Kumar & Associates, Inc.®
Geotechnical and Materials Engineers
and Environmental Scientists

An Employee Owned Company

6735 Kumar Heights
Colorado Springs, CO 80918
phone: (719) 632-7009
fax: (719) 632-1049
email: kacolospgs@kumarusa.com
www.kumarusa.com

Office Locations: Denver (HQ), Parker, Colorado Springs, Fort Collins, Glenwood Springs, and Summit County, Colorado

GEOLOGIC HAZARDS STUDY
RAMAH WASTEWATER TREATMENT PLANT
IMPROVEMENT PROJECT
RAMAH, COLORADO

Prepared by:

Rob A. Yeoman
Staff Geologist

Reviewed by:
Robert L. Duran, P.E.

COLORADO REGISTERED
ROBERT L. DURAN
57322
01/06/23
PROFESSIONAL ENGINEER

PREPARED FOR:

Nicholaus Marcotte, P.E.
Element Engineering, LLC
12687 West Cedar Drive, Suite 300
Lakewood, Colorado 80228

Project No. 22-2-102.A

January 6, 2023

TABLE OF CONTENTS

PURPOSE AND SCOPE OF STUDY....1

PROPOSED DEVELOPMENT....1

SITE CONDITIONS....1

GEOLOGIC SETTING....2

NRCS SOIL SURVEY....3

POTENTIAL MINERAL RESOURCES....3

GEOLOGIC SITE ASSESSMENT....4

- POTENTIAL FLOODING....4
- SEASONALLY SHALLOW GROUNDWATER/SEASONAL SEEPAGE....5
- PRE-EXISTING MAN-PLACED FILL....5
- EXPANSIVE/COLLAPSIBLE SOILS AND BEDROCK....5
- SUBSURFACE MINING....6
- SEISMICITY....6
- EROSIONAL FEATURES....7
- SLOPES GREATER THAN 30 PERCENT....7
- RADIOACTIVE GASES....8

DEVELOPMENT CONSIDERATIONS....8

- POTENTIAL FLOODING....8
- SEASONALLY SHALLOW GROUNDWATER/SEASONAL SEEPAGE....8
- PRE-EXISTING MAN-PLACED FILL....9
- EXPANSIVE/COLLAPSIBLE SOILS AND BEDROCK....9
- EROSIONAL FEATURES....9
- SLOPES GREATER THAN 30 PERCENT....10
- SITE GRADING AND SURFACE DRAINAGE....10

LIMITATIONS....11

REFERENCES....12

FIGURE 1 – SUBJECT SITE

FIGURE 2 – GEOLOGIC MAP

FIGURE 3 – NRCS SOIL SURVEY SOILS

FIGURE 4 – LOGS OF EXPLORATORY BORINGS

FIGURE 5 – LEGEND & NOTES

PURPOSE AND SCOPE OF STUDY

This report presents the results of a Geologic Hazards Study for the proposed Town of Ramah Wastewater System Improvements. The proposed development is shown on Figure 1. The purpose of the study was to evaluate the geologic conditions and assess their potential impact on the project and surrounding properties. The study was conducted in accordance with our proposal for geotechnical engineering services, proposal no. C22-104, dated January 10, 2022, in addition to our email communications with Element Engineering, dated October 21, 2022

A reconnaissance of the project site was conducted on November 18, 2022 to obtain information on the geologic conditions of the site. Aerial photographs and published regional geologic, engineering geology, and mineral extraction maps were also reviewed. This report summarizes the data obtained during this study and references information obtained from the Kumar & Associates, Inc. geotechnical engineering report dated April 22, 2022, Project No. 22-2-102, and presents our conclusions, recommendations, and other geologic considerations based on the proposed construction and geologic conditions observed.

PROPOSED DEVELOPMENT

We understand the project will include a new lift station for a force main that will connect to a new evaporative pond system located about half a mile away. The new ponds will include three adjacent cells, and will replace the existing one located on the north end of town, which will be decommissioned. The lift station is anticipated to have a depth of about 12 feet, and the ponds will have sloped basins ranging in depth from about 2 to 8 feet.

We anticipate that bearing loads will be light for the proposed structures. Permanent grading will consist of cuts and fills, on the order of up to about 8 feet. If conditions are significantly different from those described above or depicted in this report, we should be notified to reevaluate the recommendations contained herein.

SITE CONDITIONS

The subject site is located in the vicinity of the Town of Ramah, in northeast El Paso County, Colorado. The proposed evaporation pond site is located southeast of the Town of Ramah Cemetery, and is bordered by Ramah Road on the south and west sides, with open fields to the north and east. This part of the site is mostly located within the southwest quarter of the southwest quarter of Section 06 in Township 11 south, Range 60 west, with just the west edge of the site located within the southeast quarter of the southeast quarter of Section 01 in Township 11 south, Range 61 west, Sixth Meridian of the Public Land Survey System. The area is relatively flat to

gently sloping around the proposed pond location, generally sloping down to the northeast, with some small hills and draws. An unnamed ephemeral tributary to Big Sandy Creek borders the east side of the subject site, which was dry during our site visit. This tributary was up to approximately 5 feet lower than the subject site. A small, natural drainage swale transects the middle of the east edge of the site, which connects to the unnamed tributary near the start of a small headward eroding gully. The area appears to have been used as an agricultural field, and the vegetation has previously been tilled.

