvents	100	Very limited		Somewhat limited		Somewhat limited	
		Flooding	1.00	Depth to saturated zone	0.73	Low exchange capacity	0.75
		Low strength	1.00	Flooding	0.60	Flooding	0.60
				Unstable excavation walls	0.01	Droughty	0.10

Roads and Streets, Shallow Excavations, and Lawns and Landscaping–Mesa County Area, Colorado							
Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Lawns and landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
Tr—Turley clay loam, 0 to 2 percent slopes							
Turley	90	Very limited		Somewhat limited		Somewhat limited	
		Low strength	1.00	Dusty	0.20	Dusty	0.20
				Unstable excavation walls	0.01		

Data Source Information

Soil Survey Area: Mesa County Area, Colorado
Survey Area Data: Version 5, Sep 22, 2014

Soil Features

This table gives estimates of various soil features. The estimates are used in land use planning that involves engineering considerations.

A *restrictive layer* is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers. The table indicates the hardness and thickness of the restrictive layer, both of which significantly affect the ease of excavation. *Depth to top* is the vertical distance from the soil surface to the upper boundary of the restrictive layer.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence generally results from either desiccation and shrinkage, or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. The table shows the expected initial subsidence, which usually is a result of drainage, and total subsidence, which results from a combination of factors.

Potential for frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, saturated hydraulic conductivity (Ksat), content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel or concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel or concrete in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion also is expressed as *low*, *moderate*, or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Report—Soil Features

Soil Features–Mesa County Area, Colorado									
Map symbol and soil name	Restrictive Layer				Subsidence		Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness	Initial	Total		Uncoated steel	Concrete
		Low-RV-High	*Range*		*Low-High*	*Low-High*			
		In	*In*		*In*	*In*			
Rs—Oxyaquic Torrifluvents, 0 to 2 percent slopes									
Oxyaquic torrifluvents		—	—		0	—	Low	High	High
Tr—Turley clay loam, 0 to 2 percent slopes									
Turley		—	—		0	—	Low	High	Low

Data Source Information

Soil Survey Area: Mesa County Area, Colorado
Survey Area Data: Version 5, Sep 22, 2014

APPENDIX B
Typed Boring Logs

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

BORING NUMBER B-1

CLIENT City of Grand Junction
PROJECT NAME F.5-30.8 Rd Structure
PROJECT NUMBER 00208-0062
PROJECT LOCATION Grand Junction
DATE STARTED 6/8/15 **COMPLETED** 6/8/15
GROUND ELEVATION ____ **HOLE SIZE** 4-inch
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Truck Rig
∇ **AT TIME OF DRILLING** 18.5 ft
LOGGED BY CM **CHECKED BY** MAB
▼ **AT END OF DRILLING** 18.5 ft
NOTES
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0	ASPHALT Pavement										
	Granular Base Course										
	Sandy Lean CLAY (cl), trace gravel, brown, moist, soft to medium stiff										
		MC 1	11	5-4-3 (7)							
5											
		MC 2	67	3-3-2 (5)		95	20				
10											
		SS 1	67	3-2-2 (4)							
15											
	Sandy GRAVEL (gw), tan to brown, moist to wet, medium dense	SS 2	67	3-5-4 (9)							
20											
	SHALE, brown, soft, moderately weathered										
		SS 3	83	17-23							
	Bottom of hole at 24.0 feet.										

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

BORING NUMBER B-2

CLIENT City of Grand Junction
PROJECT NAME F.5-30.8 Rd Structure
PROJECT NUMBER 00208-0062
PROJECT LOCATION Grand Junction
DATE STARTED 6/8/15 COMPLETED 6/8/15
GROUND ELEVATION ___ HOLE SIZE 4-inch
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Truck Rig
AT TIME OF DRILLING 19.0 ft
LOGGED BY CM CHECKED BY MAB
AT END OF DRILLING 19.0 ft
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		ASPHALT Pavement										
		Granular Base Course										
		Sandy Lean CLAY (cl), trace gravel, brown, moist, soft to medium stiff										
			MC 1	67	2-2-3 (5)		89	19				
5												
			SS 1	67	2-2-2 (4)							
10												
			SS 2	89	1-2-2 (4)							
15												
			SS 3	33	4-1-3 (4)							
20		Sandy GRAVEL (gw), tan to brown, wet, medium dense										
		SHALE, brown, soft, moderately weathered										
			SS 4	78	17-21-24 (45)							
		Bottom of hole at 24.5 feet.										

