Huddleston-Berry
Engineering & Testing, LLC

GEOLOGIC HAZARDS AND PRELIMINARY GEOTECHNICAL INVESTIGATION MATCHETT PARK GRAND JUNCTION, COLORADO PROJECT#00208-0053

CITY OF GRAND JUNCTION
1340 GUNNISON AVENUE
GRAND JUNCTION, COLORADO 81501

MAY 16, 2014

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1.0 INTRODUCTION

As part of continued development in Western Colorado, the City of Grand Junction is evaluating a proposed Master Plan for Matchett Park in Grand Junction. 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 preliminary geotechnical investigation at the site.

1.1 Scope

As discussed above, a geologic hazards and preliminary geotechnical investigation was conducted for proposed improvements to Matchett Park 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 types 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 the north side of Patterson Road, east of 28 Road, in Grand Junction. The site includes approximately 205 acres. The project location is shown on Figure 1 – Site Location Map.

At the time of the investigation, the majority of the site was open agricultural land with a slight slope down to the south. Indian Wash ran through the eastern portion of the site and the land on the other side of the wash was open, undulating ground. Gravel roads and irrigation ditches cross the site. The site was bordered to the south by Patterson Road, to the east by residential subdivisions and rural residential properties, to the north by the Highline Canal, and to the west by residential subdivisions and 28¼ Road.

1.3 Proposed Construction

The proposed construction is anticipated to include several new structures, new detention ponds, new recreational facilities, new utilities, and new pavements. A copy of the proposed master site plan is included as Figure 3.

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 several soil types are present at the site. However, the predominant soil types include Sagers silty clay loam, 0 to 2 percent slopes; Persayo silty clay loam, 5 to 12 percent slopes; Killpack silty clay, 0 to 2 percent slopes; and Sagrlite loam, 0 to 2 percent slopes. Soil survey data is included in Appendix A.

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 10.0 and 22.0 feet below the ground surface. Due to the fact that the borings were conducted at the beginning of the irrigation season, the groundwater levels likely do not reflect the seasonal high groundwater elevation at the site.

3.0 FIELD INVESTIGATION

3.1 Subsurface Investigation

The subsurface investigation was conducted on April 4th, 2014 and consisted of seven geotechnical borings. The borings were drilled to depths of between 5.0 and 24.5 feet below the existing ground surface. Boring locations are shown on Figure 2 – Site Plan. 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 shown on the logs, the subsurface conditions were slightly variable. Borings B-1, B-2, and B-4, conducted in the southeastern portion of the site, generally encountered brown, moist, medium stiff lean clay soils to depths of between 1.0 and 2.5 feet. The clay was underlain by gray, very soft, completely to highly weathered shale bedrock to the bottoms of the borings. Groundwater was not encountered in B-1. However, in B-2 and B-4, groundwater was encountered at depths of 10.0 and 13.5 feet, respectively.

Borings B-3, B-5, and B-6, conducted in the southwestern and northeastern portions of the site, generally encountered brown, moist to wet, very soft to medium stiff lean clay soils to depths of between 13.0 and 23.0 feet. The clay was underlain by gray, very soft, completely to highly weathered shale bedrock to the bottoms of the borings. Groundwater was encountered in these borings at depths of between 20.0 and 22.0 feet.

Boring B-7, conducted in the northwestern portion of the site, encountered brown, moist to wet, medium stiff lean clay soils to a depth of 16.0 feet. The clay was underlain by brown, wet, medium dense to very loose sandy gravel and cobbles to the bottom of the boring. Groundwater was encountered in B-7 at a depth of 15.5 feet.

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, Atterberg limits, maximum dry density and optimum moisture (Proctor), swell/consolidation, water soluble sulfates content, and California Bearing Ratio (CBR). The laboratory testing results are included in Appendix C.

The laboratory testing results indicate that the native clay soils are slightly to moderately plastic. In addition, the native clay soils were indicated to range from slightly collapsible to slightly expansive, with between approximately 2.3% collapse and 1.4% expansion measured in the laboratory. The shale bedrock was indicated to be moderately plastic. Due to the degree of weathering and/or fracturing, undisturbed samples of the shale were unable to be collected for swell/consolidation testing. However, based upon our experience with the Mancos shale in the vicinity of the subject site, the shale bedrock at this site is anticipated to be slightly to moderately expansive. Water soluble sulfates were detected in the site soils in concentrations as high as 1.0%.

5.0 GEOLOGIC INTERPRETATION

5.1 Geologic Hazards

The most critical geologic hazard identified on the site is the presence of moisture sensitive soils and bedrock. However, flooding of Indian Wash may also impact the design and/or construction.

5.2 Geologic Constraints

In general, the primary geologic constraint to construction at the site is the presence of moisture sensitive soils and bedrock. However, shallow bedrock may impact deep utility installation at the site.

5.3 Water Resources

No water supply wells were observed on the property. As discussed previously, Indian Wash runs through the eastern portion of the site. In general, with proper design and construction, the development of the property is not anticipated to adversely impact surface water or groundwater.

5.4 Mineral Resources

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 on the subject site at the time of the investigation, nor was any literary or cartographic information discovered that indicate the existence or potential 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 this site. However, foundations, pavements, and earthwork will have to consider the impacts of moisture sensitive soils and bedrock.

7.0 RECOMMENDATIONS

7.1 Foundations

The Master Plan indicates that several structures are proposed at the site. However, the precise nature, size, location, etc. of structures may change during the design development process. The recommendations herein are preliminary in an effort to provide the Owner with information regarding likely foundation types for structures. However, additional subsurface investigation and specific recommendations should be developed for each structure as the design process moves forward.

As discussed previously, expansive soils and bedrock were encountered at the site. In addition, the shale bedrock was very shallow in the southeastern portion of the site and deeper elsewhere. In general, larger structures in the southeastern portion of the site should consider deep foundations such as drilled piers or micropiles to limit the risk of excessive differential movements. For smaller structures less sensitive to differential movements, shallow foundations such as spread footings or structural ribbed (waffle) slabs could be considered.

In the western and northern portions of the site where the shale or gravel bearing stratum is deeper, soft soils were encountered. As a result, larger structures in these areas should consider deep foundations such as driven piles or helical piles. Lightly loaded structures in these areas could consider shallow foundations such as spread footings, monolithic (turndown edge) structural slabs, or structural ribbed (waffle) slabs.

7.1.1. Southeastern Portion of Site – Shallow Shale

Drilled Piers

Based upon the expansive nature of the native shale and, it is recommended that drilled piers be designed to bear in the deeper bedrock below the zone of seasonal moisture variation. Although the active-zone of seasonal moisture variation is difficult to define at this site, a depth of 20 feet will be assumed. Piers should extend a minimum of 10 feet below the active zone; therefore, a minimum pier length of 30 feet is recommended. Where possible, longer piers should be used in lieu of more piers. A smaller number of longer piers will provide the maximum resistance to uplift.

Skin friction should be disregarded along the upper 20 feet of the piers; however, an allowable skin friction of 1,500 psf may be used below this depth in the lower bedrock. In addition, an allowable end-bearing capacity of 20,000 psf may be used for the deeper bedrock. However, the piers should be designed for a minimum dead-load pressure of 15,000 psf based upon the pier bottom end area. The skin friction given above can be assumed to act in the direction to resist uplift for the length of the pier below the active zone.

Drilled piers should be reinforced their full length using a reinforcement ratio of at least 1.0 percent; however, the piers should be adequately reinforced to resist possible tensile forces due to swelling of the shallow, expansive shale materials. Concrete used in the piers should be a fluid mix with a minimum slump of 4-inches and a minimum 28-day compressive strength of 3,000 psi.

Swelling soils and bedrock exaggerate group effects on drilled piers. Therefore, the minimum center-to-center spacing of drilled piers should be eight diameters, or twelve feet, whichever is less. Drilled piers grouped less than eight diameters, or twelve feet, center-to-center should be individually evaluated to determine the appropriate reduction in end bearing capacity. A minimum 6-inch void should be provided beneath the grade beams to concentrate pier loadings and prevent expansive materials from exerting uplift forces on the grade beams.

Proper construction of drilled piers is critical. Therefore, it is strongly recommended that the piers be installed by a highly experienced contractor. In addition, it is strongly recommended that HBET and the structural engineer conduct oversight of pier construction. Pier holes must be clean and dry prior to concrete placement. Due to the presence of groundwater, dewatering and/or tremie grouting will likely be required. It is recommended that concrete be placed the day of pier drilling. In addition, care should be taken to prevent over-sizing of the tops of the piers. Mushroomed pier heads can reduce the effective dead-load pressure on the piers. Piers should also be within 2% of vertical and constant diameter.

Micro Piles

For a micro pile foundation, it is recommended that micro piles have a minimum length of 30 feet. Due to the presence of groundwater, hollow bar, injection grouted micro piles should be considered. In order to reduce or eliminate uplift friction in the shallow bedrock, the upper 20 feet of the piles should be sleeved or cased. An allowable skin friction value of 1,500 psf may be used for the shale bedrock below the sleeved or cased zone. To ensure friction capacity, pile load testing is strongly recommended. Grout used in the bond zone of the micro piles should have a minimum 28 day compressive strength of 3,000 psi.

In general, micro piles should be installed with a center-to-center spacing of greater than 3 feet. However, to the extent practical, smaller numbers of longer micro piles should be used in lieu of larger numbers of shorter piles. The longer the piles and larger the loads on the piles, the lower the risk of movement. A minimum 6-inch void should be provided below the grade beams to concentrate loadings on the piles. The void forms should also extend above the micro piles such that only the reinforcement bar contacts the grade beam.

Spread Footing, Voided Spread Footing, or Isolated Pad and Grade Beams

In general, spread footing, voided spread footing, and isolated pad and grade beam foundations are intended to maximize the foundation pressures in order to limit the potential for excessive differential movement. In order to provide additional spreading of isolated expansion pressures, it is recommended that spread footing, isolated spread footing, and/or isolated pad and grade beam foundations be constructed above a minimum of 48-inches of structural fill.

Imported structural fill should consist of a granular, non-expansive, non-free draining material such as pit-run, crusher fines, or CDOT Class 6 base course. However, if pit-run is used as structural fill, a minimum of 6-inches of base course, crusher fines, or other suitable fill material should be placed above the pit-run to prevent large point stresses on the bottoms of the foundations due to large particles in the pit-run.