The site of the proposed lift station is located on the northwest end of town, northwest of the intersection of Pikes Peak Avenue and Rock Island Avenue. This part of the site is situated within the southwest quarter of the northeast quarter of Section 01 in Township 11 south, Range 61 west, Sixth Meridian of the Public Land Survey System. The site is bordered by Pikes Peak Avenue to the northeast and northwest, and by private residences to the southeast and southwest. Several older agricultural structures are located to the north of the site, across Pikes Peak Avenue, with Big Sandy Creek located approximately 750 feet northwest of the proposed lift station. This area is relatively flat with a slight downward slope to the north. Northwest of Pikes Peak Avenue, the elevation decreases about 8 to 10 feet into the Big Sandy Creek flood plain. Vegetation in the subject area generally consists of a grass lawn and medium to large deciduous trees nearby. The existing evaporation pond is located about 1,000 feet to the northeast.

GEOLOGIC SETTING

The main geologic lithologies in the vicinity of the project area are shown on Figure 2. This map is based on the published regional maps by Moore et al. (2001) and Dechesne et al. (2011). Features that were mapped in the field by Kumar & Associates, Inc. as part of our site reconnaissance on November 18, 2022 are also shown on Figure 2. Logs of Exploratory Borings from the Kumar & Associates, Inc. geotechnical engineering report dated April 22, 2022, Project No. 22-2-102, and the corresponding legend and notes are shown on Figures 4 and 5.

The project site is located within the Colorado Piedmont of the Great Plains physiographic province. Structurally, this area is east of the Rampart Range Faults, which bounds this portion of the Front Range. According to Robinson (1977), Trimble and Machette (1979), and Madole (2003), regional uplift east of the Front Range has exposed Upper Cretaceous to Eocene-age gently northeast dipping claystone, siltstone, sandstone and thin coal beds representing a regressional sea sequence.

Surficial geology is mapped by Moore et al. (2001) as Holocene age Arkosic loamy colluvium and sheetwash alluvium at the proposed evaporative ponds site. Moore et al. map the proposed lift station as Alluvial sand, silt, clay, and gravel dating from the Holocene and Late Pleistocene. This area represents the Denver Basin Group D1 Sequence, as mapped by Dechesne et al. (2011), spanning the K-T boundary from the Cretaceous to Paleocene. This portion of the Denver Basin Group includes the Dawson Formation and the Denver Formation and is best described as arkosic fluvial strata. This strata ranges from coarse proximal sandstone beds to shale beds, with lignite beds present on the eastern edge of the Denver Basin. Although bedrock was not encountered during the Kumar & Associates, Inc. geotechnical exploration, the geologic conditions encountered during the preparation of this report as well as the previous Kumar & Associates, Inc. geotechnical report generally correlates to the mapped surficial geology of Moore et al. (2001).

NRCS SOIL SURVEY

The United States Department of Agriculture Natural Resource Conservation Service (NRCS) Web Soil Survey indicates the subject site as overlain with several different soil units, as seen on Figure 3. The proposed evaporative pond site contains Manzanst clay loam over the majority of the site, covering the east portion of the site, with the Terry-Razor complex representing the remainder. The proposed lift station site is composed of Nunn clay loam. The Manzanst clay loam is considered well drained, and is found on geomorphic positions including drainageways and terraces. It has a parent material of clayey alluvium derived from shale, and is classified within hydrologic group C. The Terry-Razor complex has a medium runoff, is well drained, and is found on the geomorphic position of hills. It is derived from calcareous residuum weathered from sandstone, and is classified within hydrologic group B. The Nunn clay loam has a low runoff potential and is well drained. It is found on geomorphic positions including terraces and fans, and has a mixed alluvium parent material. The Nunn clay loam is classified within hydrologic group C.

POTENTIAL MINERAL RESOURCES

According to the “El Paso County – Aggregate Resource Evaluation Maps, El Paso County – Master Plan for Mineral Extraction” (1996), the subject site is indicated to contain “upland deposits”. These “upland deposits” are described as sand, gravel with silt and clay; remnants of older streams deposited on topographic highs or bench like features.

The United States Department of Agriculture Natural Resource Conservation Service (NRCS) Web Soil Survey has designated the suitability and limitations of Manzanst clay loam, the Terry-

Razor complex, and Nunn clay loam for use as roadfill, as a gravel source, and as a sand source. All three soil units are rated as a poor source of gravel. Manzanst clay loam and Nunn clay loam are rated as a poor sand source, while the Terry-Razor complex is rated as poor to fair as a sand source. The Terry-Razor complex and Manzanst clay loam are rated as a poor roadfill source, while Nunn clay loam is rated as a fair roadfill source. Evaluation of commercial feasibility of gravel, sand, or roadfill mining on the subject site is beyond the scope of this study.

GEOLOGIC SITE ASSESSMENT

The project site geology should not present major constraints or unusually high risks to the development or surrounding properties. There are, however, several conditions of a geologic nature that should be considered. These conditions, their potential risks, and suggestions to mitigate the potential risks are discussed below.

POTENTIAL FLOODING

According to the “Flood Insurance Rate Map” (FIRM), map number 08041C0410G produced by the Federal Emergency Management Agency (FEMA, 2018), the majority of the proposed evaporation ponds site is located in an unshaded region of Zone X. Unshaded regions of Zone X have been identified as areas of minimal flood hazard. The nearest flood zone identified by FEMA is located approximately 375 feet to the east of the northeast portion of the evaporative ponds, and consists of a shaded region of Zone A. Shaded regions of Zone A are designated as a Special Flood Hazard Area in which the base flood elevation has not been determined. These shaded regions of Zone A represent areas that are subject to inundation by the 1% annual chance flood, also known as the 100-year flood. This 100-year floodplain is associated with an unnamed tributary of Big Sandy Creek. The site of the proposed lift station is located in an unshaded region of Zone X, with the nearest flood zone identified by FEMA located approximately 75 feet to the west of the subject site. This flood hazard is the floodplain associated with Big Sandy Creek. Floodplain migration can occur over time as a result of man-induced change, erosional processes, or other natural factors. Although both locations are currently situated on areas designated as a minimal flooding hazard, it would be reasonable to assume that the nearby flooding hazards may migrate, particularly at the proposed lift station, which may in turn situate the subject site within the vicinity of a flooding hazard at some point in the future. See the Potential Flooding and Site Grading and Surface Drainage sections in Development Considerations below for further discussion. No flood modeling was performed as a part of this study.