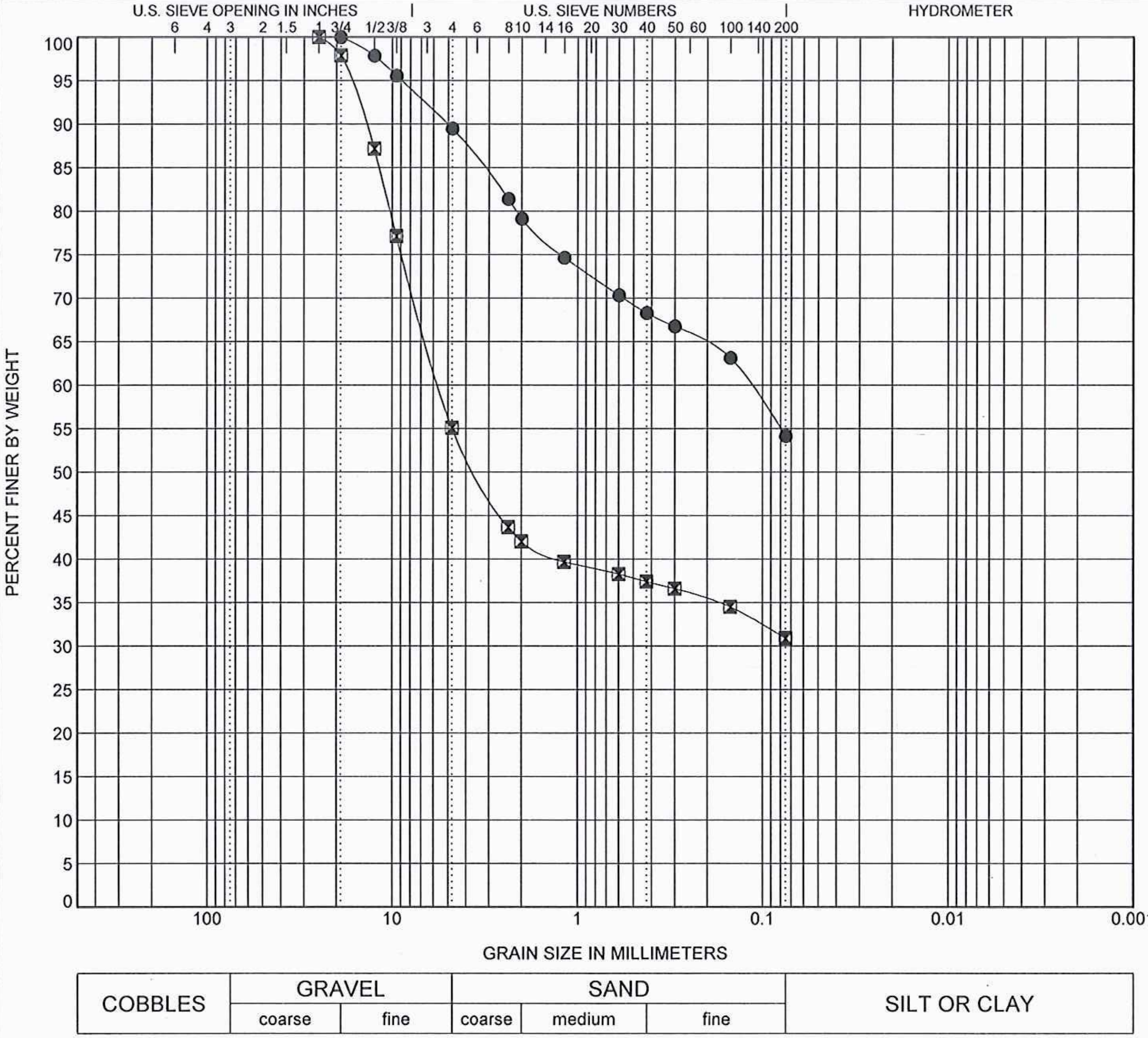
APPENDIX C
Laboratory Testing Results

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

GRAIN SIZE DISTRIBUTION

CLIENT City of Grand Junction **PROJECT NAME** F.5-30.8 Rd Structure

PROJECT NUMBER 00208-0062 **PROJECT LOCATION** Grand Junction



Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● **Composite**	**06/15**	**SANDY LEAN CLAY(CL)**	**30**	**15**	**15**		
⊠ **Creekbed**	**06/15**						

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **Composite**	**06/15**	**19**	**0.118**			**10.5**	**35.3**	**54.2**	
⊠ **Creekbed**	**06/15**	**25**	**5.545**			**44.9**	**24.2**	**30.9**	