Prior to placement of structural fill, it is recommended that the bottom of the foundation excavation in bedrock be proofrolled to identify any soft or weak materials. Soft or weak materials should be removed and replaced with structural fill. 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 90% of the 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.

For the foundation building pad prepared as recommended with structural fill consisting of imported granular materials above competent shale bedrock, a maximum allowable bearing capacity of 2,500 psf may be used. However, a minimum dead-load pressure of 750 psf is recommended for spread footing, voided spread footing, or isolated pad and grade beam foundations. Where the minimum dead load is not achievable, such as for interior footings, the dead load should be maximized to the extent practical. In order to limit the potential for a punching shear bearing capacity failure in the structural fill, footings should be a minimum of 12-inches wide. The bottoms of exterior foundations should extend a minimum of 24-inches below grade for frost protection.

Ribbed (Waffle) Structural Slabs

Whereas spread footing type foundations above expansive subgrades are intended to limit the potential for movement by maximizing the foundation pressures, structural waffle slab foundations are anticipated to move. However, this type of foundation should be designed such that the entire slab and structure move together under isolated expansive pressures. Slab bending is typically limited by the use of several grade beams or 'ribs' at the base of the slab to provide rigidity. The depth, thickness, and location of the ribs should be determined by the structural engineer.

In general, it is recommended that the grade beams below the slab be excavated into a layer of structural fill placed above the shale bedrock. The structural fill should extend a minimum of 12-inches beyond the bottom of the ribs. Subgrade preparation, structural fill materials, and structural fill placement should be in accordance with the *Spread Footing, Voided Spread Footing, or Isolated Pad and Grade Beams* section of this report.

For the foundation building pad prepared as recommended with structural fill consisting of imported granular materials, a maximum allowable bearing capacity of 2,500 psf may be used. In addition, a modulus of subgrade reaction of 250 pci may be used. The bottoms of exterior grade beams should extend a minimum of 24-inches below grade for frost protection.

7.1.2. Western and Northern Portions of Site – Soft Soils and Deep Bearing

Driven Steel Piles

It is anticipated that most of the axial pile capacity will be developed in end bearing in the shale bedrock or dense gravel and cobble soils. Therefore, concrete filled pipe piles are recommended.

Based upon the anticipated working loads and pile driving conditions, pipe piles should be a minimum of 10¾ inch diameter. The piles should penetrate the soft / loose clay soils and bear into the shale bedrock or dense gravel and cobble soils. The actual penetration of individual piles will be dependent upon driving conditions and size of pile used; however, it is anticipated that the piles will reach refusal within 3 to 10 feet of the top of the bearing layer. As indicated in the boring logs, the bearing stratum was encountered at depths of between 13.0 and 23.0 feet. Therefore, pile lengths of up to approximately 33 feet may be possible.

The refusal criterion for driven piles is dependent upon the type and size of the hammer. However, the refusal criteria should be established as the number of blows required for the last few inches of penetration. For a hammer delivering 20,000 foot-pounds of energy to a 10¾ inch pipe pile, we would expect refusal to be at approximately 5 to 8 blows per inch. However, the contractor should coordinate with HBET to develop specific pile refusal criteria. To reduce the possibility of excessive tip deflection and tip damage, pile tip reinforcement is recommended.

For 10¾-inch diameter, concrete filled pipe piles driven to refusal, HBET recommends an allowable geotechnical capacity of 50 tons. In general, a minimum 3/8-inch wall thickness is recommended. However, ¼-inch wall thickness may be utilized provided the structural engineer and/or contractor can verify that the driving stresses will not damage the thinner walled piles. The lateral capacity of the piles should consider the low lateral support provided by the soft clay soils.

To eliminate reductions in capacity from group effects, the minimum center-to-center spacing of piles should be 3 pile diameters. Group effects should be considered for piles grouped less than 3 diameters apart.

Helical Piles

Helical piles consist of circular steel shafts with load carrying helices attached to them. Some of these types of piles are proprietary. In general, the precise type, size, and quantity of piles should be established by the contractor in conjunction with the structural engineer. However, HBET provides the following design comments.

In general, helical piles should be designed to penetrate the clay soils and bear into the shale bedrock or dense gravel soils. In addition, to eliminate reductions in capacity from group effects, the piles should be spaced a distance equal to three times the diameter of the largest helix. It is anticipated that the helical piles will reach refusal within 5 to 15 feet of the bearing stratum. Therefore, pile lengths of up to approximately 38 feet may be possible.

Based upon our experience with other projects utilizing helical piles, allowable axial capacities of between approximately 40 and 60 tons are anticipated for piles with a minimum shaft diameter of 4-inches. However, higher capacities are possible depending on the specific pile type/size proposed. The actual allowable capacity should be determined based upon the results of pile load testing conducted on the project site. Also, the design of helical piles should consider the low lateral support provided by the native soils. Where necessary, battered piles should be utilized to carry lateral loads

Spread Footings or Monolithic (Turndown) Structural Slabs

Spread footings and monolithic structural slabs are both appropriate shallow foundation alternatives for lightly loaded structures above the native clay soils. However, as discussed previously, the native clay soils are moisture sensitive and these types of foundations will provide limited resistance to differential movements associated with volume change in the native soils. In order to reduce the potential for excessive differential movements, it is recommended that spread footings or monolithic structural slabs be constructed above a minimum of 30-inches of structural fill.

Due to their potential for expansion, it is recommended that the native clay soils not be reused as structural fill. Imported structural fill should consist of a granular, non-expansive, non-free draining material such as pit run, crusher fines, or CDOT Class 6 base course. However, if pit-run is used as structural fill, a minimum of six inches of Class 6 base course or crusher fines should be placed on top of the pit-run to prevent large point stresses on the bottoms of the foundations due to large particles in the pit-run.

Prior to placement of structural fill, it is recommended that the bottoms of the foundation excavations be scarified to a depth of 6 to 8-inches, moisture conditioned, and re-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, as discussed previously, soft soils were encountered in some of the borings and this may make compaction of the subgrade difficult. Where soft conditions exist, subgrade stabilization utilizing pit-run and geotextile and/or geogrid may be required. HBET should be contacted to provide specific recommendations for subgrade stabilization based upon the actual subgrade conditions encountered during construction. However, it may be necessary to use up to 30-inches of additional pit-run and two to three layers of geogrid to achieve subgrade stability.

Structural fill should extend laterally beyond the edges of the foundations 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 or 90% of the modified Proctor maximum dry density for coarse grained soils, within ±2% of the optimum moisture content as determined in accordance with ASTM D698 or D1557C, respectively. Pit-run should be proofrolled to the Engineer's satisfaction.

For foundation building pads prepared as recommended with structural fill consisting of imported granular materials, a maximum allowable bearing capacity of 1,500 psf may be used. In addition, a modulus of subgrade reaction of 250 pci may be used for structural fill consisting of pit-run, crusher fines, or base course. It is recommended that the bottoms of exterior foundations be at least 24-inches below the final grade for frost protection.

Ribbed or Waffle Structural Slabs

As stated previously, structural waffle slab foundations are anticipated to move. However, this type of foundation should be designed such that the entire slab and structure move together. Slab bending is typically limited by the use of several grade beams or 'ribs' at the base of the slab to provide rigidity. The depth, thickness, and location of the ribs should be determined by the structural engineer.

In general, it is recommended that the grade beams below the slab be excavated into a layer of structural fill. The structural fill should extend a minimum of 12-inches beyond the bottom of the ribs. Subgrade preparation, structural fill materials, and structural fill placement should be in accordance with the *Spread Footings and Monolithic (Turndown) Structural Slabs* section of this report.

For the foundation building pad prepared as recommended with structural fill consisting of imported granular materials, a maximum allowable bearing capacity of 1,500 psf may be used. In addition, a modulus of subgrade reaction of 250 pci may be used. The bottoms of exterior grade beams should extend a minimum of 24-inches below grade for frost protection.

7.2 Seismic Design Criteria

In general based upon the results of the subsurface investigation, the northern and western portions of the site classify as Site Class E for a soft soil profile. The southeastern portion of the site classifies ad Site Class D for a stiff soil profile.

7.3 Corrosion of Steel and Concrete

As indicated previously, water soluble sulfates were encountered in the site soils in concentrations as high as 1.0%. These concentrations represent a severe degree of potential sulfate attack on concrete. Therefore, Type V cement is recommended in accordance with the International Building Code. 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.

With regard to steel corrosion, corrosivity testing was not completed as part of this preliminary investigation. The soils in the Grand Valley generally have a slight potential for steel corrosion. However, it is recommended that corrosivity testing be completed as part of structure specific geotechnical investigations at this site where driven piles or helical piles may be considered.

7.4 Non-Structural Floor Slabs and Exterior Flatwork

As mentioned above, expansive materials are present in the subsurface at the site. In general, slabs-on-grade cannot develop sufficient bearing pressures to resist swelling pressures. Therefore, some movement of slabs-on-grade should be expected. The risk will be higher in the southeastern portion of the site where shallow shale bedrock is present. The only way to limit the potential for excessive differential movements would be to utilize a structural floor supported by the foundations. However, where a structurally supported floor is not used, while the risk of movement cannot be eliminated, the risk can be reduced by constructing a floating floor slab on a minimum of 36 inches of structural fill. Exterior flatwork in the southeastern portion of the site should be constructed on a minimum of 18-inches of structural fill. Floating slabs-on-grade, such as non-structurally supported floor slabs and exterior flatwork, in the southeastern portion of the site should not be tied in or connected to the foundations in any manner. If a non-structurally supported floor slab is used, interior non-bearing partitions should include a slip-joint or framing void which permits a minimum of 2-inches of vertical movement.

In the northern and western portions of the site where the shale is deeper, it is recommended that non-structural floor slabs be constructed above a minimum of 18-inches of structural fill. Exterior flatwork should be constructed above a minimum of 12-inches of structural fill.

7.5 Lateral Earth Pressures

Stemwalls and/or any retaining walls should be designed to resist lateral earth pressures. For backfill consisting of the native clay soils or imported granular, non-free draining, non-expansive material, we recommend that the walls be designed for an equivalent fluid unit weight of 55 pcf in areas where no surcharge loads are present. Lateral earth pressures should be increased as necessary to reflect any surcharge loading behind the walls. Shale bedrock materials should not be used as backfill.