SEASONALLY SHALLOW GROUNDWATER/SEASONAL SEEPAGE

Indications of possible seasonally shallow groundwater were observed at the proposed lift station site, with groundwater encountered at about 15.3 feet in the borings drilled for the Kumar & Associates, Inc. geotechnical engineering report dated April 22, 2022, Project No. 22-2-102. This depth is near the elevation of the base of the lift station, and groundwater may be a construction consideration at this site. Groundwater is anticipated to fluctuate over time. Fluctuations in water level may occur with time, particularly after precipitation events and as a result of nearby irrigation practices after development. Evidence of seepage was not encountered during the geotechnical exploration, nor during the site visit for the preparation of this report. This area should be evaluated for seepage during a period of seasonally high flow. If seepage is encountered, it may need to be collected and diverted away from structures and pavements. Water may become perched upon impermeable layers, such as bedrock. The extent and amount of perched water beneath the building site as a result of irrigation and inadequate surface drainage is difficult, if not impossible, to foresee.

PRE-EXISTING MAN-PLACED FILL

Existing fill was encountered at the location of the proposed lift station to a depth of about 6 feet. Pre-existing man-placed fill should be considered unsuitable for the support of foundations and roadways unless documentation is available stating the site fills were properly controlled to the compaction criteria presented in the applicable geotechnical engineering report. Any pre-existing man-placed fill should be evaluated prior to use as foundation support or other site grading uses. Uncontrolled or inadequately compacted fill presents risks of excessive or differential settlement of foundations or roadways constructed on the fill. Engineering risk from uncontrolled fill is typically mitigated by removal and replacement of the material. The vertical and lateral extent of man-placed fill on the development was not determined and is beyond the scope of our work for this study.

EXPANSIVE/COLLAPSIBLE SOILS & BEDROCK

Soils tested from the Kumar & Associates, Inc. geotechnical engineering report were found to range from a low to high swell potential, with swell at the proposed evaporative ponds ranging from 3.4 to 5.7 percent, and at the proposed lift station with a swell of 0.2 percent upon wetting under a surcharge pressure of 1,000 psf. Such materials are stable at their natural moisture content, but will undergo high volume changes with changes in moisture content. Expansive materials may cause distress to structures or pavements if changes in moisture content occur. Over excavation and replacement, moisture conditioning of expansive materials, or the use of a deep foundation system are standard construction practices commonly used in this area for

mitigation of moisture sensitive soils. Swell/consolidation characteristics of the soil and bedrock are expected to vary across the development.

SUBSURFACE MINING

The Colorado Geological Survey indicates the nearest historic mine in the area to be located approximately just under 3,000 feet to the east-northeast of the proposed lift station and approximately just under 3,500 feet north of the proposed evaporative ponds. This historic mine is unnamed, and basic information regarding the history of this mine was incomplete. Historic mines in this region are generally part of the Colorado Springs Coal Field, which encompasses a southwest portion of the Denver Basin, and historically removed approximately 16 million tons of coal from the Laramie Formation in the Colorado Springs region (Roberts, 2007). The Colorado Springs Coal Field trends northwest to southeast through Colorado Springs, from just south of the US Air Force Academy to just north of the Colorado Springs Airport, continuing southeast then east from there (El Paso County – Master Plan for Mineral Extraction, 1996). The El Paso County Master Plan for Mineral Extraction also indicates a large region located in the northeast corner of El Paso County to contain coal with 0 to 150 feet of overburden, which is located nearby the subject site. Subsidence has been an issue related to these historic mines as relatively shallow tunnels are located beneath densely populated neighborhoods through the Colorado Springs area. The subject site, however, displayed no evidence of mine subsidence at the surface, and the risk is considered minimal as the site is not within a close proximity (3,000 feet) to any known historic mines.

SEISMICITY

The Rampart Range Fault, a high-angle generally north-south trending reverse fault is mapped about 40 miles west of the subject site. According to the “Preliminary Quaternary Fault and Fold Map and Database of Colorado” by Widmann, Kirkham and Rogers (1998), there is evidence that the Rampart Range Fault may have moved between 600,000 and 30,000 years ago. The largest historic earthquake in the project region occurred in 1882. It was located in the northern Front Range and had an estimated magnitude of M6.4 ± 0.2 and a maximum intensity of VII. Historic ground shaking at the project site does not appear to have exceeded Modified Mercalli Intensity VI (Kirkham and Rogers, 2000). Modified Mercalli Intensity VI ground shaking should be expected during a reasonable exposure time for the development, but the probability of stronger ground shaking is low. Intensity VI ground shaking is felt by most people and causes general alarm, but results in negligible damage to structures of good design and construction.

Using estimated shear wave velocities for the subgrade materials encountered based on standard penetration testing from the Kumar & Associates, Inc. geotechnical engineering report, project number 22-2-102, calculations indicate that the seismic soil profile within the upper 100 feet at the subject site should be considered Class D, *stiff soil*, as described in the 2015 International Building Code, unless site specific shear wave velocity studies show otherwise. Based on the subsurface profile and the anticipated ground conditions, liquefaction is not a design consideration. Using the USGS National Earthquake Hazard Reduction Program online database, the following probabilistic ground motion values are reported for the subject site.

Site Class D, *Stiff Soil*	
Intensity Measure Type	Intensity Measure Level 2 percent in 50 Years
0.2 Sec. Spectral Acceleration S_s	0.145
1.0 Sec. Spectral Acceleration S_1	0.053

The USGS National Earthquake Hazard Reduction Program online database also indicates a peak ground acceleration (PGA) of 0.072 for site class D, *Stiff Soils*, at the subject site. The PGA is the lower of the deterministic or the probabilistic value with a 2% exceedance probability for a 50-year exposure time at the project site (statistical recurrence interval of 2,500 years).

