Ten X Residential Housing Project – Request for Proposal

WATER, RECLAIM WATER, AND SEWER UTILITIES

Date:	10/25/2018
Project:	Ten X Residential Housing Project
Location:	Tusayan, AZ
Activity:	WATER, RECLAIM WATER, AND SEWER UTILITIES
Bid Due Date:	**Friday, November 2nd, 2018 by 5 pm MST**

Project Info

The Project area is located on a 20-acre parcel approximately three miles east of Highway 64 along Forest Road 302 in the Town of Tusayan, Coconino County. The proposed development will consist of up to 34 single-family units and 28 townhomes at buildout.

If you are interested in bidding this Project, please contact James Kelton to receive the necessary invite to Procore in order to download the drawings and submit a proposal. Proposals must be submitted through Procore, any other form of submission will not be accepted.

Email: james.kelton@premierbuilders.com
Phone: (520) 293-0300 ext. 139

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A. Instructions to Bidders

Please read all bid documents carefully:

1. Each bidding subcontractor shall submit a comprehensive bid package to include quantities/pricing relative to the discipline and scope of the intended bid.
2. Each bidding subcontractor shall be licensed within the development's jurisdiction.
3. Your bid should state that you are bidding per plans, specs, and intent. Please do not exclude items that are required to provide a complete working system for your scope. If clarifications are required, please include them as an attachment.
4. Subcontractor selection will be best value, based on price, resume, available equipment and manpower and approach to fast-tracking the schedule.
5. A bid analysis will be conducted of the received proposals. Any questions relative to the scope of work, quantities, and pricing will be addressed individually with the bidding subcontractor's estimator or equivalent. Any revisions or negotiations shall be in written form and included with the final documents prior to executing an awarded contract.
6. All bidders will receive a written response of acceptance or non acceptance of proposals prior to contracts being administered.
7. All awarded subcontractors shall attend a Pre-Construction meeting at a date and location to be determined prior to mobilization.
8. It is the intent of Premier Building Group to establish a team of reputable subcontractors who understand the value of cost and time, with emphasis on commitment to quality, safety, and lifestyle.
9. This project will NOT have an Owner-Provided Insurance Policy for all on site Products Completed Operations. Subcontractor will still need to provide their own Insurance that meets Premier Building Group's requirements that also include, Auto Liability, Workman's Comp per state statute, and General Liability.

ALL PROPOSALS MUST INLCUDE A TIMELINE FOR PROCURMENT AND CASH FLOW FOR ALL NECESSARY COMPONENTS. PROPOSALS THAT DO NOT INLCUDE A TIMELINE WILL NOT BE CONSIDERED FOR AWARD.

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B. <u>Attachments</u>

1. Drawing Log **(Exhibit "A")**.
2. Geotechnical Engineering Study, *Dated March 27, 2018* **(Exhibit "B")**.
3. Insurance Requirements **(Exhibit "C")**.

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EXHIBIT "A"

DRAWING LOG

Drawing No.	Drawing Title	Rev. No.	Drawing Date
C-201	10X RANCH SANITARY SEWER & FORCE MAIN PLANS COVER SHEET	NOREV1	8/24/2018
C-202	10 RANCH SANITARY SEWER & FORCE MAIN PLANS NOTES	NOREV1	8/24/2018
C-203	10 RANCH SANITARY SEWER & FORCE MAIN PLANS PLAN AND PROFILE	NOREV1	8/24/2018
C-204	10 RANCH SANITARY SEWER & FORCE MAIN PLANS PLAN AND PROFILE	NOREV1	8/24/2018
C-205	10 RANCH SANITARY SEWER & FORCE MAIN PLANS PLAN AND PROFILE	NOREV1	8/24/2018
C-206	10 RANCH SANITARY SEWER & FORCE MAIN PLANS PLAN AND PROFILE	NOREV1	8/24/2018
C-207	10 RANCH SANITARY SEWER & FORCE MAIN PLANS PLAN AND PROFILE	NOREV1	8/24/2018
C-301	10X RANCH DOMESTIC WATER AND RECLAIM WATER PLANS COVER SHEET	NOREV	8/13/2018
C-302	10X RANCH DOMESTIC WATER AND RECLAIM WATER PLANS NOTES	NOREV	8/13/2018
C-303	10X RANCH DOMESTIC WATER AND RECLAIM WATER PLANS	NOREV	8/13/2018
C-304	10X RANCH DOMESTIC WATER AND RECLAIM WATER PLANS	NOREV	8/13/2018
C-305	10X RANCH DOMESTIC WATER AND RECLAIM WATER PLANS	NOREV	8/13/2018
C-306	10X RANCH DOMESTIC WATER AND RECLAIM WATER PLANS	NOREV	8/13/2018

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EXHIBIT "B"