7.6 Excavations

Excavations in the soils at the site may stand for short periods of time but should not be considered to be stable. The native clay soils generally classify as Type C soil with regard to OSHA's *Construction Standards for Excavations*. For Type C soils, the maximum allowable slope in temporary cuts is 1.5H:1V. The weathered shale bedrock generally classifies as Type B soil. For Type B soils, the maximum allowable slope in temporary cuts is 1H:1V. However, the soil classifications above are based solely upon the geotechnical boring data. HBET should be contacted to further evaluate site soils and/or bedrock with regard to OSHA soil classification at the time of construction.

7.7 Pavements

The proposed construction is anticipated to include new site roadways, parking lots, etc. As discussed previously, the pavement subgrade materials at the site consist primarily of native clay soils. The design California Bearing Ratio (CBR) of the native clay soils was determined in the laboratory to be less than 2.0. Therefore, the minimum recommended Resilient Modulus of 3,000 psi will be used for the pavement design.

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*. The following pavement section alternatives are recommended:

Automobile Parking Areas (Limited Truck Traffic)
ESAL's = 100,000, Structural Number = 3.10

ALTERNATIVE	PAVEMENT SECTION (Inches)				
	Hot-Mix Asphalt Pavement	CDOT Class 6 Base Course	CDOT Class 3 Subbase Course	Concrete Pavement	TOTAL
Full Depth HMA	7.0				7.0
A	3.0	13.0			16.0
B	4.0	10.0			14.0
C	3.0	6.0	10.0		19.0
Rigid Pavement		6.0		6.0	12.0

Mixed Use Areas (Higher Truck Traffic)
ESAL's = 350,000; Structural Number = 3.50

ALTERNATIVE	PAVEMENT SECTION (Inches)				
	Hot-Mix Asphalt Pavement	CDOT Class 6 Base Course	CDOT Class 3 Subbase Course	Rigid Pavement	TOTAL
Full Depth HMA	9.0				9.0
A	4.0	14.0			18.0
B	5.0	11.0			16.0
C	4.0	6.0	11.0		21.0
Rigid Pavement		6.0		8.0	14.0

Prior to new pavement placement, areas to be paved should be stripped of all topsoil, 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 ±2% of optimum moisture content as determined by AASHTO T-99. However, as discussed previously, soft soils were encountered in portions of the site and subgrade stabilization using geotextile and/or geogrid in conjunction with granular fill may be required. HBET should be contacted to provide specific recommendations for subgrade stabilization based upon the actual subgrade conditions during construction. However, up to approximately 30-inches of pit-run and three layers of geogrid may be required to stabilize the subgrade.

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. It is recommended that rigid pavements consist of CDOT Class P concrete or alternative approved by the Engineer. In addition, pavements should conform to local specifications.

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 preliminary and are based upon the results of seven borings across the 200 acre site. The recommendations are intended to provide the Owner sufficient information to permit preliminary planning and design for cost estimating purposes. However, additional subsurface investigation should be completed for each structure to verify the subsurface conditions and validate the recommendations included in this report. .

As discussed previously, moisture sensitive soils and bedrock were encountered at the site. The recommendations contained herein are designed to reduce the potential for excessive differential movements; however, HBET cannot predict long-term changes in subsurface moisture conditions and/or the precise magnitude or extent of volume change. Where significant increases in subsurface moisture occur due to poor grading, improper stormwater management, utility line failure, excess irrigation, etc. either during construction or the result of actions of the Owner, significant movements are possible.