EROSIONAL FEATURES

No major erosional features were observed at the proposed lift station. No loose soils that may be easily eroded were found near the surface at either site. The unnamed tributary of Big Sandy Creek located east of the proposed evaporative ponds was found to contain the start of headward eroding gullies east of the site, as well as nearby erosional cut banks southeast of the site. A headward eroding gully is starting to form approximately just over 500 feet east of the site, and is anticipated to progress if not mitigated by site grading, landscaping, or other means. If site development concentrates surface water flow over these features, accelerated erosion should be expected and the project civil engineer should evaluate possible methods to mitigate the potential for erosion.

SLOPES GREATER THAN 30%

Slopes within the subject site were not found to exceed 30%. Although not within the site itself, several slopes along the unnamed tributary of Big Sandy Creek east of the proposed evaporative ponds were found to exceed 30%. These slopes were observed along the unnamed creek, which

is located over 500 feet east of the subject site. These slopes are associated with erosion along the creek, and may be anticipated to increase over time if not mitigated. The proposed development is not situated in the immediate vicinity of slopes greater than 30%, and should not be negatively impacted by steep slopes if the considerations in the Site Grading and Surface Drainage section below are followed.

RADIOACTIVE GASES

According to the Environmental Protection Agency (EPA) and the El Paso County Department of Health, elevated levels of radon gas (4pCi/L or more) have been found in buildings in El Paso County. Radon is a radioactive gas that forms from the natural breakdown of uranium in soil, rock, and water. Radon tends to accumulate in poorly ventilated areas below ground level; however, radon may accumulate inside any above or below grade construction. According to the EPA, radon levels in buildings can be reduced by several methods, including pressurization of the building using a heating, ventilation and air-conditioning system, sealing of cracks in the foundation walls and floor slabs which may allow entry of radon, and using active soil depressurization (ASD) systems. Radon risk and potential mitigation measures should be evaluated by an industry professional based on structure type and potential risk in accordance with established guidelines.

DEVELOPMENT CONSIDERATIONS

Presented below is a discussion of geologic and geotechnical engineering related development considerations, including identified geologic hazards.

Potential Flooding:

Special flood hazard areas have been identified near the subject site. These flood hazard areas also have the potential to migrate from their current locations. As such, we recommend that a floodplain buffer be considered in the development design. In areas with less elevation change between the development and the floodplain, such as the proposed lift station, ensuring a buffer of at least 50 feet from the existing special flood hazard areas would reduce the risk from potential flooding. A buffer of 25’ in areas of increased elevation separation between development and the floodplain should be sufficient, such as for the proposed evaporative ponds. Development should not be planned within these buffer zones in order to reduce the risk of potential flooding.

Seasonally Shallow Groundwater/Seasonal Seepage:

Groundwater was encountered at a depth of about 15.3 feet at the proposed lift station during the preparation of the Kumar & Associates, Inc. geotechnical engineering report. This depth is near

the elevation of the base of the proposed lift station. Groundwater is anticipated to fluctuate over time, particularly after precipitation events and as a result of nearby irrigation practices after development. Dewatering may be necessary for stable excavations during construction. If water is present above the depth of excavation, flatter slopes will be required. See the Kumar & Associates, Inc. geotechnical engineering report dated April 22, 2022, Project No. 22-2-102 for further discussion on construction considerations related to groundwater. OSHA regulations require that excavations greater than 20 feet in depth and excavations that extend below the ground water level be designed by a professional engineer.

Pre-existing Man-placed Fill:

Evidence of pre-existing man-placed fill was observed within the subject site. Given the unknown history of the fill placement, it is our opinion that it should be considered unsuitable for support of foundations and roadways unless documentation is available stating the site fills were properly controlled to the compaction criteria presented in the applicable geotechnical engineering report. Areas of pre-existing artificial fill may contain deleterious materials, which should be removed from any potential site fills. The specifications contained in the Kumar & Associates, Inc. geotechnical engineering report, project number 22-2-102, should be followed.

Expansive/Collapsible Soils/Bedrock:

Soils found within the subject site were found to range from a low to high swell potential. Shallow foundations placed directly on or near expansive materials similar to that encountered at this site can experience movement causing structural distress if the materials are subjected to changes in moisture content. Typically, a structural fill layer is intended to provide separation between the expansive materials and thereby reduce the potential for foundation and slab movement. Increasing the thickness of this structural fill layer and removal of the entire extent of native clays or the use of a deep foundation system will further reduce the potential for uplift. The Kumar & Associates, Inc. geotechnical engineering report dated April 22, 2022, Project No. 22-2-102, recommends that any structures that are sensitive to heave related movement constructed in this area be constructed on deep foundations such as helical piers that extend to the underlying granular soils found below the clays.

Erosional Features:

Erosional features should be protected from further accelerated erosion. Accelerated erosion should be mitigated by regrading slopes to 3:1 (horizontal to vertical) or flatter, and revegetating or otherwise protecting the new slopes from erosion. Concentrated surface flows should be collected or diverted away from development areas. Plans provided to Kumar & Associates, Inc.,

indicate a drainage swale outlet near the start of a headward eroding gully on the unnamed tributary east of the proposed evaporative ponds. Engineering controls should be implemented to prevent the concentrated flows associated with the drainage swale from further progressing the headward erosion. Recommendations from the Site Grading and Surface Drainage section below and from the Kumar & Associates, Inc. geotechnical engineering report dated April 22, 2022, Project No. 22-2-102, should be followed to reduce impacts resulting from concentrated surface flow over erosional features.