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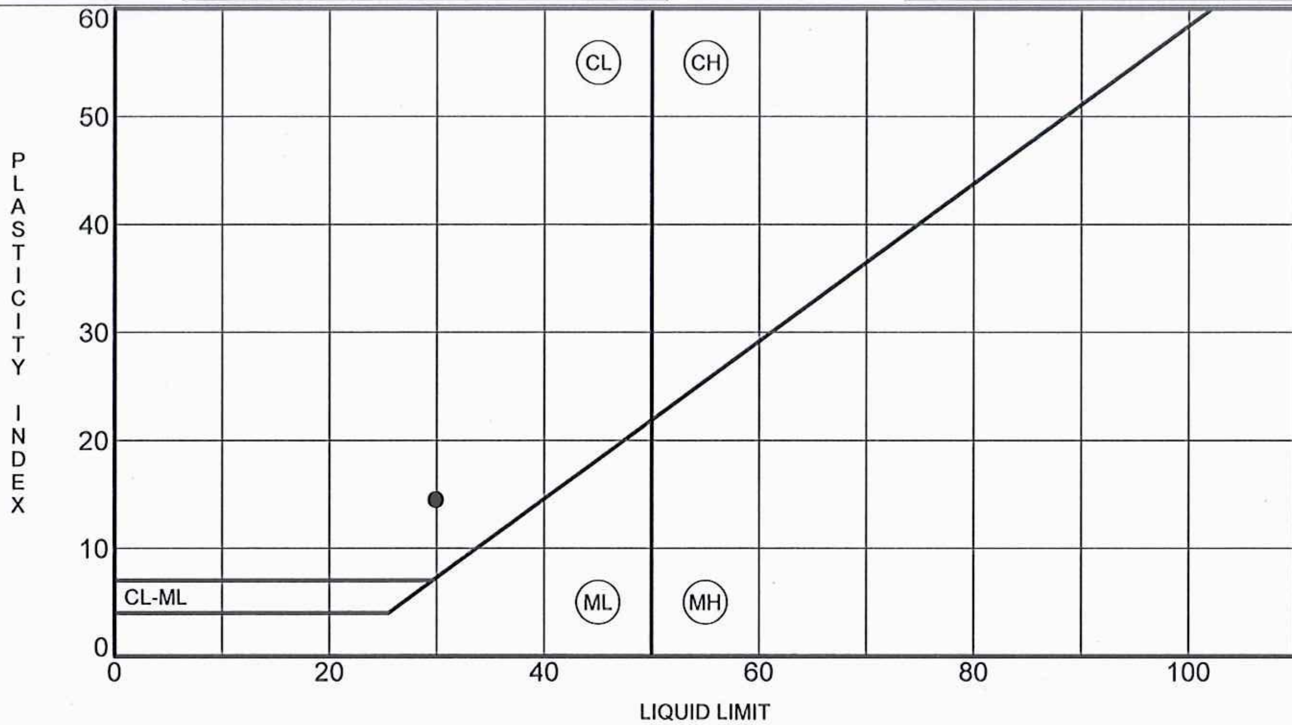
ATTERBERG LIMITS' RESULTS

CLIENT City of Grand Junction

PROJECT NAME F.5-30.8 Rd Structure

PROJECT NUMBER 00208-0062

PROJECT LOCATION Grand Junction



	Specimen Identification		LL	PL	PI	#200	Classification
●	**Composite**	**6/2015**	**30**	**15**	**15**	**54**	**SANDY LEAN CLAY(CL)**

