December 18, 2012

Ms. Katie Bartojay
Conifer Senior High School Booster Club
10441 County Road 73
Conifer, Colorado 80433

Subject: Geotechnical Engineering Study, Conifer Senior High School Football Field Improvements, Conifer, Colorado

Project No. 12-1-488

Dear Ms. Bartojay:

This letter presents the results of a geotechnical engineering study for the proposed improvements to the football field located at the Conifer Senior High School, 10441 County Road 73 in Conifer, Colorado. A subsurface study was conducted for the purpose of developing foundation recommendations associated with the four high-mast light poles and the modular building structures to be constructed at the site. The project site is shown on Fig. 1. The study was conducted in accordance with the scope of work in our Proposal No. P-12-543 to the Booster Club dated October 11, 2012.

A field exploration program consisting of exploratory borings was conducted to obtain information on subsurface conditions. Samples of the soils and bedrock obtained during the field exploration were tested in the laboratory to determine their classification and engineering characteristics. The results of the field exploration and laboratory testing were analyzed to develop recommendations for foundation types, depths and allowable pressures for the proposed high-mast lighting and modular building foundations. The results of the field exploration and laboratory testing are presented herein.

This report has been prepared to summarize the data obtained during this study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to construction of the proposed improvements are included in the report.

Proposed Construction: We understand that four high-mast lights will be constructed just outside of the asphalt-paved track area for the football field at approximately the 15/20 yard lines. Three modular structures will be located just outside the end zone area at the southeastern end of the field. The modular structures will be utilized as team rooms for the football teams and a third structure to house the referees. Site grading for the proposed improvements is to be considered negligible.
If the proposed construction varies significantly from that described above or depicted in this report, we should be notified to reevaluate the recommendations provided in this report.

**Site Conditions:** The project site consists of a synthetic-turf football field located east-northeast of the Senior High School building facility. An asphalt-paved track circles the football field. Rudimentary bleachers are located on the west side of the field. A baseball field is located to the east, a softball field and practice field is located to the west, an access road to the High School facility is located to the south, and vacant land to the north.

The original topography within the limits of the athletic fields sloped steeply down from the west to the east. Site grading to accommodate the athletic fields consisted of terracing the topography where significant fills were placed on the east side of the fields and minor cuts on the west side. The overall area was vegetated with natural grasses and medium to large coniferous trees.

**Subsurface Conditions:** To evaluate the subsurface conditions at the site, six exploratory borings were drilled at the approximate locations shown on Fig. 1. Four borings were drilled for the proposed high-mast lighting, one at each approximate light location. The remaining two borings were drilled at the southeastern end of the football field, in the approximate locations of the proposed modular building structures. Graphic logs of the borings along with a legend and notes describing the subsoils encountered are presented on Figs. 2 and 3, respectively.

The borings were advanced into the subsoils with 4-inch diameter continuous flight augers. The borings were logged by a representative of Kumar & Associates, Inc. Samples of the soils and bedrock materials were taken with either a 2-inch I.D. California liner sampler or a 1-3/8 inch I.D. standard sampler. The samplers were driven into the various strata with blows from a 140-pound hammer falling 30 inches. The California liner test is similar to the standard penetration test described by ASTM Method D 1586. Penetration resistance values, when properly evaluated, indicate the relative density or consistency of the soils. Depths at which the samples were taken and the penetration resistance values are shown on the Logs of Exploratory Borings, Fig. 2.

The subsurface conditions encountered in the borings consisted of either 3.5 to 4.5 inches of asphalt or 6 to 12 inches of topsoil overlying areas of man-placed fill underlain by areas of residual soil/high weathered bedrock. Quartz monzonite bedrock was encountered in all of the four borings at depths ranging from 1 foot to 23 feet.