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

COLORADO REGISTERED MICHAEL ALLAN BERRY 39010 05/16/14 PROFESSIONAL ENGINEER

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

FIGURES

City of Grand Junction

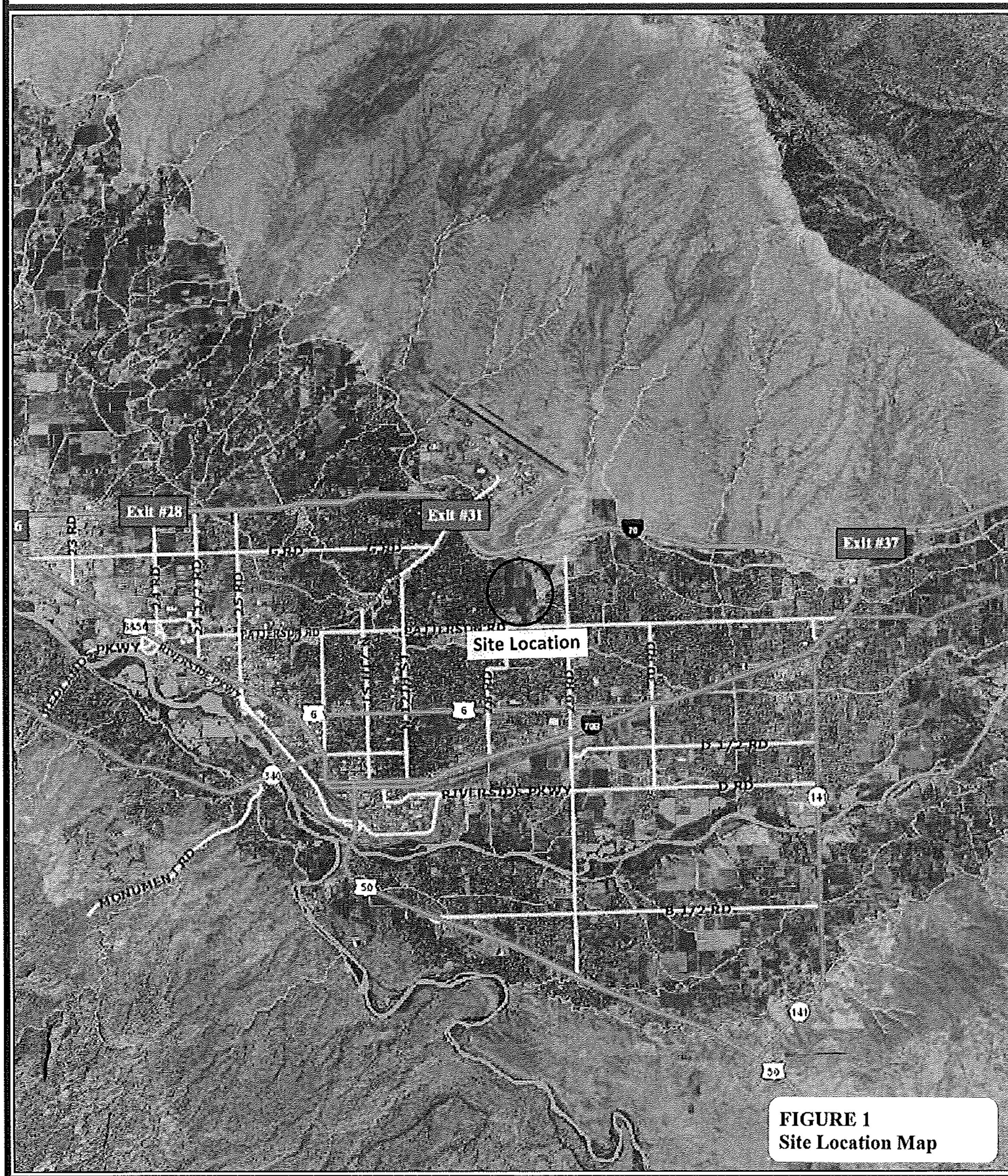


FIGURE 1
Site Location Map

N

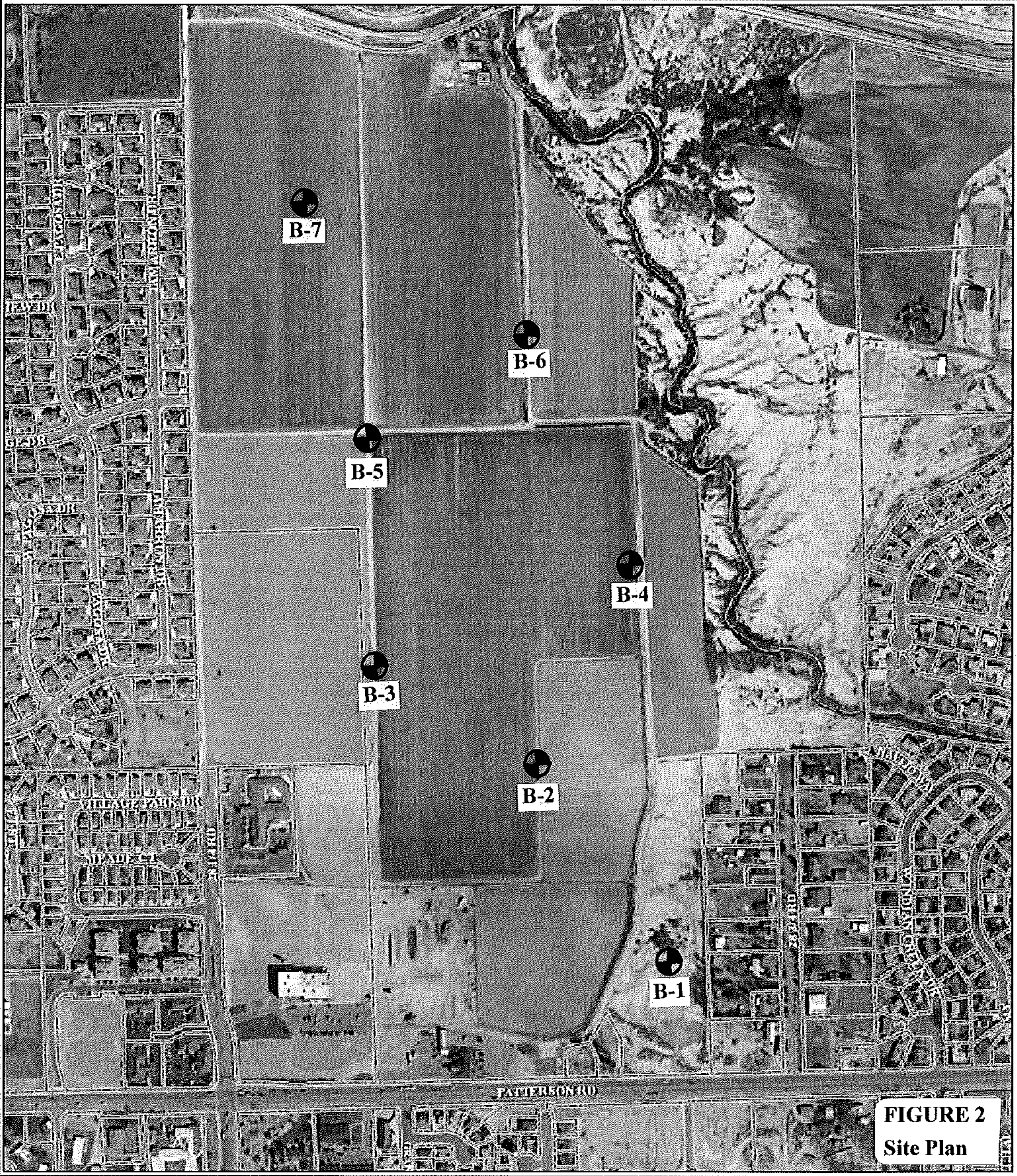
0 2.25 4.5 Miles

Printed: 5/7/2014

1 inch = 8,043 feet

City of Grand Junction Colorado
Geographic Information System

City of Grand Junction



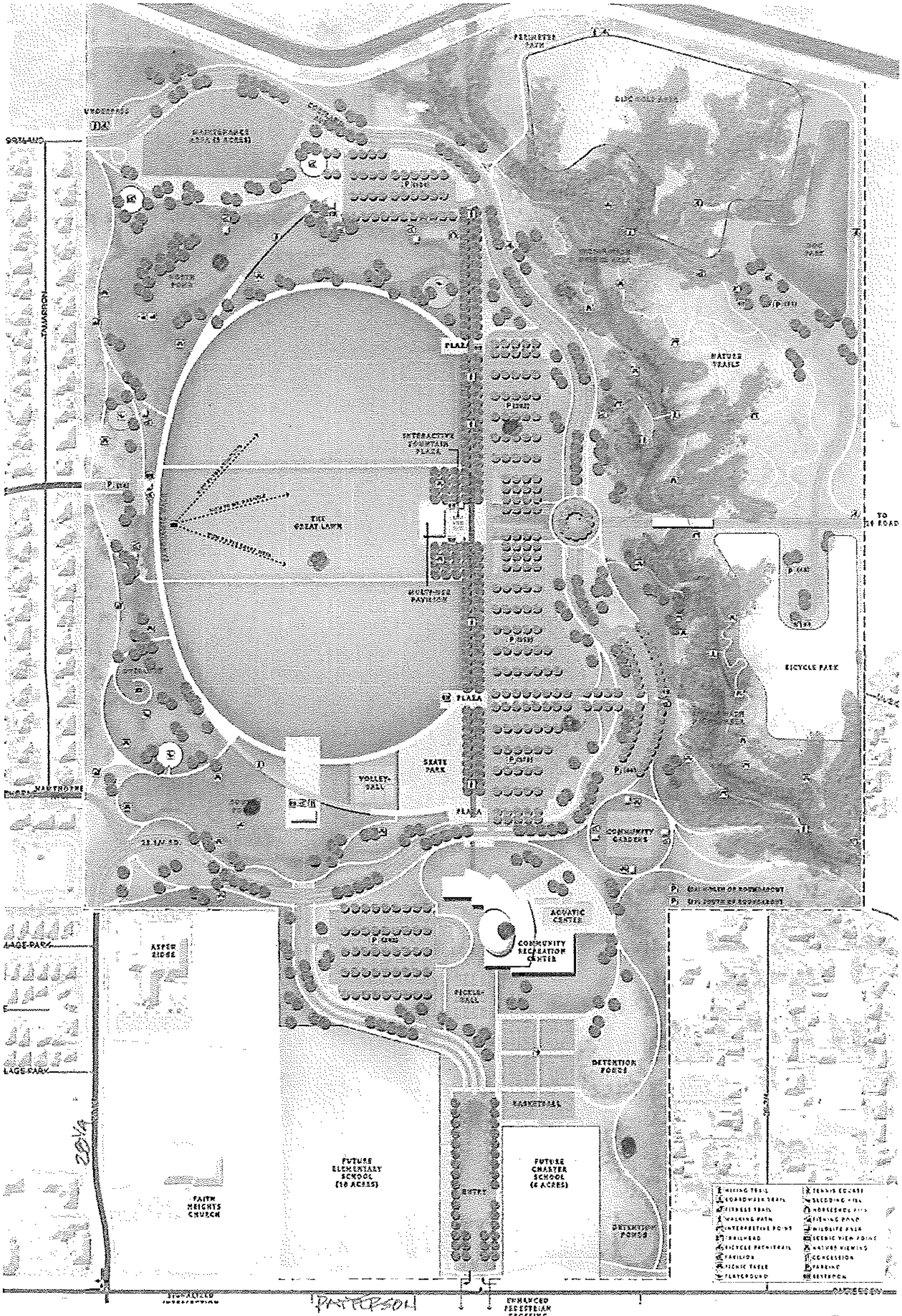
N

0 0.125 0.25 Miles

Printed: 5/7/2014

1 inch = 503 feet

City of Grand Junction Colorado
Geographic Information System



Matchett Park Master Plan

March 11, 2014

DESIGNWORKSHOP

FIGURE 3
Master Site Plan

APPENDIX A
Soil Survey Data

Soil Map—Mesa County Area, Colorado

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 4, Jan 2, 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**
75	Uffens fine sandy loam, 1 to 6 percent slopes	0.0	0.0%
Bc	Sagers silty clay loam, 0 to 2 percent slopes	71.7	25.2%
Cc	Persayo silty clay loam, 5 to 12 percent slopes	58.3	20.5%
Fe	Fruita clay loam, 0 to 2 percent slopes	5.3	1.9%
Hj	Killpack silty clay, 2 to 5 percent slopes	9.0	3.2%
Hk	Killpack silty clay, 0 to 2 percent slopes	47.1	16.6%
Re	Sagrlite loam, 0 to 2 percent slopes	57.8	20.3%
Rp	Persayo silty clay loam, 12 to 40 percent slopes	34.9	12.3%
Rs	Ustifluvents, 0 to 2 percent slopes	0.0	0.0%
Totals for Area of Interest		**284.0**	**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

75—Uffens fine sandy loam, 1 to 6 percent slopes

Map Unit Setting

Elevation: 5,000 to 5,500 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 47 to 50 degrees F
Frost-free period: 120 to 150 days

Map Unit Composition

Uffens and similar soils: 85 percent

Description of Uffens

Setting

Landform: Pediments, terraces
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Tread
Down-slope shape: Convex, linear
Across-slope shape: Linear
Parent material: Alluvium derived from sandstone and shale

Typical profile

E - 0 to 3 inches: strongly alkaline, fine sandy loam
EBtn - 3 to 10 inches: very strongly alkaline, loam
Btkn - 10 to 28 inches: very strongly alkaline, clay loam
Bky - 28 to 52 inches: strongly alkaline, sandy clay loam
Cy - 52 to 65 inches: moderately alkaline, cobbly sandy clay loam

Properties and qualities

Slope: 1 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 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: 30 percent
Gypsum, maximum in profile: 5 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (4.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 60.0
Available water storage in profile: Moderate (about 7.6 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: B
Ecological site: Loamy Saltdesert (R034XY401CO)

Bc—Sagers silty clay loam, 0 to 2 percent slopes

Map Unit Setting

Elevation: 4,500 to 5,900 feet
Mean annual precipitation: 5 to 8 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 150 to 190 days

Map Unit Composition

Sagers and similar soils: 90 percent

Description of Sagers

Setting

Landform: Alluvial fans, terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Alluvium and slope alluvium derived from calcareous shale and sandstone

Typical profile

Ap - 0 to 12 inches: moderately alkaline, silty clay loam
C - 12 to 25 inches: moderately alkaline, silty clay loam
Cy - 25 to 60 inches: moderately alkaline, silty clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
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: 15 percent
Gypsum, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to slightly saline (2.0 to 8.0 mmhos/cm)
Available water storage in profile: High (about 9.8 inches)

Interpretive groups

Farmland classification: Prime farmland if irrigated
Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: B

Cc—Persayo silty clay loam, 5 to 12 percent slopes

Map Unit Setting

Elevation: 4,500 to 5,200 feet
Mean annual precipitation: 6 to 10 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 150 to 190 days

Map Unit Composition

Persayo and similar soils: 90 percent

Description of Persayo

Setting

Landform: Ridges
Landform position (two-dimensional): Backslope

Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Residuum weathered from calcareous shale

Typical profile
Ap - 0 to 4 inches: moderately alkaline, silty clay loam
C - 4 to 15 inches: moderately alkaline, silty clay loam
Cr - 15 to 19 inches: , weathered bedrock

Properties and qualities
Slope: 5 to 12 percent
Depth to restrictive feature: 10 to 20 inches to paralithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 40 percent
Gypsum, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to slightly saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Very low (about 2.5 inches)

Interpretive groups
Farmland classification: Not prime farmland
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: D
Ecological site: Silty Saltdesert (R034XY410CO)

Fe—Fruita clay loam, 0 to 2 percent slopes

Map Unit Setting
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

Map Unit Composition
Fruita and similar soils: 90 percent

Description of Fruita

Setting
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium derived from shale over alluvium derived from sandstone and shale

Typical profile

Ap1 - 0 to 2 inches: moderately alkaline, clay loam
Ap2 - 2 to 6 inches: moderately alkaline, clay loam
Btk1 - 6 to 16 inches: moderately alkaline, clay loam
Btk2 - 16 to 22 inches: moderately alkaline, clay loam
Btk3 - 22 to 32 inches: moderately alkaline, loam
Bky - 32 to 60 inches: slightly alkaline, gypsiferous sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
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: 50 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (4.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 10.0
Available water storage in profile: High (about 9.1 inches)

Interpretive groups

Farmland classification: Prime farmland if irrigated
Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: B

Hj—Killpack silty clay, 2 to 5 percent slopes

Map Unit Setting

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

Map Unit Composition

Killpack and similar soils: 85 percent

Description of Killpack

Setting

Landform: Hills
Landform position (two-dimensional): Toeslope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Residuum weathered from clayey shale