Slopes Greater Than 30%:

Based on our review of the current site conditions, the information provided, and our experience in the area, the proposed site plan is feasible from a geotechnical viewpoint. The Horizontal Control & Grading plans provided to Kumar & Associates, Inc. by Element Engineering LLC, dated October 22, Job Name 0043.0001, indicate proposed features will not be located near steep slopes greater than 30%, which were observed along the unnamed tributary of Big Sandy Creek east of the site. Permanent slopes should not be steeper than 3:1 (horizontal to vertical), and should not exceed 30 feet in height. Observed slopes east of the site greater than 30% do not show signs of mass movement and appear stable, and should not adversely affect the proposed development if the site grading and drainage recommendations below are followed. Additional consideration should be given to non-structural design elements near slopes greater than 30%.

Site Grading and Surface Drainage:

Proper surface drainage is very important for acceptable performance of the development during the proposed construction and after construction has been completed. Development plans should attempt to place structures relatively high with respect to the surrounding ground. Grading to accommodate the collection and diversion of surface drainage away from building and pavement locations is recommended. Site grading modifications should be planned to provide positive surface drainage away from all building and pavement areas and wetting of subgrade soils should be prevented. The ponding of water should not be allowed in backfill material or in a zone within 10 feet of the foundation walls of the structure, whichever is greater. We recommend a minimum slope of 6 inches in the first 10 feet in unpaved areas. Site drainage beyond the 10-foot zone should be designed to promote runoff and reduce infiltration. A minimum slope of 3 inches in the first 10 feet is recommended in paved areas. These slopes may be changed as required for handicap access points in accordance with the Americans with Disabilities Act. Surface diversion features should be provided around staging areas and roadways to prevent surface runoff from flowing across developed surfaces. The likelihood of maintaining relatively stable foundations and floor slabs for the life of the project will be significantly increased by planning a well-drained

development with little to no irrigation adjacent to structures. Drainage recommendations provided by local, state and national entities should be followed based on the intended use of the structure. The use of proper drainage will also reduce potential runoff impacts to surrounding properties.

Fill should not contain concentrations of organic matter or other deleterious substances. A geotechnical engineer should evaluate the suitability of proposed imported fill materials prior to placement.

Permanent slopes should not be steeper than 3:1 (horizontal to vertical). The risk of slope instability will be significantly increased if seepage is encountered in cuts. If seepage is encountered in permanent excavations, and investigation should be conducted to determine if the seepage will adversely affect the cut stability. Good surface drainage should be provided for all permanent cuts and fills to direct the surface runoff away from the slope faces. Cut and fill slopes and other stripped areas should be protected against erosion by revegetation or other means. Fills should be benched into hillsides that exceed 4:1 (horizontal to vertical). Site grading should be planned to provide positive surface drainage away from all building and pavement areas. No formal stability analyses were performed to evaluate the slopes recommended above. Published literature and our experience with similar cuts and fills indicate the recommended slopes should have adequate factors of safety. If a detailed stability analysis is required, we should be notified.

LIMITATIONS

This study has been conducted for exclusive use by the client for geotechnical related design and construction criteria for the project. The conclusions and preliminary recommendations submitted in this report are based upon the data obtained from the exploratory borings, the site reconnaissance, published regional geology information, the proposed type of construction and our experience in the area. Our services do not include determining the presence, prevention or possibility of mold or other biological contaminants (MOBC) developing in the future. If the client is concerned about MOBC, then a professional in this special field of practice should be consulted. This report may not reflect subsurface variations that occur, and the nature and extent of variations across the site may not become evident until site grading and excavations are performed. If during construction, fill, soil, bedrock, or water 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.

RAY\th

References

Moore, D.W., Staub, A.W., Berry, M.E., Baker, M.L., and Brandt, T.R., 2001, *Generalized Surficial Geologic map of the Denver 1°x2° Quadrangle, Colorado*: United States Geological Survey, MF2347.

Dechesne, M., Raynolds, R.G., Barkmann, P.E., and Johnson, K.R., 2011, *Notes on the Denver Basin Geologic Maps: Bedrock Geology, Structure, and Isopach Maps of the Upper Cretaceous to Paleogene Strata between Greeley and Colorado Springs, Colorado*: Colorado Geological Survey.

Robinson, C.S., 1977, *Environmental and Engineering Geologic Map for Land Use, Elsmere Quadrangle*: United States Geological Survey.

Trimble, D.E., and Machette, M.N., 1979, *Geologic Map of the Colorado Springs-Castle Rock Area, Front Range Urban Corridor, Colorado*: United States Geological Survey.

Madole, R.F., 2003, *Geologic Map of the Falcon NW Quadrangle, El Paso County, Colorado*: Colorado Geological Survey.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at the following link: https://websoilsurvey.sc.egov.usda.gov/. Accessed [12/14/2022].

El Paso County, 1996, *El Paso County-Aggregate Resource Evaluation Map 1, 2, and 3*: El Paso County-Master Plan for Mineral Extraction.

Federal Emergency Management Agency (FEMA), December 7, 2018, Flood Insurance Rate Map (FIRM): Map No. 08041C0410G.

Kirkham, R.M., and Rogers, W.P., 1981, *Earthquake Potential in Colorado*: Colorado Geological Survey, Bulletin 43.

International Code Council, 2015, *International Building Code*: Falls Church, Va, International Code Council.

Applied Technology Council, *Hazards by Location*: ATC Hazards by Location. Available online at the following link: https://hazards.atcouncil.org/. Accessed [12/14/2022].