The man-placed fill was encountered in 4 borings to depths ranging from 12 to 20 feet. The fill generally consisted of residual soil and bedrock materials excavated locally in the area. The fill generally consisted of silty sand with gravel to silty gravel with sand, fine to coarse grained with cobbles, medium dense to dense, slightly moisture, dark gray, brown and pink. In Borings 2 and 3, residual soil/highly decomposed quartz monzonite was encountered below the topsoil and fill, respectively. The residual soil was silty to occasionally clayey, fine to coarse grained with cobbles, loose to dense, moist, brown, gray pink.

Based on a review of applicable geologic data (Reconnaissance Geologic Map of the Conifer Quadrangle, Jefferson County, Colorado, Bryant, 1974) and our knowledge of the site, the bedrock materials are part of the Precambrian, Silver Plume Quartz Monzonite formation. The bedrock materials are coarse-grained to fairly fine grained light-gray to moderate orange-pink muscovite-biotite quartz monzonite. The bedrock contains numerous inclusions of migmatite,
biotite gneiss, and sillimanite muscovite-biotite schist. As indicated, the bedrock was encountered in all 6 borings at depths ranging from approximately 1 foot to 23 feet.

Free groundwater was not encountered in the borings at the time of drilling. Static water level measurements were evaluated in the borings 4 days subsequent to drilling where water was encountered in Boring 1 at a depth of approximately 13.6 feet.

Limited laboratory testing was performed on selected samples obtained in the borings. The testing generally consisted of natural moisture content and dry density, gradation analysis, and concentration of water soluble sulfates. The results of the laboratory testing are shown adjacent to the boring logs on Fig. 2, graphically plotted on Figs. 4 through 6, and are summarized in Table I.

Gradation analysis test results are presented on Figs. 4 through 6. It should be noted that the method of sampling limits the maximum particle size retrieved to be less than 2 inches. The materials tested for sieve size should be considered to consist of the matrix material between the cobbles which appeared to have a maximum size on the order of 1 to 2 feet.

Foundation Recommendations: As indicated, the foundations associated with the structures to be constructed for the improvements are to consist of straight-shaft piers drilled into the underlying bedrock for support of the proposed four high-mast lights, and a shallow footing foundation system for the three modular buildings.

Modular Building Structures: Considering the subsurface conditions encountered in the exploratory borings and the nature of the proposed construction, we recommend the facilities building be founded on spread footings placed on undisturbed natural soils and/or suitable existing fill materials.

The design and construction criteria presented below should be observed for a spread footing foundation system. The construction details should be considered when preparing project documents.

1. Footings placed on the undisturbed natural soils or suitable fill materials should be designed for an allowable soil bearing pressure of 2,500 psf.

2. Spread footings placed on granular soils should have a minimum footing width of 16 inches for continuous footings and 24 inches for isolated pads.

3. Exterior footings and footings beneath unheated areas should be provided with adequate soil cover above their bearing elevation for frost protection. Placement of foundations at least 36 inches below the exterior grade is typically used in this area.

4. The lateral resistance of a spread footing placed on undisturbed natural soils and/or suitable fill material will be a combination of the sliding resistance of the footing on the foundation materials and passive earth pressure against the side of the footing. Resistance to sliding at the bottoms of the footings can be calculated based on a coefficient of friction of 0.35. Passive pressure against the sides of the footings can be calculated using an equivalent fluid unit weight of 210 pcf. The above values are working values.
Compacted fill placed against the sides of the footings to resist lateral loads should be an on-site granular material. Fill should be placed and compacted to at least 95% of the standard Proctor (ASTM D 698) maximum dry density at a moisture content within 2 percentage points of optimum.

5. Areas of loose, soft material or deleterious substances encountered within the foundation excavation should be removed and the footings extended to adequate natural bearing material. As an alternate, the loose, soft material or deleterious substances may be removed and replaced with suitable on-site fill material compacted to at least 98% of the standard Proctor (ASTM D 698) maximum dry density within 2 percentage points of the optimum moisture content. New fill should extend down from the edges of the footings at a 1 horizontal to 1 vertical projection.