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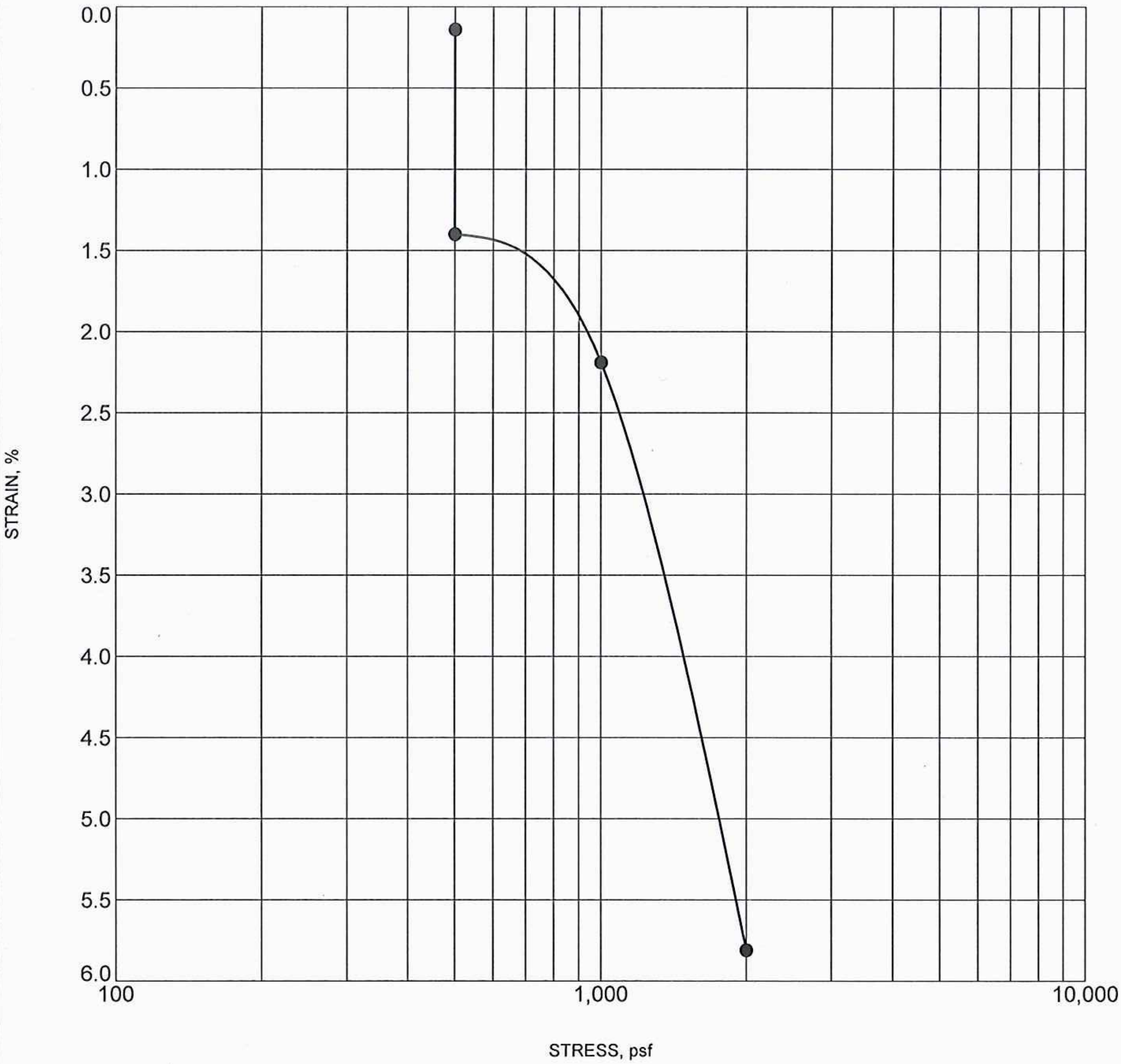
CONSOLIDATION TEST

CLIENT City of Grand Junction

PROJECT NAME F.5-30.8 Rd Structure

PROJECT NUMBER 00208-0062

PROJECT LOCATION Grand Junction



	Specimen Identification		Classification	γ_d	MC%
●	B-1	7.0		95	20

CONSOL STRAIN 00208-0062 F 1.2STRUCTURE.GPJ GINT US LAB.GDT 6/22/15

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Grand Junction, CO 81501
970-255-8005
970-255-6818