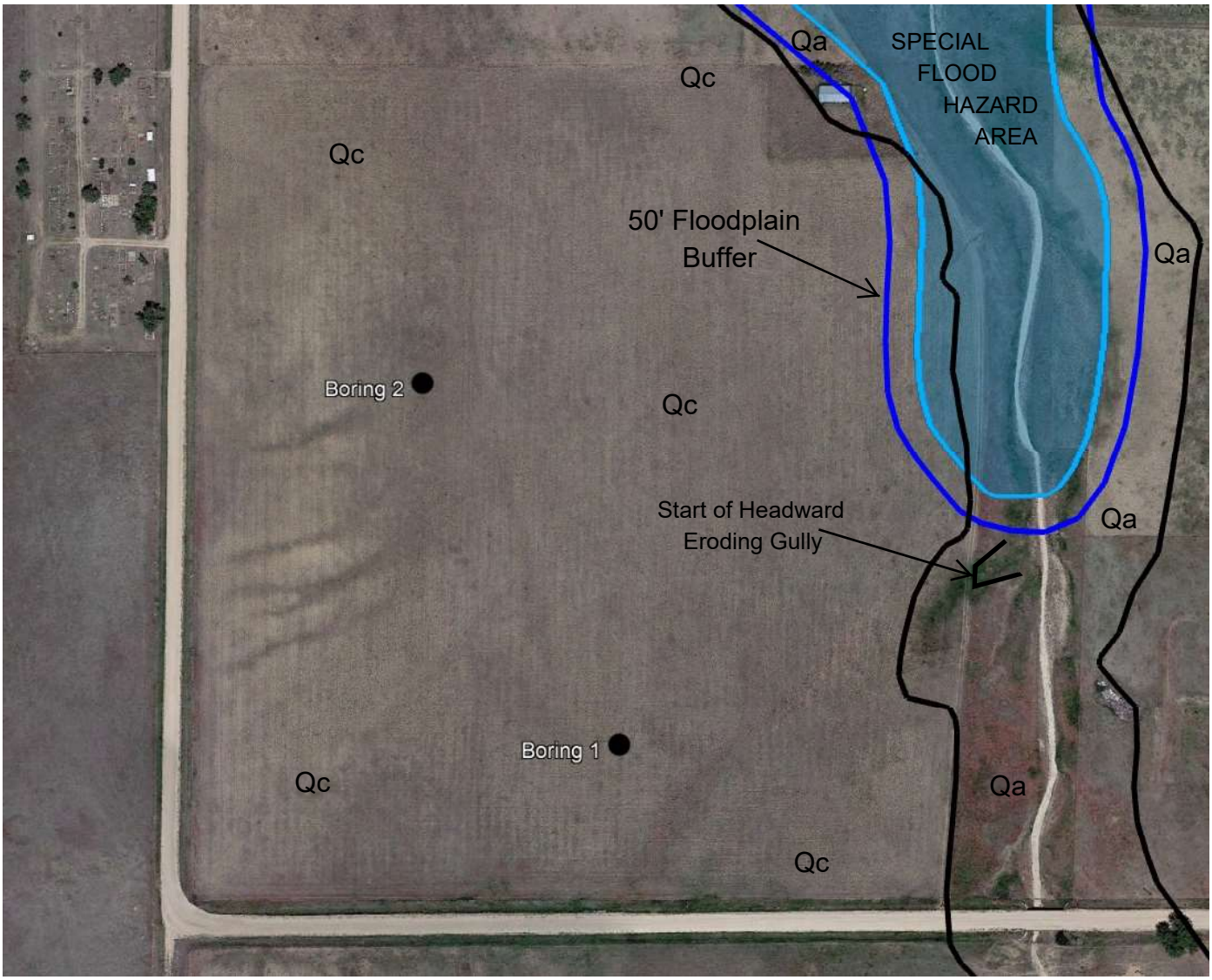
U.S. Environmental Protection Agency (EPA), *Radon*: EPA, Available online at the following link: https://epa.gov/radon/. Accessed [2/17/2021].

El Paso County Health Department, *Facts About Radon in the Pikes Peak Region* [Pamphlet]: Colorado Springs, Co, Available online at the following link: https://www.elpasocountyhealth.org/sites/default/files/files/services/Public-Health-Alerts/FactsAboutRadonDec11.pdf. Accessed [2/17/2021].