6. Granular foundation soils should be re-densified with a smooth vibratory compactor just prior to placement of the reinforcing steel and concrete.

7. A representative of the geotechnical engineer should observe all footing excavations prior to concrete placement.

High-Mast Lighting: Based on the proposed construction and the data obtained during the field study, we recommend straight-shaft piers drilled into the underlying quartz monzonite bedrock be used to support the proposed high-mast lighting.

The design and construction criteria presented below should be observed for a straight-shaft pier foundation system. The construction details should be considered when preparing project documents.

1. Piers should be designed for an allowable end bearing pressure of 40,000 psf and a skin friction of 4,000 psf for the portion of the pier penetration in the quartz monzonite bedrock. Uplift due to structural loadings on the piers can be resisted by using 75% of the allowable skin friction value plus an allowance for pier weight.

2. For axial loading conditions, piers should penetrate at least three pier diameters into the bedrock. The minimum pier length should be based on the lateral load analysis.

3. Piers should be designed to resist lateral loads using a modulus of horizontal subgrade reaction in the fill and residual soils of 75 tcf and a modulus of horizontal subgrade reaction of 350 tcf in the bedrock. The modulus value given is for a long one-foot wide pier and must be corrected for pier size.

In the event that a computerized approved is used to evaluate the lateral capacity of the piers, the following table presents the lateral design parameters for the LPILE computer program. These values should be used when analyzing lateral capacity of drilled piers with the LPILE software.
4. Concrete used in the piers should be a fluid mix with sufficient slump so it will fill the void between reinforcing steel and the pier hole. We recommend a concrete slump in the range of 5 to 8 inches be used.

5. Pier holes should be properly cleaned prior to the placement of concrete.

6. The absence of water in the exploratory borings indicates the use of temporary casing or dewatering equipment in the pier holes will probably not be required to reduce water infiltration. However, if water infiltration does occur, the requirements for casing can sometimes be reduced by placing concrete immediately upon cleaning and observing the pier hole. In no case should concrete be placed in more than 3 inches of water unless placed through an improved tremie method.

7. The drilled shaft contractor should mobilize equipment of sufficient size and operating condition to achieve the required bedrock penetration in the bedrock.

8. Concrete should be placed in piers the same day they are drilled. The presence of water or caving soils may require that concrete be placed immediately after the pier hole is completed. Failure to place concrete the day of drilling will normally result in a requirement for additional bedrock penetration.

9. A representative of the geotechnical engineer should observe pier drilling operations on a full-time basis to assist in identification of adequate bedrock strata and monitor pier construction procedures.

Water Soluble Sulfates: The concentration of water soluble sulfates measured in samples obtained from the exploratory borings was determined to be less than 0.02%. This concentration of water soluble sulfates represents a Class 0 severity exposure of sulfate attack on concrete exposed to these materials. The degree of attack is based on a range of Class 0, Class 1, Class 2 and Class 3 severity exposure as presented in ACI 201.

Based on this information, we believe special sulfate resistant cement will not be required for concrete exposed to the on-site soils.
Limitations: This study has been conducted in accordance with generally accepted geotechnical engineering practices in this area for exclusive use by the client for design purposes. The conclusions and recommendations submitted in this report are based upon the data obtained from the exploratory borings at the locations indicated on Fig. 1, and the proposed type of construction. This report may not reflect subsurface variations that occur between the exploratory borings, and the nature and extent of variations across the site may not become evident until excavations are performed. If during construction, fill, soil, bedrock or groundwater conditions appear to be different from those described herein, Kumar & Associates, Inc. should be advised at once so that a re-evaluation of the recommendations presented in this report can be made. Kumar & Associates, Inc. is not responsible for liability associated with interpretation of subsurface data by others.

Sincerely,

KUMAR & ASSOCIATES, INC.

James A. Noll, P.E.