Typical profile

Ap - 0 to 6 inches: moderately alkaline, silty clay

Bw - 6 to 17 inches: moderately alkaline, silty clay
BCy - 17 to 21 inches: slightly alkaline, silty clay
C1 - 21 to 24 inches: slightly alkaline, silty clay
C2 - 24 to 38 inches: slightly alkaline, silty clay loam
Cr - 38 to 60 inches: , weathered bedrock

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 40 percent
Gypsum, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to slightly saline (0.0 to 7.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 2.0
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: C

Hk—Killpack silty clay, 0 to 2 percent slopes

Map Unit Setting

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

Map Unit Composition

Killpack and similar soils: 85 percent

Description of Killpack

Setting

Landform: Hills
Landform position (two-dimensional): Toeslope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Residuum weathered from clayey shale

Typical profile

Ap - 0 to 6 inches: moderately alkaline, silty clay
Bw - 6 to 17 inches: moderately alkaline, silty clay
BCy - 17 to 21 inches: slightly alkaline, silty clay
C1 - 21 to 24 inches: slightly alkaline, silty clay

C2 - 24 to 38 inches: slightly alkaline, silty clay loam
Cr - 38 to 60 inches: , weathered bedrock

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 40 percent
Gypsum, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to slightly saline (0.0 to 7.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 2.0
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups
Farmland classification: Not prime farmland
Land capability classification (irrigated): 3s
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: C

Re—Sagrlite loam, 0 to 2 percent slopes

Map Unit Setting
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

Map Unit Composition
Sagrlite and similar soils: 90 percent

Description of Sagrlite

Setting
Landform: Terraces, alluvial fans
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sandstone and shale

Typical profile
Ap - 0 to 13 inches: moderately alkaline, loam
C - 13 to 60 inches: moderately alkaline, silt loam

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 20 percent
Gypsum, maximum in profile: 1 percent
Salinity, maximum in profile: Nonsaline to slightly saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 10.0
Available water storage in profile: High (about 9.4 inches)

Interpretive groups

Farmland classification: Prime farmland if irrigated
Land capability classification (irrigated): 2s
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: B

Rp—Persayo silty clay loam, 12 to 40 percent slopes

Map Unit Setting

Elevation: 4,500 to 5,200 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 150 to 190 days

Map Unit Composition

Persayo and similar soils: 70 percent

Description of Persayo

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Residuum weathered from clayey shale

Typical profile

A - 0 to 4 inches: moderately alkaline, silty clay loam
C - 4 to 15 inches: moderately alkaline, silty clay loam
Cr - 15 to 19 inches: , weathered bedrock

Properties and qualities

Slope: 12 to 40 percent
Depth to restrictive feature: 10 to 20 inches to paralithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Calcium carbonate, maximum in profile: 40 percent
Gypsum, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to slightly saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Very low (about 2.5 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: D
Ecological site: Silty Saltdesert (R034XY410CO)

Rs—Ustifluvents, 0 to 2 percent slopes

Map Unit Setting

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

Map Unit Composition

Ustifluvents and similar soils: 85 percent

Description of Ustifluvents

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: moderately alkaline, sandy loam
Cyz - 2 to 8 inches: moderately alkaline, very fine sandy loam
Cz1 - 8 to 22 inches: moderately alkaline, stratified loamy sand to sandy clay loam
Cz2 - 22 to 60 inches: moderately alkaline, 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
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: Slightly saline to moderately saline (8.0 to 16.0 mmhos/cm)

Available water storage in profile: Low (about 4.6 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: B
Ecological site: Saltdesert Overflow (R034XY407CO)

Data Source Information

Soil Survey Area: Mesa County Area, Colorado
Survey Area Data: Version 4, Jan 2, 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 Parks Dept	PROJECT NAME: Matchett Park Master Plan
PROJECT NUMBER: 00208-0053	PROJECT LOCATION: Grand Junction, CO
DATE STARTED: 4/4/14 COMPLETED: 4/4/14	GROUND ELEVATION: HOLE SIZE: 4"
DRILLING CONTRACTOR: S. McKracken	GROUND WATER LEVELS:
DRILLING METHOD: Simco 2000 Truck Rig	AT TIME OF DRILLING: dry
LOGGED BY: NWB CHECKED BY: MAB	AT END OF DRILLING: dry
NOTES: 39.093, -108.523	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 (%)
0.0		Lean CLAY with Organics (TOPSOIL), brown, moist										
		SHALE, gray, very soft, highly weathered										
2.5			MC 1	89	18-18-38 (56)		102	8				
5.0		Bottom of hole at 5.0 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 Parks Dept
PROJECT NAME Matchett Park Master Plan
PROJECT NUMBER 00208-0053
PROJECT LOCATION Grand Junction, CO
DATE STARTED 4/4/14 COMPLETED 4/4/14
GROUND ELEVATION ____ HOLE SIZE 4"
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Truck Rig
AT TIME OF DRILLING 10.0 ft
LOGGED BY NWB CHECKED BY MAB
AT END OF DRILLING 10.0 ft
NOTES 39.095, -108.525
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	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0		Lean CLAY with Organics (TOPSOIL), brown, moist										
		Lean CLAY (cl), brown, moist, medium stiff										
		SHALE, gray, very soft, highly weathered	MC 1	89	7-9-12 (21)		105	9				
5												
			SS 1	72	19-20-31 (51)				40	21	19	
10	▼											
			SS 2	67	35							
15												
			SS 3	100	50/3"							
20		*** Auger Refusal at 20 ft ***										
		Bottom of hole at 20.0 feet.										

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

BORING NUMBER B-3

CLIENT City of Grand Junction Parks Dept
PROJECT NAME Matchett Park Master Plan
PROJECT NUMBER 00208-0053
PROJECT LOCATION Grand Junction, CO
DATE STARTED 4/4/14 COMPLETED 4/4/14
GROUND ELEVATION HOLE SIZE 4"
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Truck Rig
AT TIME OF DRILLING 22.0 ft
LOGGED BY NWB CHECKED BY MAB
AT END OF DRILLING 22.0 ft
NOTES 39.096, -108.527
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	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0		Lean CLAY with Organics (TOPSOIL), brown, moist										
		Lean CLAY (CL), brown, moist to wet, stiff to very soft										
			MC 1	67	5-6-6 (12)		99	16				
5												
			SS 1	67	2-2-3 (5)							
10												
		*** Lab Classified SS2 ***	SS 2	94	0-0-1 (1)			26	27	17	10	90
15												
			SS 3	83	0-0-2 (2)							
20												
		SHALE, gray, very soft, completely to highly weathered	SS 4	67	2-12-30 (42)							
		Bottom of hole at 24.5 feet.										

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

BORING NUMBER B-4

CLIENT City of Grand Junction Parks Dept
PROJECT NAME Matchett Park Master Plan
PROJECT NUMBER 00208-0053
PROJECT LOCATION Grand Junction, CO
DATE STARTED 4/4/14 COMPLETED 4/4/14
GROUND ELEVATION ______ HOLE SIZE 4"
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Truck Rig
AT TIME OF DRILLING 13.5 ft
LOGGED BY NWB CHECKED BY MAB
AT END OF DRILLING 13.5 ft
NOTES 39.097, -108.523
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		Lean CLAY with Organics (TOPSOIL), brown, moist										
		Lean CLAY (cl), brown, moist, medium stiff										
		SHALE, gray, very soft, completely to highly weathered	SS 1	67	6-5-7 (12)							
5												
			SS 2	61	20-18-16 (34)				46	22	24	
10												
			SS 3	50	15-22							
15												
			SS 4	75	25-25							
		*** Auger Refusal at 19 ft ***										

Bottom of hole at 19.0 feet.

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

BORING NUMBER B-5

CLIENT City of Grand Junction Parks Dept
PROJECT NAME Matchett Park Master Plan
PROJECT NUMBER 00208-0053
PROJECT LOCATION Grand Junction, CO
DATE STARTED 4/4/14 COMPLETED 4/4/14
GROUND ELEVATION
HOLE SIZE 4"
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Truck Rig
AT TIME OF DRILLING 21.0 ft
LOGGED BY NWB CHECKED BY MAB
AT END OF DRILLING 21.0 ft
NOTES 39.099, -108.527
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		Lean CLAY with Organics (TOPSOIL), brown, moist										
		Lean CLAY (cl), brown, moist to wet, soft to very soft										
			SS 1	72	1-2-2 (4)							
5												
			SS 2	67	2-1-2 (3)							
10												
			SS 3	78	1-1-1 (2)							
15												
			SS 4	94	0-1-2 (3)							
20												
		SHALE, gray, very soft, highly weathered	SS 5	67	20-20							
		Bottom of hole at 24.0 feet.										

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BORING NUMBER B-6

CLIENT City of Grand Junction Parks Dept
PROJECT NAME Matchett Park Master Plan
PROJECT NUMBER 00208-0053
PROJECT LOCATION Grand Junction, CO
DATE STARTED 4/4/14 COMPLETED 4/4/14
GROUND ELEVATION HOLE SIZE 4"
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Truck Rig
AT TIME OF DRILLING 20.0 ft
LOGGED BY NWB CHECKED BY MAB
AT END OF DRILLING 20.0 ft
NOTES 39.100, -108.525
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	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0		Lean CLAY with Organics (TOPSOIL), brown, moist										
		Lean CLAY (cl), brown, moist, soft to medium stiff										
			SS 1	72	2-2-2 (4)							
5												
			SS 2	44	0-2-1 (3)							
10												
			SS 3	72	0-2-9 (11)							
		SHALE, gray, very soft, highly weathered										
15												
			SS 4	75	30-20							
20	▼											
			SS 5	58	30-20							
		Bottom of hole at 24.0 feet.										

GEOTECH BH COLUMNS 00208-0053 MATCHETT PARK MASTER PLAN.GPJ GINT US LAB.GDT 5/14/14

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BORING NUMBER B-7

CLIENT City of Grand Junction Parks Dept
PROJECT NAME Matchett Park Master Plan
PROJECT NUMBER 00208-0053
PROJECT LOCATION Grand Junction, CO
DATE STARTED 4/4/14 COMPLETED 4/4/14
GROUND ELEVATION
HOLE SIZE 4"
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Truck Rig
AT TIME OF DRILLING 15.5 ft
LOGGED BY NWB CHECKED BY MAB
AT END OF DRILLING 15.5 ft
NOTES 39.102, -108.528
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	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0		Lean CLAY with Organics (TOPSOIL), brown, moist										
		Lean CLAY (cl), brown, moist to wet, medium stiff										
			MC 1	89	3-2-2 (4)		88	14				
5												
			SS 1	61	3-2-3 (5)							
10												
			SS 2	44	2-2-2 (4)							
15												
		Sandy GRAVEL and COBBLES (gw), brown, wet, medium dense to very loose										
			SS 3	56	7-6-9 (15)							
20												
			SS 4	11	1-1-1 (2)							
		Bottom of hole at 24.5 feet.										