VICINITY MAP
NOT TO SCALE

200 0 200 400
APPROXIMATE SCALE - FEET

22-2-102.A	Kumar & Associates	SUBJECT SITE	Fig. 1



APPROXIMATE SCALE - FEET

100 0 100 200

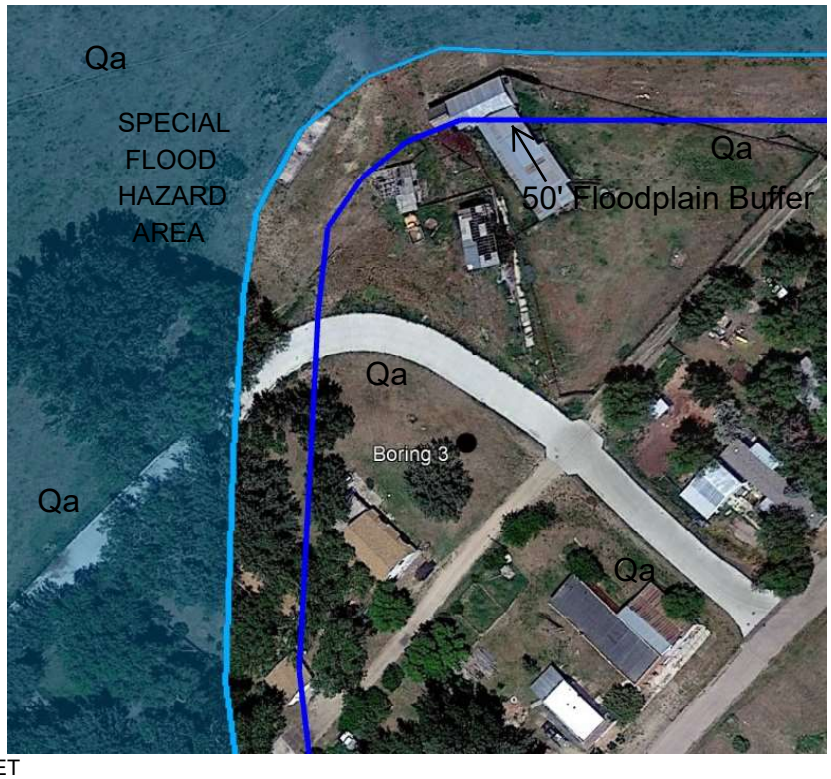
: Special Flood Hazard Area

: 50' Floodplain Buffer

: Geologic contact

Qc: Arkosic loamy colluvium & sheetwash alluvium

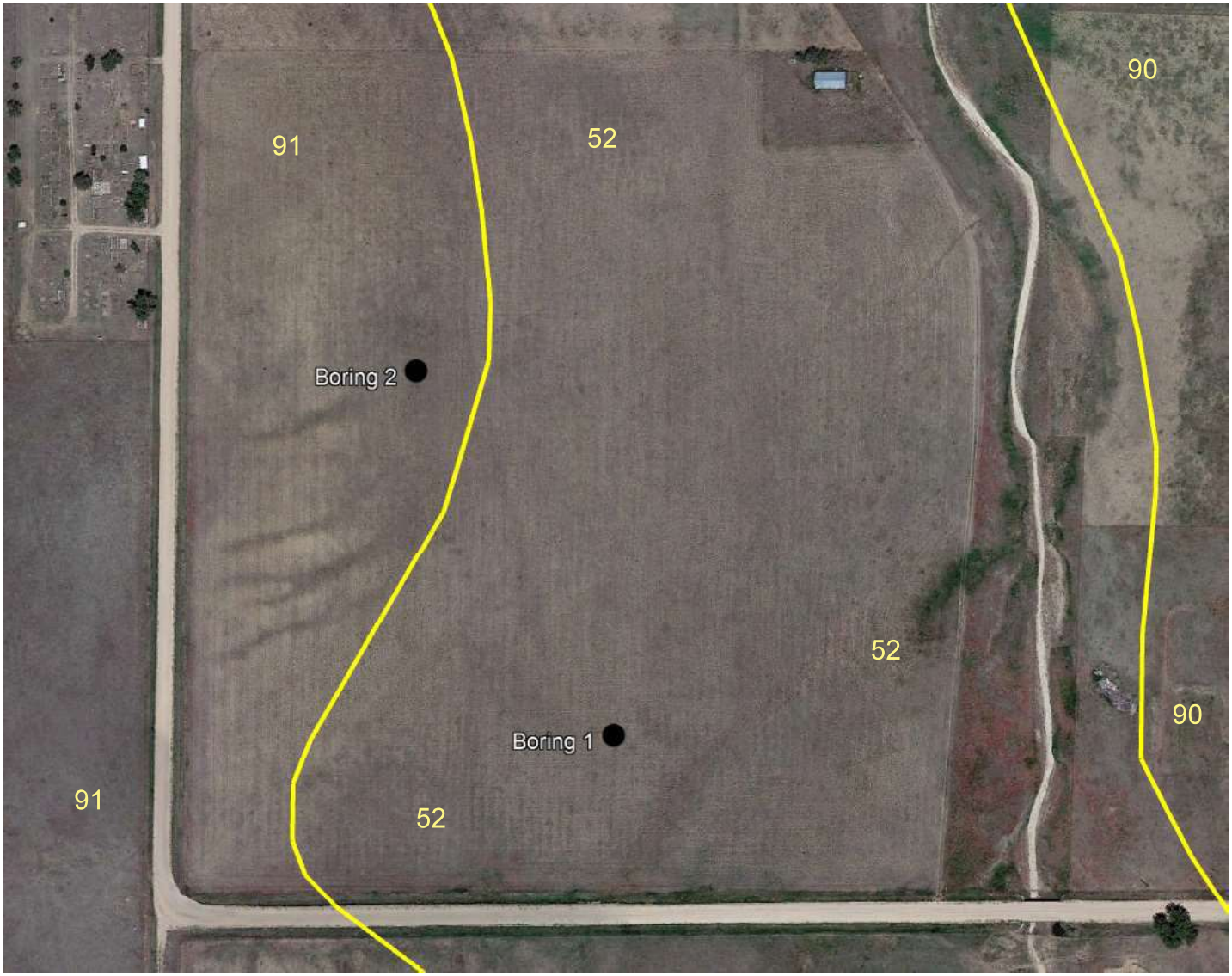
Qa: Alluvial sand, silt, clay, & Gravel



50 0 50 100

APPROXIMATE SCALE - FEET

22-2-102.A	Kumar & Associates	GEOLOGIC MAP	Fig. 2



APPROXIMATE SCALE - FEET

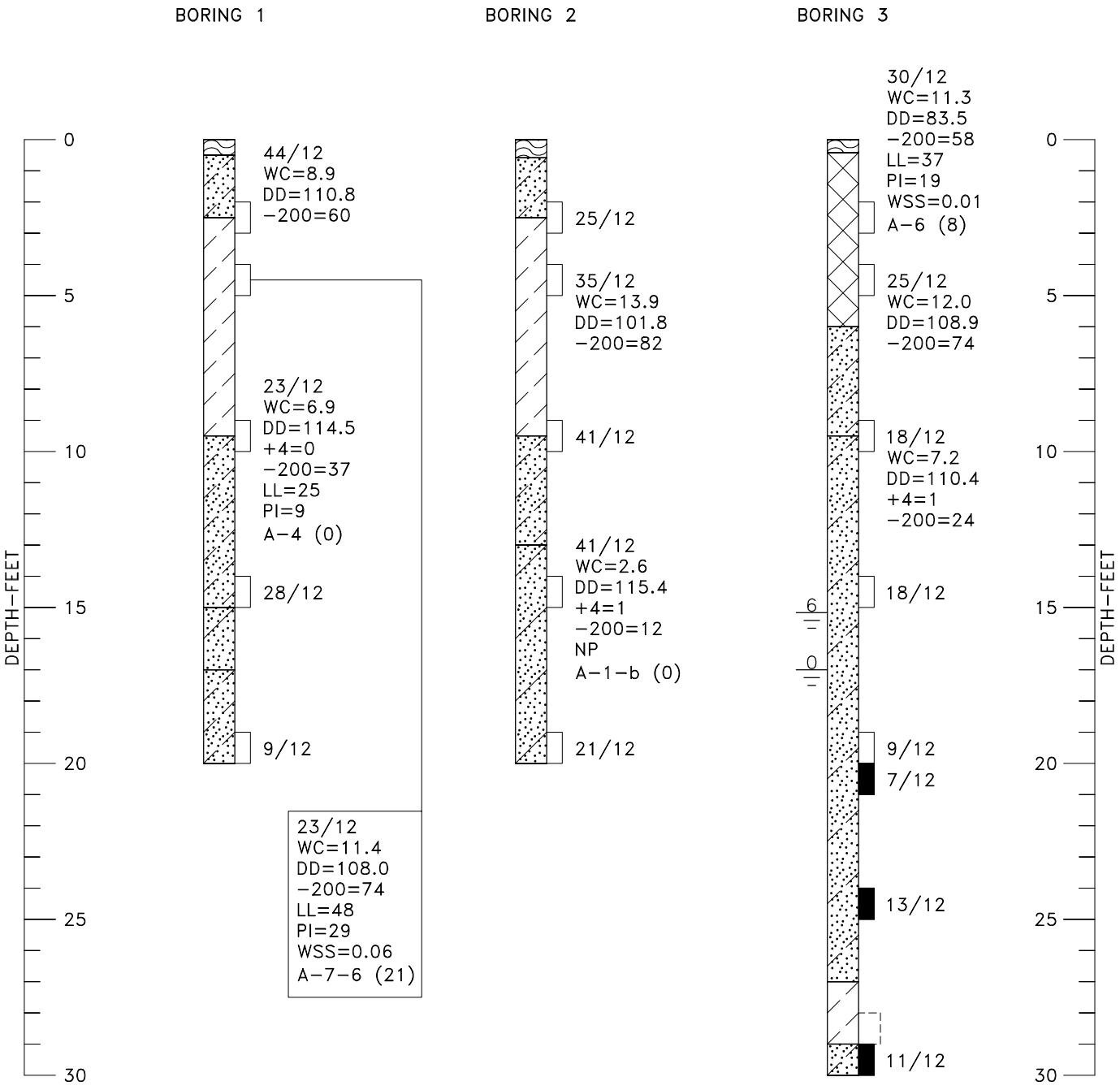
100 0 100 200

52: Manzanst clay loam
59: Nunn clay loam
90: Terry sandy loam
91: Terry-Razor complex
101: Ustic Torrifluvents, loamy
105: Vona sandy loam

100 0 100 200

APPROXIMATE SCALE - FEET

22-2-102.A	Kumar & Associates	NRCS SOIL SURVEY SOILS	Fig. 3



22-2-102	Kumar & Associates	LOGS OF EXPLORATORY BORINGS	Fig. 4

LEGEND


TOPSOIL.


FILL: SANDY LEAN CLAY AND LEAN CLAY WITH SAND (CL), FINE TO COARSE GRAINED SAND FRACTION, MOIST, MOTTLED BROWNS.


CLAYEY SAND (SC), FINE TO COARSE GRAINED, MEDIUM DENSE TO DENSE, SLIGHTLY MOIST TO VERY MOIST, LIGHT BROWN TO GRAY–BROWN.


SANDY LEAN CLAY TO LEAN CLAY WITH SAND (CL), FINE TO COARSE GRAINED SAND FRACTION, VERY STIFF TO HARD, SLIGHTLY MOIST TO MOIST, LIGHT TO DARK BROWN.