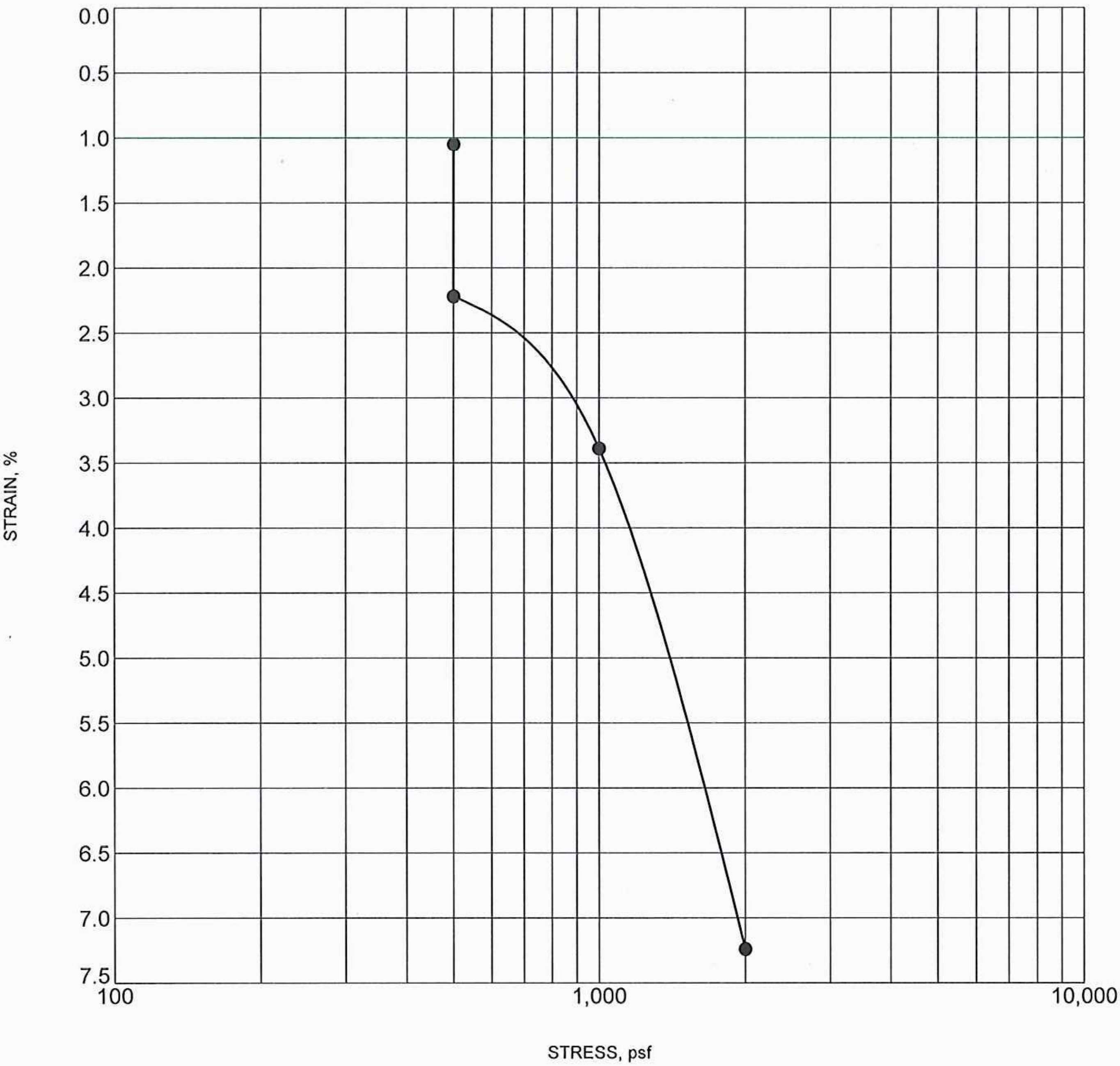
CONSOLIDATION TEST

CLIENT City of Grand Junction

PROJECT NAME F.5-30.8 Rd Structure

PROJECT NUMBER 00208-0062

PROJECT LOCATION Grand Junction



	Specimen Identification		Classification	γ_d	MC%
●	B-2	2.0		89	19

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MOISTURE-DENSITY RELATIONSHIP

CLIENT City of Grand Junction

PROJECT NAME F.5-30.8 Rd Structure

PROJECT NUMBER 00208-0062

PROJECT LOCATION Grand Junction

Sample Date:	6/8/2015
Sample No.:	1
Source of Material:	Composite
Description of Material:	SANDY LEAN CLAY(CL)
Test Method:	ASTM D698A