APPENDIX C
Laboratory Testing Results

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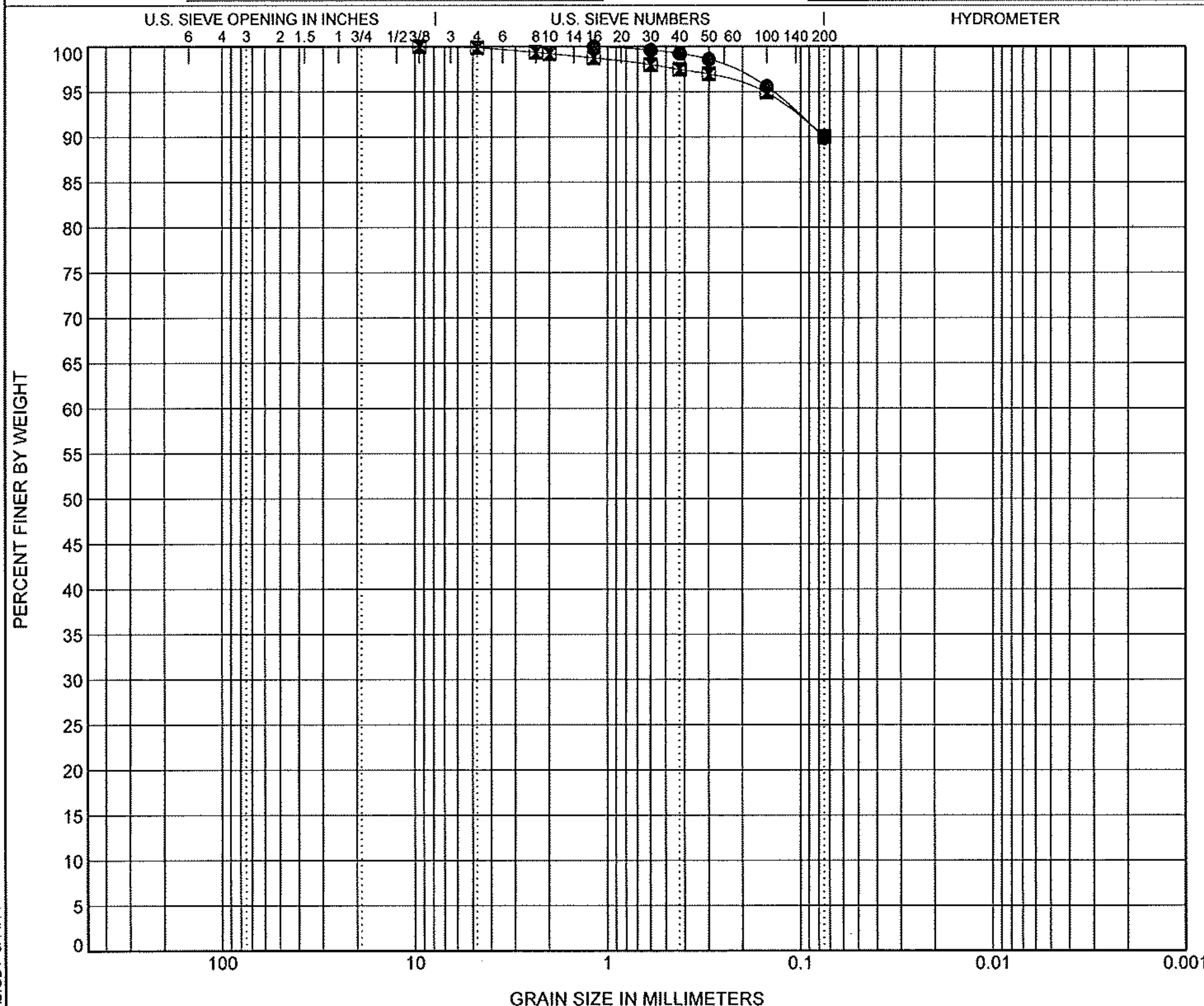
GRAIN SIZE DISTRIBUTION

CLIENT City of Grand Junction Parks Dept

PROJECT NAME Matchett Park Master Plan

PROJECT NUMBER 00208-0053

PROJECT LOCATION Grand Junction, CO



Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-3, SS2 4/4/2014	LEAN CLAY(CL)	27	17	10		
⊠	Composite 4/2014	LEAN CLAY(CL)	34	16	18		

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-3, SS2 4/4/2014	1.18				0.0	10.1	89.9	
⊠	Composite 4/2014	9.5				0.1	9.8	90.1	

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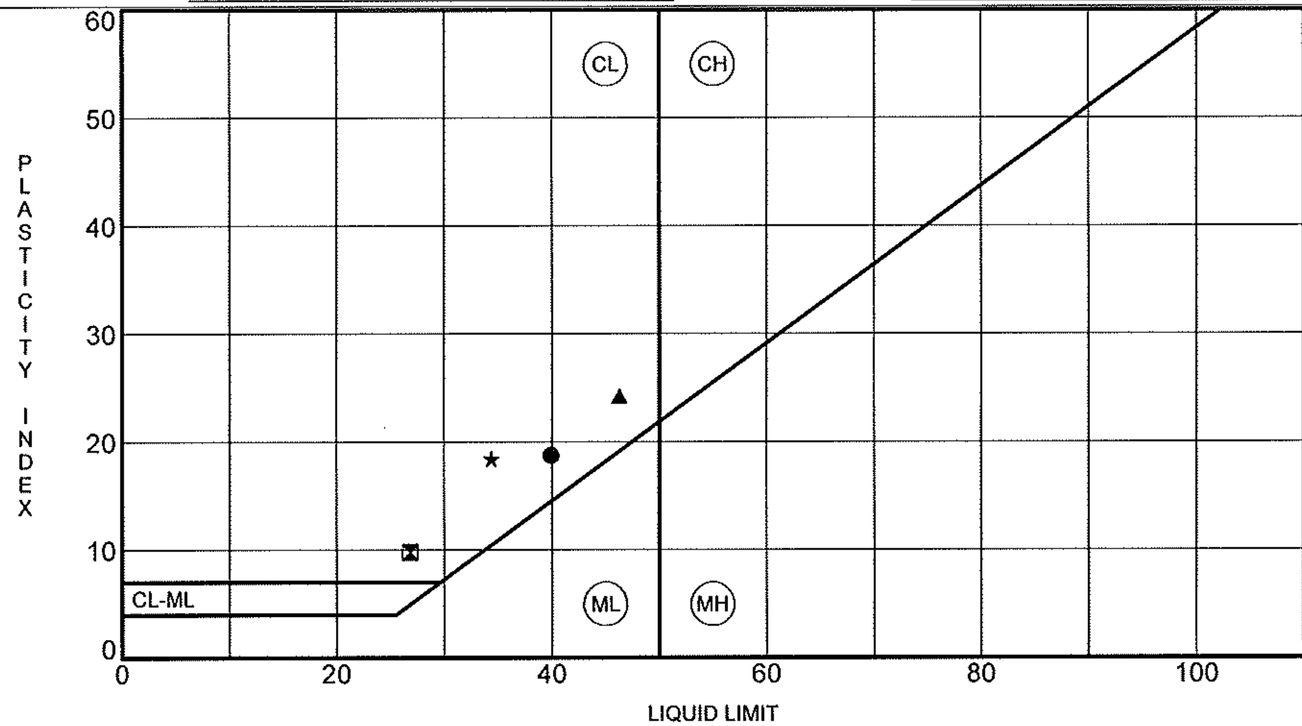
ATTERBERG LIMITS' RESULTS

CLIENT City of Grand Junction Parks Dept
PROJECT NAME Matchett Park Master Plan
PROJECT NUMBER 00208-0053
PROJECT LOCATION Grand Junction, CO



	Specimen Identification		LL	PL	PI	#200	Classification
●		4/4/2014	40	21	19		
⊠	B-3, SS2	4/4/2014	27	17	10	90	LEAN CLAY(CL)
▲		4/4/2014	46	22	24		
★	Composite	4/4/2014	34	16	18	90	LEAN CLAY(CL)