GEOTECHNICAL ENGINEERING STUDY

CMT ENGINEERING LABORATORIES

Engineering
Geology
Environmental (ESA I & II)
Organic Chemistry
Materials Testing
Special Inspections

GEOTECHNICAL ENGINEERING STUDY

TEN X RANCH

Forest Road 302
Tusayan, Arizona

Prepared For:

Town of Tusayan
PO Box 709
845 Mustang Drive
Tusayan, Arizona 86023

CMT Project No. 1079
March 27, 2018

March 27, 2018

Mr. Eric Duthie, Town Manager
Town of Tusayan
PO Box 709
845 Mustang Drive
Tusayan, Arizona 86023

Subject: Geotechnical Engineering Study
Ten X Ranch
Forest Road 302
Tusayan, Arizona
CMT Project Number: 1079

Mr. Duthie:

Submitted herewith is the report of our geotechnical engineering study for the subject site. This report contains the results of our findings and an engineering interpretation of the results with respect to the available project characteristics. It also contains recommendations to aid in the design and construction of the earth related phases of this project.

On March 8-9, 2018, CMT Engineering Laboratories (CMT) personnel were on site and performed percolation testing and supervised the drilling of 20 borings extending to depths up to 25 feet below the existing ground surface. Soil samples were obtained during the field operations and subsequently transported to our laboratory for further testing and observation.

Conventional footings may be utilized to support the proposed residential homes, provided the recommendations in this report are followed. A detailed discussion of design and construction criteria is presented in this report. Recommendations for a box culvert, septic tank, and water/wastewater facilities are also included.

We appreciate the opportunity to work with you at this stage of the project. CMT offers a full range of Geotechnical Engineering, Geological, Material Testing, Special Inspection services, and Phase I and II Environmental Site Assessments. With three offices throughout Arizona and four in Northern Utah, our staff is capable of efficiently serving your project needs. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at (602) 241-1097.

Sincerely,
CMT Engineering Laboratories

Registered Professional Engineer (Civil)
CERTIFICATE NO. 49104
HANK BELLISTON
Date Signed 03-27-18
ARIZONA U.S.A.
Expires March 31, 2021

Hank Belliston, M.S., P.E.
Arizona Engineering Manager

Reviewed by:

Jeffrey J. Egbert, P.E., LEED A.P., M. ASCE
Senior Geotechnical Engineer

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APPENDIX

Figure 1: Site Plan
Figures 2-22: Bore Hole Logs
Figure 23: Key to Symbols

1.0 INTRODUCTION

1.1 General

CMT Engineering Laboratories (CMT) was retained to conduct a geotechnical subsurface study for a proposed residential development to be located at the southeast corner of Forest Road 302 and Forest Road 303 in Tusayan, Arizona, as shown in the **Vicinity Map** below.

Vicinity Map

1.2 Objectives, Scope and Authorization

The objectives and scope of our study were planned in discussions between Mr. Matt Cawley, P.E., of WestLand Resources, Inc., Mr. Eric Duthie, Tusayan Town Manager, and Mr. Hank Belliston of CMT Engineering Laboratories (CMT). In general, the objectives of this study were to define and evaluate the subsurface soil and groundwater conditions at the site, and provide appropriate foundation, earthwork, pavement, and seismic recommendations to be utilized in the design and construction of the proposed development.

In accomplishing these objectives, our scope of work has included performing field exploration, which consisted of the drilling/logging/sampling of 21 bore holes, performing laboratory testing on representative samples, and conducting an office program, which consisted of correlating available data, performing engineering analyses, and preparing this summary report. In addition, 5 near-surface percolation tests were performed at

representative locations within the drainage area defined by the Client. This scope of work was authorized by returning a signed copy of our proposal dated February 26, 2018 and executed on February 26, 2018.

1.3 Description of Proposed Construction

We understand that the proposed construction consists of single-family residences which we project will have one or two levels of wood frame construction above grade. We project that wall loads will not exceed 4,000 pounds per linear foot and column loads will not exceed 50,000 pounds. Floor slab loads are anticipated to be relatively light, with an average uniform loading not exceeding 150 pounds per square foot. If the loading conditions are different than we have projected, please notify us so that any appropriate modifications to our conclusions and recommendations contained herein can be made.

In addition to the homes, water and wastewater facilities will also be constructed at the site. This will include a buried septic tank and several above-ground tanks for water and water treatment.

The new local roads within the subdivision will utilize asphalt pavement. One box culvert crossing is expected. Traffic within the subdivision is projected to consist of mostly automobiles and light trucks, a few medium-weight delivery trucks, a weekly garbage truck and tanker truck, and an occasional fire truck.

Site development will require some earthwork in the form of minor cutting and filling. A site grading plan was not available at the time of this report, but we project that maximum cuts and fills may be on the order of 3 to 5 feet. If deeper cuts or fills are planned, CMT should be notified to provide additional recommendations, if needed.