TEST RESULTS

Maximum Dry Density 117.5 PCF

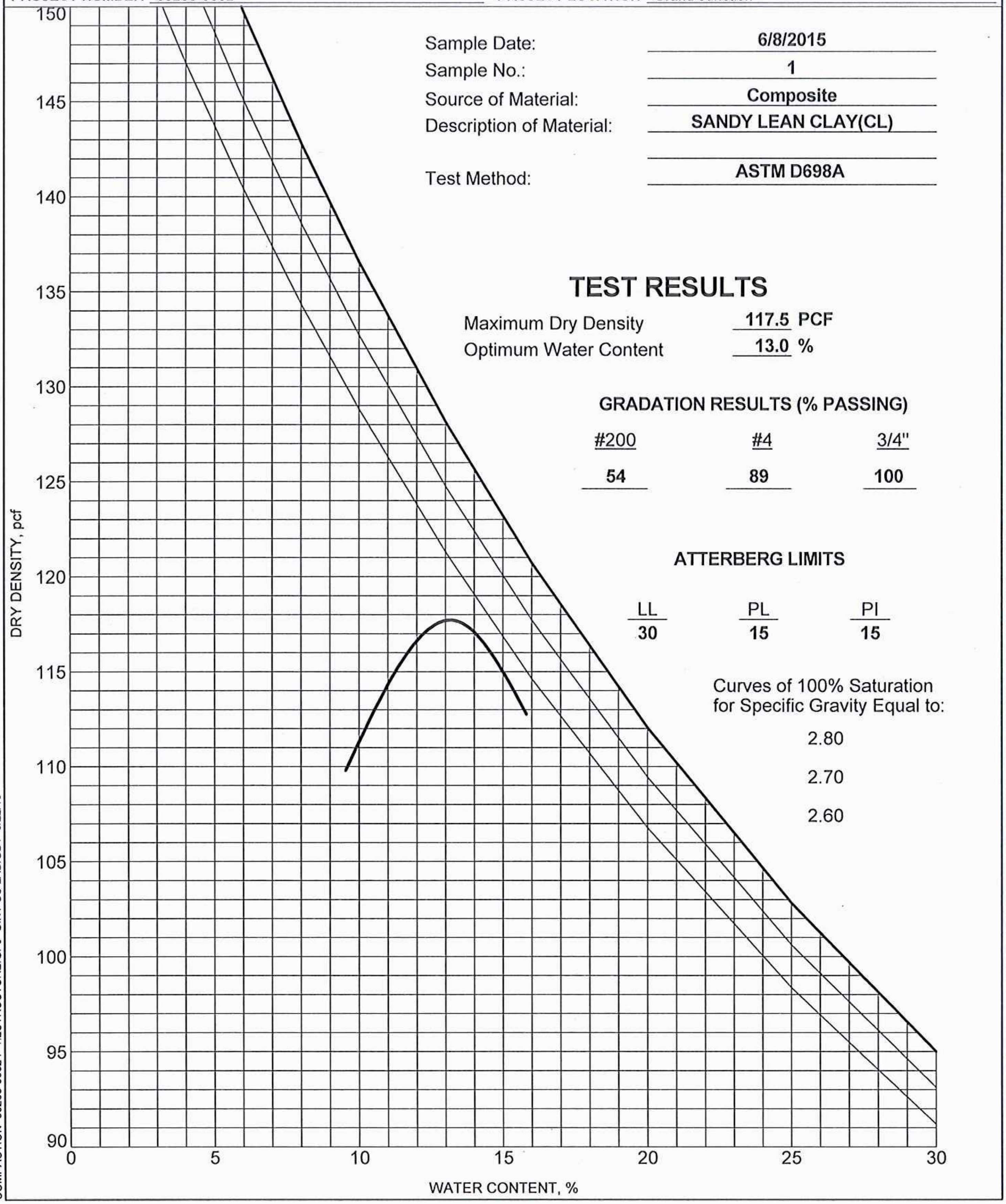
Optimum Water Content 13.0 %

GRADATION RESULTS (% PASSING)

#200	#4	3/4"
54	89	100

ATTERBERG LIMITS

LL	PL	PI
30	15	15



CALIFORNIA BEARING RATIO
ASTM D1883

Huddleston-Berry Engineering & Testing, LLC

Project No.:	00208-0062	**Authorized By:**	Client	**Date:**	06/08/15
Project Name:	F.5 - 30.8 Road Structure	**Sampled By:**	CM	**Date:**	06/08/15
Client Name:	City of Grand Junction	**Submitted By:**	CM	**Date:**	06/08/15
Sample Number:	15-0266 **Location:** Composite	**Reviewed By:**	MAB	**Date:**	06/24/15