WELL GRADED SAND WITH SILT (SW–SM), FINE TO COARSE GRAINED, MEDIUM DENSE TO DENSE, MOIST, LIGHT BROWN.


WELL GRADED SAND WITH CLAY (SW–SC), FINE TO COARSE GRAINED, LOOSE TO MEDIUM DENSE, MOIST TO WET, LIGHT BROWN TO GRAY–BROWN.


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


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


DISTURBED BULK SAMPLE.

44/12 DRIVE SAMPLE BLOW COUNT. INDICATES THAT 44 BLOWS OF A 140–POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 12 INCHES.


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

NOTES

1. THE EXPLORATORY BORINGS WERE DRILLED ON MARCH 15, 2022 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 AND SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

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

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

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

6. LABORATORY TEST RESULTS:
   WC = WATER CONTENT (%) (ASTM D2216);
   DD = DRY DENSITY (pcf) (ASTM D2216);
   +4 = PERCENTAGE RETAINED ON NO. 4 SIEVE (ASTM D6913);
   –200= PERCENTAGE PASSING NO. 200 SIEVE (ASTM D1140);
   LL = LIQUID LIMIT (ASTM D4318);
   PI = PLASTICITY INDEX (ASTM D4318);
   NP = NON–PLASTIC (ASTM D4318);
   WSS = WATER SOLUBLE SULFATES (%) (CP–L 2103);
   A–7–6 (21) = AASHTO CLASSIFICATION (GROUP INDEX) (AASHTO M 145).