1.4 Executive Summary

The most significant geotechnical aspects regarding site development include the following:

1. Mature native trees exist on some of the site, which will require removal of all roots within structural areas, including building pads and roadways;
2. Rock outcrops and shallow bedrock was encountered during drilling operations - excavation within these areas will require heavy equipment and/or other methods;
3. Groundwater, which was not encountered at depths of our drilling, is not expected to impact construction;
4. Foundations and floor slabs may be constructed on suitable structural/engineered fill which extends to natural soils, or on bedrock, but not a combination of these.

CMT must assess that all topsoil, and any undocumented fill, disturbed, or unsuitable soils have been removed and that suitable soils have been encountered prior to placing site grading fills, footings, slabs, and pavements.

In the following sections, detailed discussions pertaining to the site and subsurface descriptions, geologic/seismic setting, earthwork, foundations, lateral resistance, lateral pressure, floor slabs, and pavements are provided.

2.0 FIELD EXPLORATION

In order to define and evaluate the subsurface soil and groundwater conditions at the site, 20 bore holes were drilled throughout the site to depths of up to 26.5 feet below the existing ground surface. It should be noted that the planned bore hole within the water/wastewater campus was not accessible due to large rocks, outcrops, and trees. Locations of the bore holes are presented on **Figure 1, Site Plan**, included in the Appendix.

Samples of the subsurface soils encountered in the bore holes were collected at varying depths through the hollow stem drill augers. Relatively undisturbed samples of the subsurface soils were collected utilizing a Dames and Moore ring sampler. Disturbed samples were collected utilizing a standard split spoon sampler. The split spoon sampler was driven 18 inches into the soils below the drill augers using a 140 pound hammer free-falling a distance of 30 inches. The number of hammer blows needed for each 6 inch interval was recorded. The sum of the hammer blows for the final 12 inches of penetration is known as a standard penetration test and this 'blow count' was recorded on the bore hole logs. The blow count provides a reasonable approximation of the relative density of granular soils, but only a limited indication of the relative consistency of fine grained soils because the consistency of these soils is significantly influenced by the moisture content. Bulk samples were also collected.

The subsurface soils encountered in the bore holes were logged and described in general accordance with ASTM[1] D-2488. Soil samples were collected as described above, and were classified in the field based upon visual and textural examination. These field classifications were supplemented by subsequent examination and testing of select samples in our laboratory. Logs of the bore holes, including a description of the soil strata encountered, is presented on each individual Bore Hole Log, **Figures 2 through 22**, included in the Appendix. Sampling information and other pertinent data and observations are also included on the logs. In addition, a Key to Symbols defining the terms and symbols used on the logs is provided as **Figure 23** in the Appendix.

3.0 LABORATORY TESTING

3.1 General

Selected samples of the subsurface soils were subjected to various laboratory tests to assess pertinent engineering properties, as follows:

1. Moisture Content, ASTM D-2216, Percent moisture representative of field conditions
2. Atterberg Limits, ASTM D-4318, Plasticity and workability
3. Gradation Analysis, ASTM D-1140/C-117, Grain Size Analysis
4. One Dimension Consolidation, ASTM D-2435, Consolidation properties, moisture sensitivity

[1]American Society for Testing and Materials

3.2 Lab Summary

Laboratory test results are presented on the bore hole logs (**Figures 2 through 22**) and in the following Lab Summary Table:

Lab Summary Table

Bore Hole	Depth (feet)	Soil Class	Sample Type	Moisture Content (%)	Dry Denstiy (pcf)	Gradation			Atterberg Limits			Collapse (-) or Expansion (+)
						Grav	Sand	Fines	LL	PL	PI	
B-1	2.5-4	CL-ML	SPT	9.0		2.0	33.4	64.6	24	18	6	
B-3	0-5	CL	Bulk	10.1		0	32.6	67.4	29	18	11	
B-3	2.5-3.5	CL	Ring	10.6	88.1							-6.8%
B-6	2.5-4	CL-ML	SPT	7.3		3.0	33.9	63.1	24	18	6	
B-7	0-5	CL	Bulk	10.1		0	36.4	63.6	29	17	12	
B-9	0-5	CL	Bulk	10.5		0.7	34.3	65.0	26	17	9	
B-9	2.5-3.5	CL	Ring	6.4	94.6							-1.5%
B-13	0-4	CL	Bulk	8.7		7.7	37.7	54.6	27	16	11	
BC-1	0-5	CL	Bulk	8.0		0	42.7	57.3	28	16	12	
BC-1	5-6	CL	Ring	10.0	95.1							-2.0%
ST-1	10-11.5	GM	SPT	4.0		45.2	35.2	19.6	NV	NP	NP	
P-1	0-5	SC	Bulk	7.7		1.8	51.0	47.2	26	16	10	
P-2	0-5	CL	Bulk	8.9		1.6	44.2	54.2	28	17	11	
P-3	0-1	CL-ML	Bulk	10.0		4.3	33.8	61.9	25	19	6	
P-4	0-5	CL	Bulk	8.9		0	33.1	66.9	27	16	11	
P-5	0-5	CL-ML	Bulk	9.5		0	36	64	24	17	7	