Compaction Method: ASTM D698, Method A

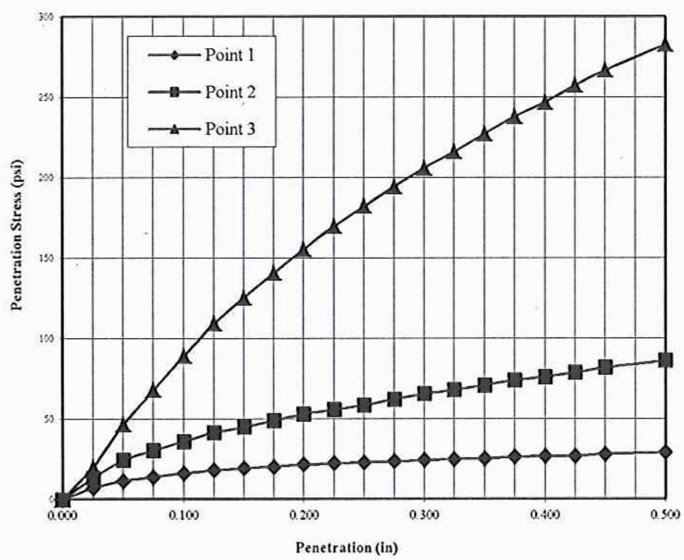
Maximum Dry Density (pcf): 117.5

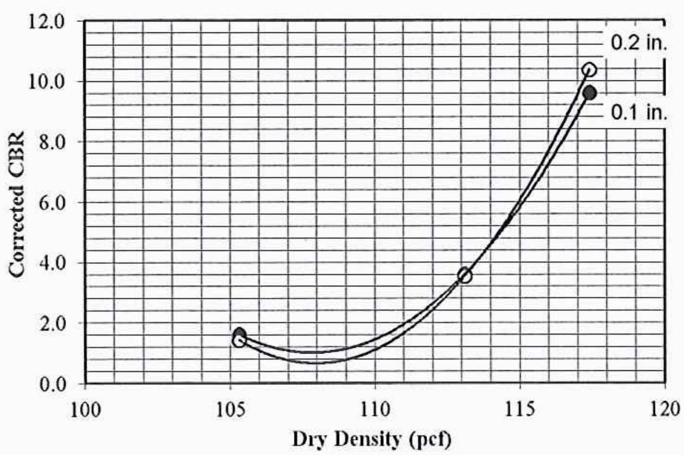
Opt. Moisture Content (%): 16.5

Sample Condition: Soaked

Remarks:

Sample Data		Point 1	Point 2	Point 3
Blows per Compacted Lift:		15	25	56
Surcharge Weight (lbs):		10.0	10.0	10.0
Dry Density Before Soak (pcf):		105.3	113.1	117.4
Dry Density After Soak (pcf):		104.4	112.3	116.9
Moisture Content (%)	Bottom Pre-Test	10.6	10.3	11.5
	Top Pre-Test	10.7	10.0	11.3
	Top 1" After Test	17.7	16.4	13.9
	Average After Soak:	19.0	15.4	13.5
Percent Swell After Soak:		0.9	0.7	0.4