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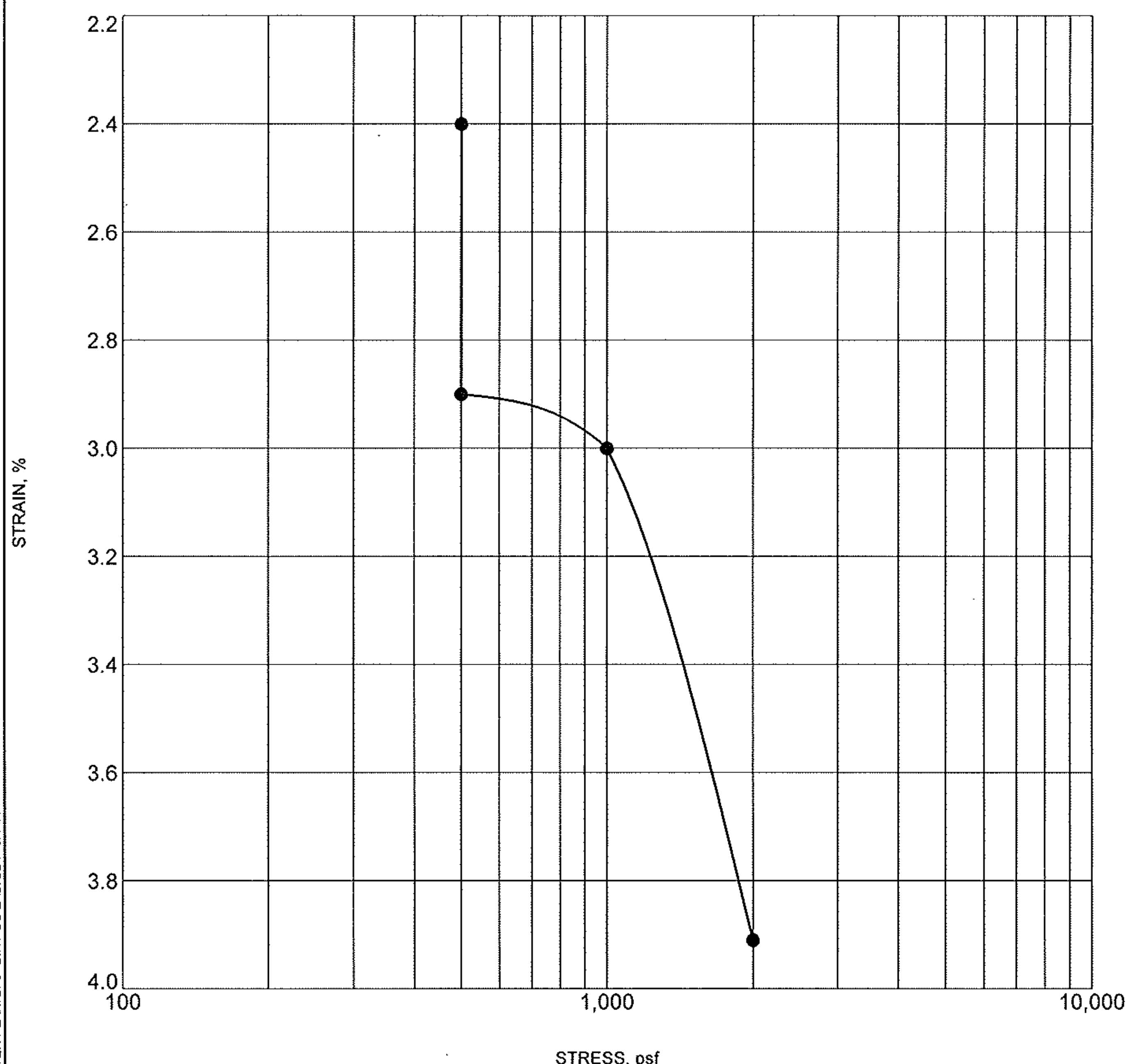
CONSOLIDATION TEST

CLIENT City of Grand Junction Parks Dept **PROJECT NAME** Matchett Park Master Plan

PROJECT NUMBER 00208-0053 **PROJECT LOCATION** Grand Junction, CO



	Specimen Identification		Classification	γ_d	MC%
●	B-2	2.0		105	9

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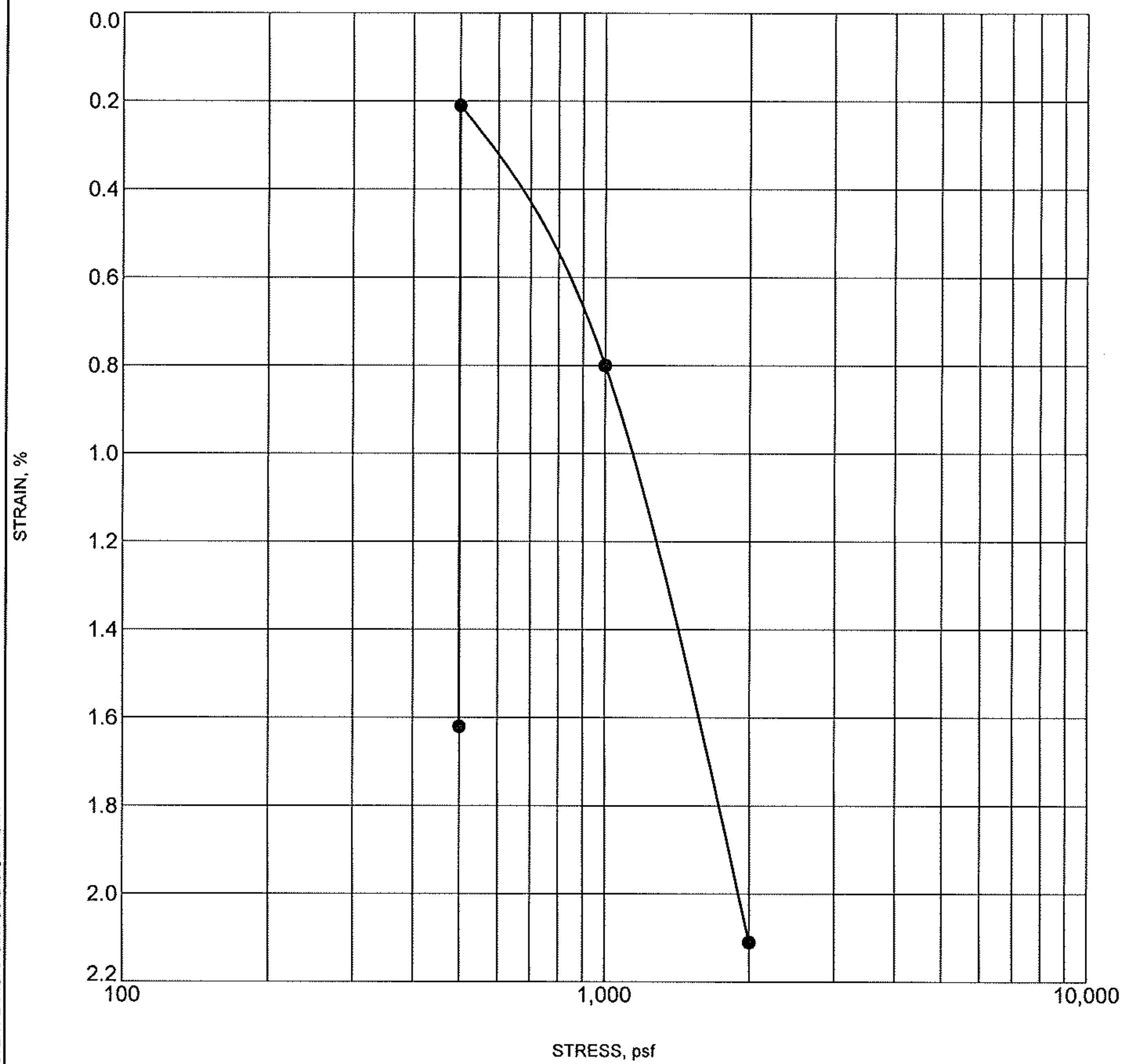
CONSOLIDATION TEST

CLIENT City of Grand Junction Parks Dept
PROJECT NAME Matchett Park Master Plan
PROJECT NUMBER 00208-0053
PROJECT LOCATION Grand Junction, CO



	Specimen Identification		Classification	γ_d	MC%
●	B-3	2.0		99	16

CONSOL STRAIN 00208-0053 MATCHETT PARK MASTER PLAN.GPJ GINT US LAB.GDT 5/7/14

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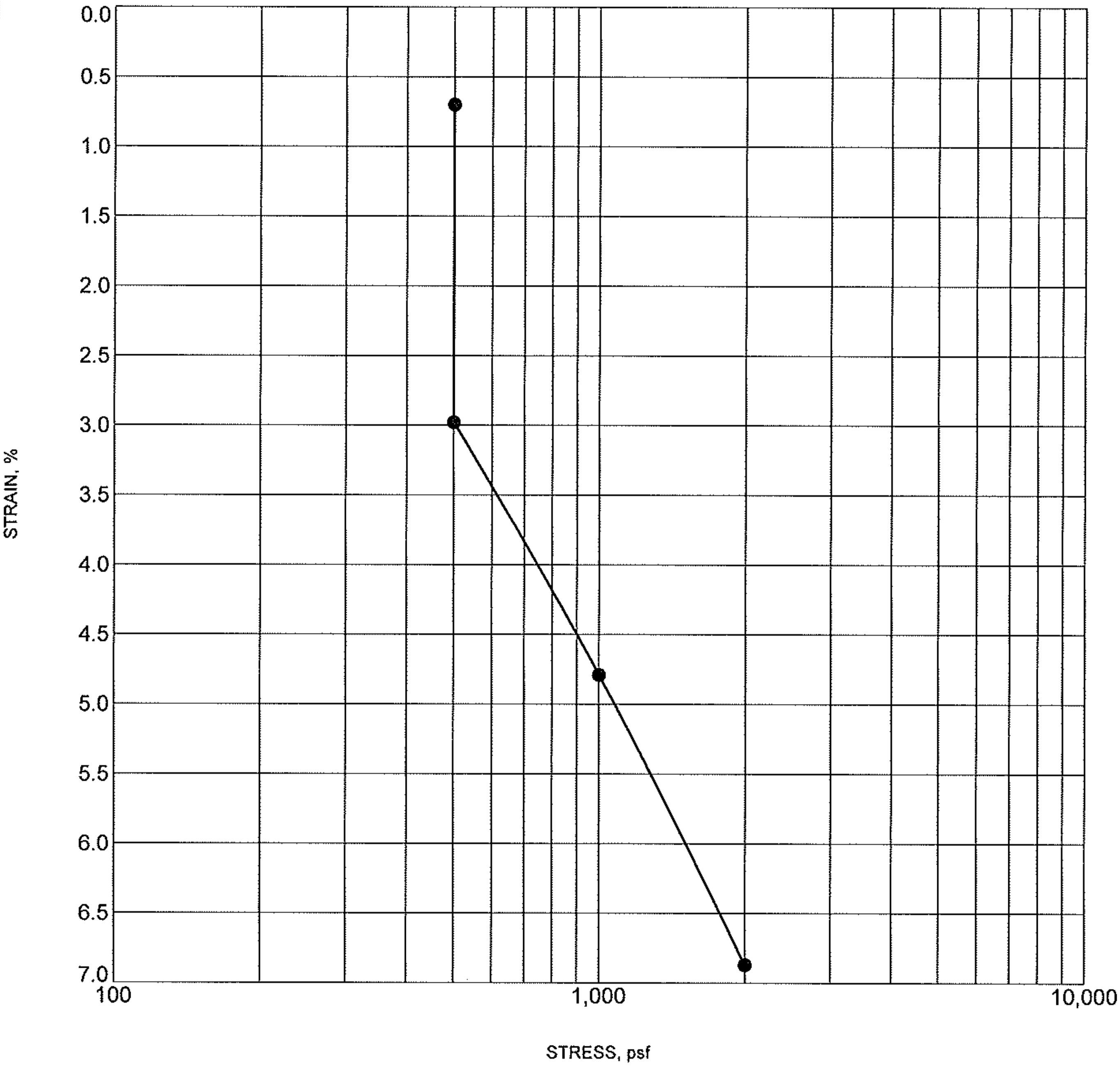
CONSOLIDATION TEST