JAN/jw
Attachments
cc: file, book
**LEGEND**

(3.75) ASPHALT, THICKNESS IN INCHES SHOWN IN PARENTHESES TO LEFT OF THE LOG.

TOPSOIL.

FILL: SILTY SAND WITH GRAVEL (SM) TO SILTY GRAVEL WITH SAND (GM), FINE TO COARSE GRAINED WITH COBBLES, MEDIUM DENSE TO DENSE, SLIGHTLY MOIST, DARK GRAY, BROWN, PINK.

RESIDUAL SOIL/HIGHLY DECOMPOSED QUARTZ MONZONITE, SILTY TO OCCASIONALLY CLAYEY, FINE TO COARSE GRAINED WITH COBBLES, LOOSE TO DENSE, MOIST, BROWN, GRAY, PINK.

SILVER PLUME QUARTZ MONZONITE, COARSE-GRAINED TO FAIRLY FINE GRAINED LIGHT-GRAY TO MODERATE ORANGE-PINK MUSCOVITE-BIOTITE QUARTZ MONZONITE. CONTAINS NUMEROUS INCLUSIONS OF MIGMATITE, BIOTITE GNEISS, AND SILLIMANITE MUSCOVITE-BIOTITE SCHIST.

DRIVE SAMPLE, 2-INCH I.D. CALIFORNIA LINER SAMPLE.

DRIVE SAMPLE, 1 3/8-INCH I.D. SPLIT SPOON STANDARD PENETRATION TEST.

37/12 DRIVE SAMPLE BLOW COUNT. INDICATES THAT 37 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 12 INCHES.

1/4 DEPTH TO WATER LEVEL AND NUMBER OF DAYS AFTER DRILLING MEASUREMENT WAS MADE.

DEEP BORE IN BORING WHEN WATER LEVEL MEASUREMENTS WERE TAKEN 4 DAY SUBSEQUENT TO COMPLETION OF THE DRILLING.

**NOTES**

1. THE EXPLORATORY BORINGS WERE DRILLED ON NOVEMBER 5, 2012 WITH A 4-INCH DIAMETER CONTINUOUS FLIGHT POWER AUGER.

2. THE LOCATIONS OF THE EXPLORATORY BORINGS WERE MEASURED APPROXIMATELY BY PACING FROM FEATURES SHOWN ON THE SITE PLAN PROVIDED.

3. THE ELEVATIONS OF THE EXPLORATORY BORINGS WERE NOT MEASURED AND THE LOGS OF THE EXPLORATORY BORINGS ARE PLOTTED TO DEPTH.

4. THE EXPLORATORY BORING LOCATIONS SHOULD BE CONSIDERED Accurate ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

5. THE LINES BETWEEN MATERIALS SHOWN ON THE EXPLORATORY BORING LOGS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.

6. GROUND WATER LEVELS SHOWN ON THE LOGS WERE MEASURED AT THE TIME AND UNDER CONDITIONS INDICATED. FLUCTUATIONS IN THE WATER LEVEL MAY OCCUR WITH TIME.

7. LABORATORY TEST RESULTS:
   WC = WATER CONTENT (%) (ASTM D 2216);
   DD = DRY DENSITY (pcf) (ASTM D 2216);
   +4 = PERCENTAGE RETAINED ON NO. 4 SIEVE (ASTM D 422);
   −200 = PERCENTAGE PASSING NO. 200 SIEVE (ASTM D 1140);
   WSS = WATER SOLUBLE SULFATES (%) (AASHTO T 290).
HYDROMETER ANALYSIS

<table>
<thead>
<tr>
<th>TIME READINGS</th>
<th>U.S. STANDARD SERIES</th>
<th>CLEAR SQUARE OPENINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 HRS</td>
<td>7 HRS</td>
<td>45 MIN</td>
</tr>
<tr>
<td>100</td>
<td>90</td>
<td>80</td>
</tr>
</tbody>
</table>