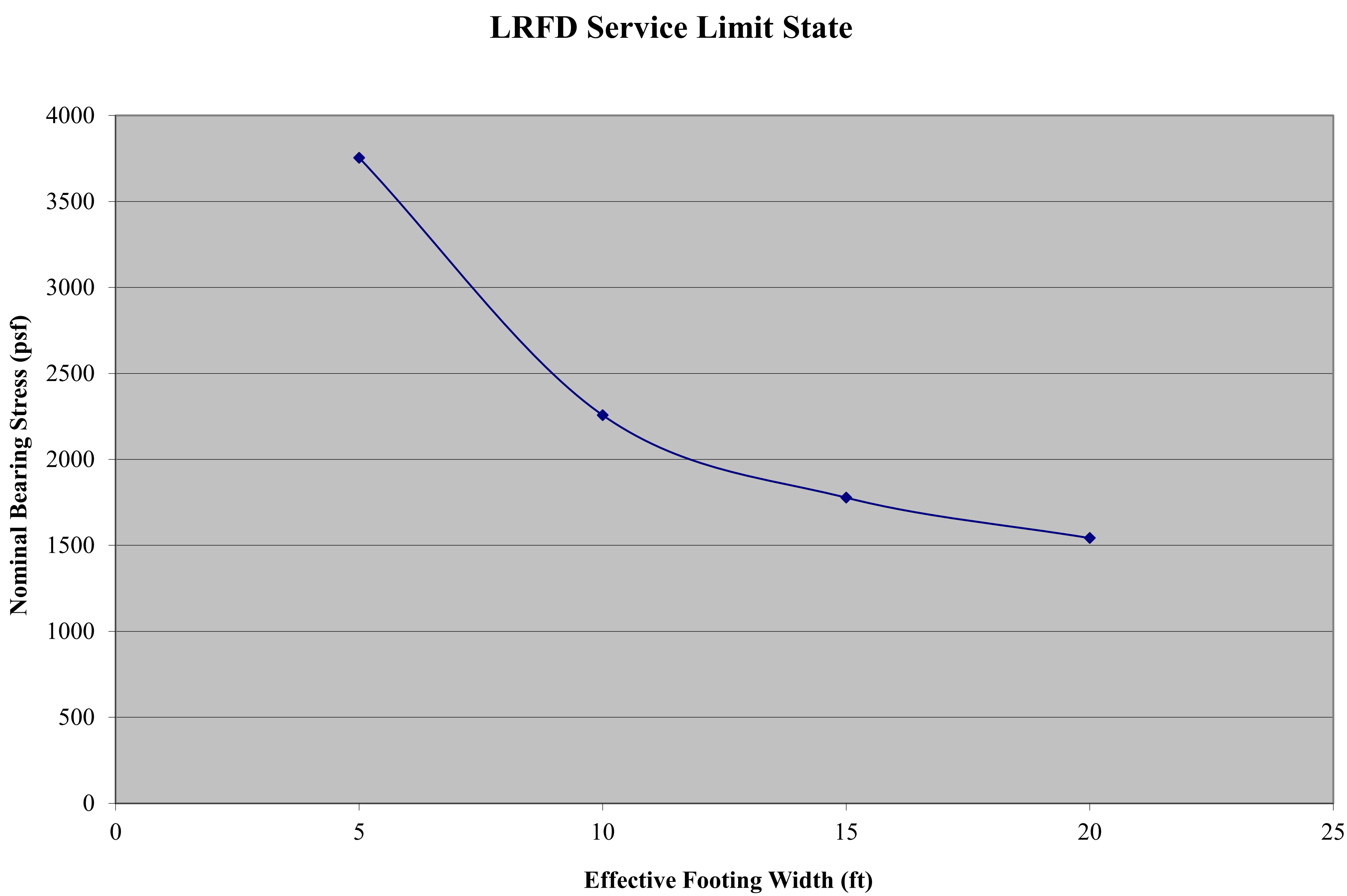
Penetration Data								
Point 1			Point 2			Point 3		
Dist. (in)	Load (lbs)	Stress (psi)	Dist. (in)	Load (lbs)	Stress (psi)	Dist. (in)	Load (lbs)	Stress (psi)
0.000	0	0	0.000	0	0	0.000	0	0
0.025	21	7	0.025	40	14	0.025	60	20
0.050	34	12	0.050	72	24	0.050	138	47
0.075	41	14	0.075	90	30	0.075	201	68
0.100	48	16	0.100	107	36	0.100	264	89
0.125	54	18	0.125	123	42	0.125	323	109
0.150	57	19	0.150	133	45	0.150	371	126
0.175	60	20	0.175	145	49	0.175	416	141
0.200	64	22	0.200	157	53	0.200	460	156
0.225	66	22	0.225	165	56	0.225	502	170
0.250	68	23	0.250	173	59	0.250	539	182
0.275	70	24	0.275	184	62	0.275	575	195
0.300	72	24	0.300	194	66	0.300	609	206
0.325	74	25	0.325	201	68	0.325	639	216
0.350	75	25	0.350	210	71	0.350	672	227
0.375	78	26	0.375	219	74	0.375	704	238
0.400	79	27	0.400	225	76	0.400	730	247
0.425	80	27	0.425	233	79	0.425	761	257
0.450	83	28	0.450	242	82	0.450	789	267
0.500	86	29	0.500	255	86	0.500	836	283

Corrected CBR @ 0.1"		
1.6	3.6	9.6
Corrected CBR @ 0.2"		
1.4	3.5	10.4

Penetration Distance Correction (in)		
0.000	0.000	0.000

Figure: ____

APPENDIX D
Nominal Bearing Resistance at the Service Limit State


LRFD Service Limit State
4000
3500
3000
2500
2000
1500
1000
500
0
Nominal Bearing Stress (psf)
0
5
10
15
20
25
Effective Footing Width (ft)

APPENDIX E
ESAL Calculations

Given: (From City of GJ)

$2010\ ADT = 1679$

Assumptions:

5.% of vehicles are trucks

80% of trucks are single unit

20% of trucks are combination

2% annual growth

Calculate ADT in 2015

$ADT_{2015} = (1679)(1.02)^5 = 1854$

Calculate ADT in 2035

$ADT_{2035} = (1679)(1.02)^{25} = 2755$

Calculate ADT at Midpoint

$ADT = (1854 + 2755)/2 = 2305$

Calculate breakdown of vehicles and multiply by equivalency factors for flexible pavement

$Automobiles = (2305)(0.95)(0.003) \approx 7$

$Single\ Unit = (2305)(0.05)(0.8)(0.249) \approx 23$

$Combination = (2305)(0.05)(0.2)(1.087) \approx \underline{25}$

55

Calculate flexible pavement ESAL's

$ESAL's = (55)(365\ days/yr)(20\ yr)(0.6) = 240,900 \approx \underline{\underline{250,000}}$ ←

↑ 1 lane each direction