CLIENT City of Grand Junction Parks Dept
PROJECT NAME Matchett Park Master Plan
PROJECT NUMBER 00208-0053
PROJECT LOCATION Grand Junction, CO



	Specimen Identification		Classification	γ_d	MC%
●	B-7	2.0		88	14

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MOISTURE-DENSITY RELATIONSHIP

CLIENT City of Grand Junction Parks Dept

PROJECT NAME Matchett Park Master Plan

PROJECT NUMBER 00208-0053

PROJECT LOCATION Grand Junction, CO

Sample Date:	**4/4/2014**
Sample No.:	
Source of Material:	**Composite**
Description of Material:	**POORLY GRADED SAND(SP)**
Test Method:	**ASTM D698A**

TEST RESULTS

Maximum Dry Density **112.0** PCF

Optimum Water Content **16.0** %

GRADATION RESULTS (% PASSING)

#200	#4	3/4"
3	**99**	**100**

ATTERBERG LIMITS

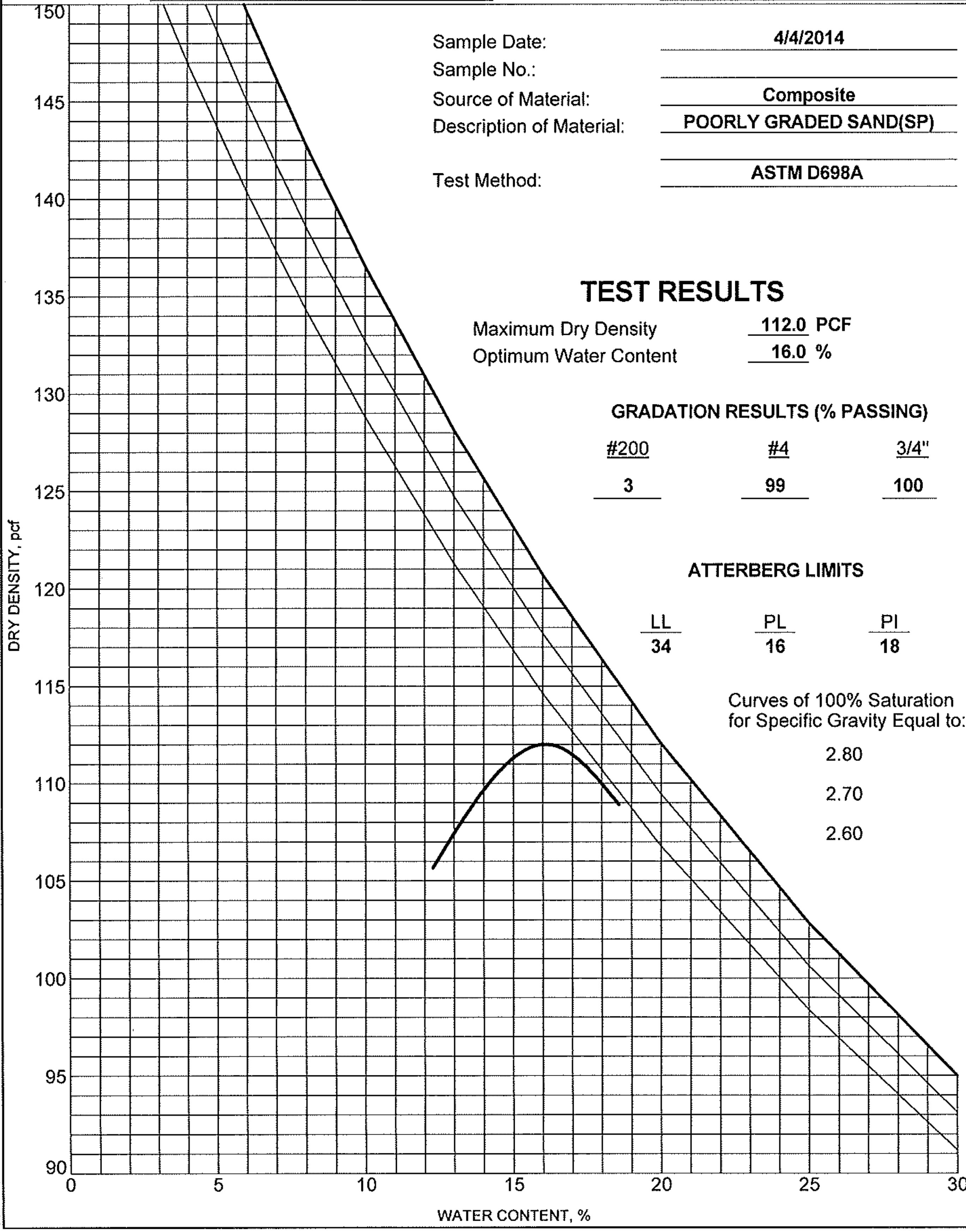
LL	PL	PI
34	**16**	**18**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

2.60



COMPACTION 00208-0053 MATCHETT PARK MASTER PLAN.GPJ GINT US LAB.GDT 5/7/14

Huddleston-Berry
Engineering & Testing, LLC

CALIFORNIA BEARING RATIO
ASTM D1883

Project No.:	00208-0053	**Authorized By:**	Client	**Date:**	04/04/14
Project Name:	Matchett Park Master Plan	**Sampled By:**	NB	**Date:**	04/04/14
Client Name:	City of Grand Junction Parks Department	**Submitted By:**	NB	**Date:**	05/07/14
Sample Number:	14-0261 **Location:** Composite	**Reviewed By:**	MAB	**Date:**	05/14/14

Compaction Methoc ASTM D698, Method A

Maximum Dry Density (pcf): 112.0

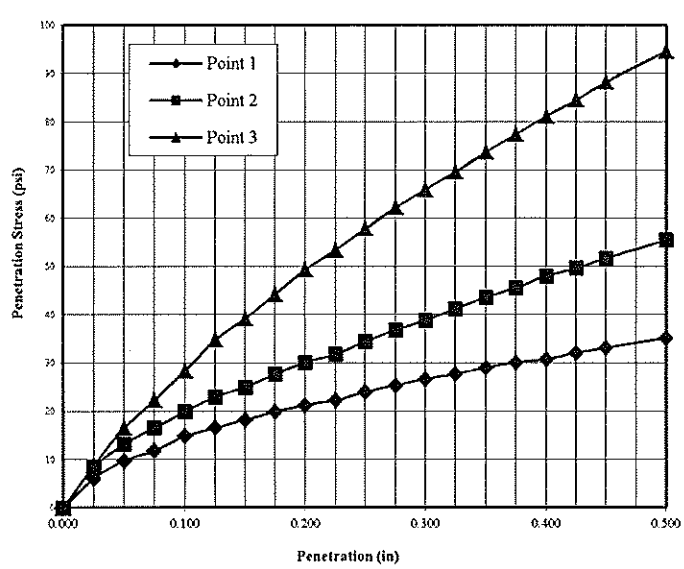
Opt. Moisture Content (%): 16.0

Sample Condition: Soaked

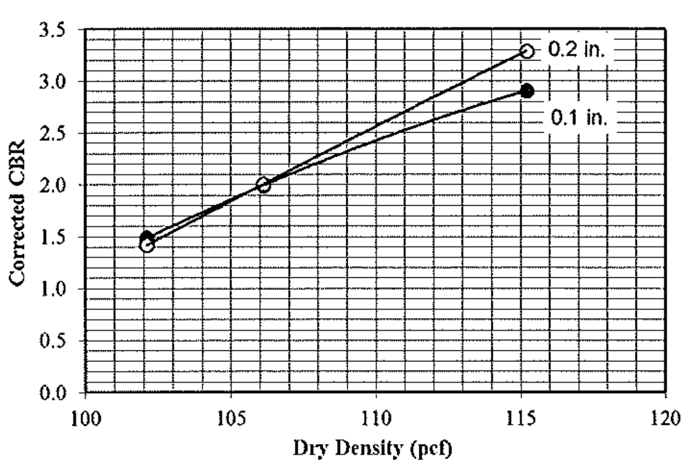
Remarks:

	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):	102.1	106.1	115.2
Dry Density After Soak (pcf):	100.3	104.3	113.5
Moisture Content (%) Bottom Pre-Test	16.1	16.2	7.7
Moisture Content (%) Top Pre-Test	15.5	15.5	15.8
Moisture Content (%) Top 1" After Test	23.5	22.5	21.0
Moisture Content (%) Average After Soak:	22.1	19.4	17.5
Percent Swell After Soak:	1.8	1.7	1.5

Load Pentration Curve(s)



Dry Density vs CBR



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	18	6	0.025	25	8	0.025	26	9
0.050	29	10	0.050	39	13	0.050	49	17
0.075	35	12	0.075	49	17	0.075	66	22
0.100	44	15	0.100	59	20	0.100	84	28
0.125	49	17	0.125	68	23	0.125	103	35
0.150	54	18	0.150	74	25	0.150	116	39
0.175	59	20	0.175	82	28	0.175	131	44
0.200	63	21	0.200	89	30	0.200	146	49
0.225	66	22	0.225	94	32	0.225	158	53
0.250	71	24	0.250	102	35	0.250	171	58
0.275	75	25	0.275	109	37	0.275	184	62
0.300	79	27	0.300	115	39	0.300	195	66
0.325	82	28	0.325	122	41	0.325	206	70
0.350	86	29	0.350	129	44	0.350	218	74
0.375	89	30	0.375	135	46	0.375	229	77
0.400	91	31	0.400	142	48	0.400	240	81
0.425	95	32	0.425	147	50	0.425	250	85
0.450	98	33	0.450	153	52	0.450	261	88
0.500	104	35	0.500	164	55	0.500	280	95

Corrected CBR @ 0.1"		
1.5	2.0	2.9
Corrected CBR @ 0.2"		
1.4	2.0	3.3

Penetration Distance Correction (in)		
0.000	0.000	0.000

Figure: _____