DIA. OF PARTICLES IN MILLIMETERS

CLAY TO SILT | SAND | GRAVEL | COBBLES

FINE | MEDIUM | COARSE | FINE | COARSE

GRAVEL 15% | SAND 67% | SILT AND CLAY 18%

LIQUID LIMIT

PLASTICITY INDEX

SAMPLE OF: Fill: Silty Sand with Gravel (SM) FROM: Boring 4 Ø 10'

HYDROMETER ANALYSIS

TIME READINGS
| 24 HRS | 7 HRS | 45 MIN | 15 MIN | 60 MIN | 19 MIN | 4 MIN | 1 MIN | #200 | #100 | #50 | #10 | #4 | 3/8" | 3/4" | 1 1/2" | 2" | 5/6" |
|-------|-------|--------|--------|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 100   | 90    | 80     | 70     | 60     | 50     | 40    | 30    | 20    | 10    | 0     |

DIA. OF PARTICLES IN MILLIMETERS

CLAY TO SILT | SAND | GRAVEL | COBBLES

FINE | MEDIUM | COARSE | FINE | COARSE

GRAVEL 44% | SAND 41% | SILT AND CLAY 15%

LIQUID LIMIT

PLASTICITY INDEX

SAMPLE OF: Fill: Silty Gravel with Sand (GM) FROM: Boring 5 Ø 5'

These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D422, ASTM C156 and/or ASTM D1140.

12-1-488 Kumar & Associates GRADATION TEST RESULTS Fig. 5
GRANULAR ANALYSIS

<table>
<thead>
<tr>
<th>Diameter of Particles in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay to Silt</td>
</tr>
<tr>
<td>Fine</td>
</tr>
</tbody>
</table>

**Gravel**: 31%  
**Sand**: 54%  
**Silt and Clay**: 15%

**Liquid Limit**  
**Plasticity Index**

**Sample of**: Silty Sand with Gravel (SM)  
**From**: Boring 6 @ 5'

These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc.

Sieve analysis testing is performed in accordance with ASTM D422, ASTM C1356 and/or ASTM D1140.

12-1-488  
Kumar & Associates  
GRADATION TEST RESULTS  
Fig. 6
## Table I
### Summary of Laboratory Test Results

<table>
<thead>
<tr>
<th>Boring</th>
<th>Depth (feet)</th>
<th>Date Tested</th>
<th>Natural Moisture Content (%)</th>
<th>Natural Dry Density (pcf)</th>
<th>Gradation Gravel (%)</th>
<th>Gradation Sand (%)</th>
<th>Percent Passing No. 200 Sieve</th>
<th>Water Soluble Sulfates (%)</th>
<th>Soil or Bedrock Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1</td>
<td>11-16-12</td>
<td>8.5</td>
<td>118.1</td>
<td>20</td>
<td>63</td>
<td>17</td>
<td></td>
<td>Silty Sand with Gravel (SM)</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>11-19-12</td>
<td>5.9</td>
<td>130.2</td>
<td>27</td>
<td>58</td>
<td>15</td>
<td></td>
<td>Fill: Silty Sand with Gravel (SM)</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>11-16-12</td>
<td>7.8</td>
<td>129.6</td>
<td>15</td>
<td>67</td>
<td>18</td>
<td></td>
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</tr>
<tr>
<td>5</td>
<td>5</td>
<td>11-19-12</td>
<td>4.7</td>
<td>145.2</td>
<td>44</td>
<td>41</td>
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<td>&lt;0.02</td>
<td>Fill: Silty Gravel with Sand (GM)</td>
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<tr>
<td>6</td>
<td>5</td>
<td>11-19-12</td>
<td>6.3</td>
<td>137.3</td>
<td>31</td>
<td>54</td>
<td>15</td>
<td>&lt;0.02</td>
<td>Fill: Silty Sand with Gravel (SM)</td>
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</tbody>
</table>