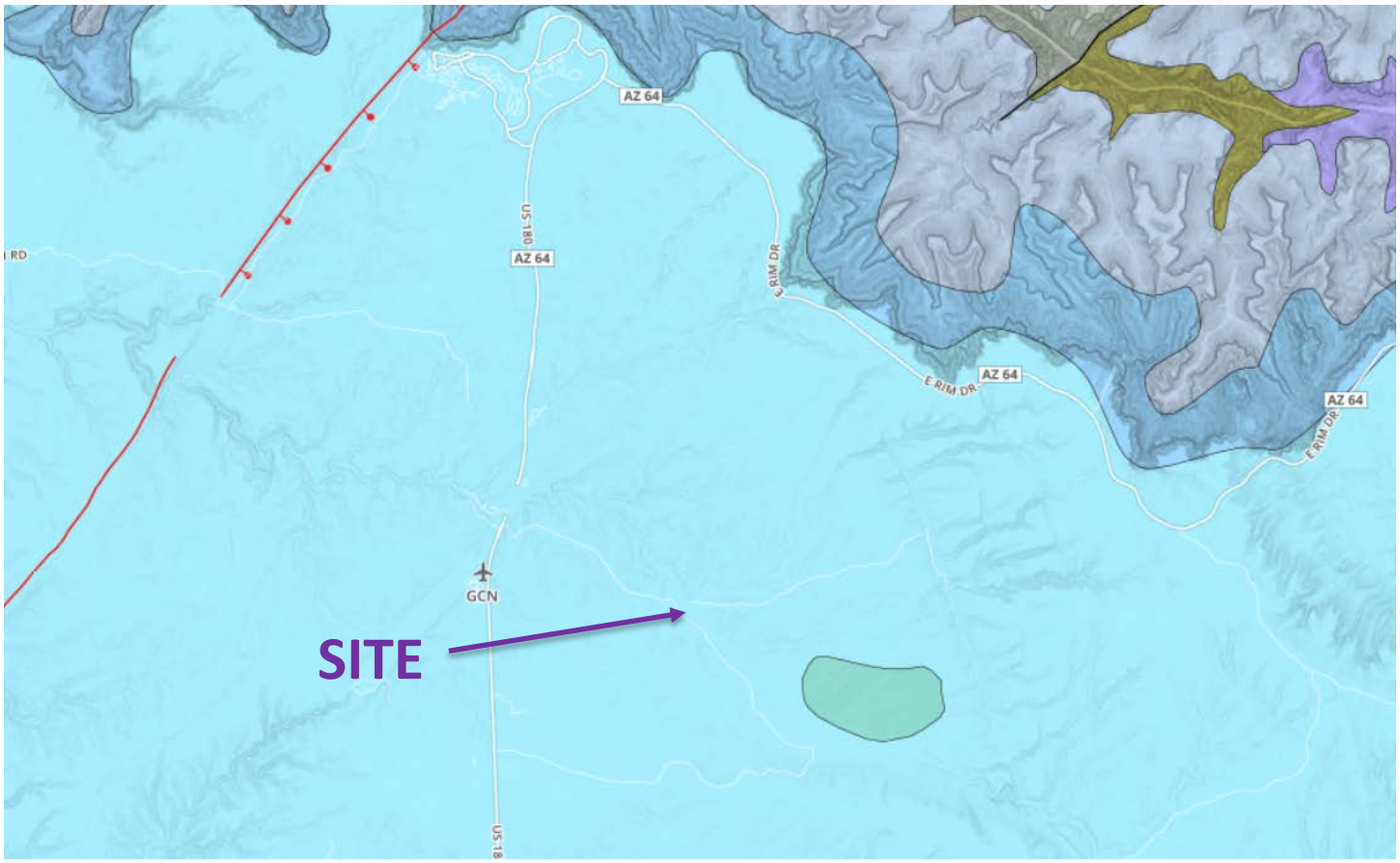
4.0 GEOLOGIC & SEISMIC CONDITIONS

4.1 Geologic Setting

The subject site is located in the central portion of Coconino County in North-central Arizona, approximately 4.3 miles south of the south rim of the Grand Canyon. The site sits at an elevation of between approximately 6,730 and 6,741 feet above sea level. The site is located in an area of somewhat flat to hilly terrain that is part of the Colorado Plateau Physiographic Province.

The geology of the location of the subject site has been mapped and is included on an internet-based interactive geologic map provided by the Arizona Geological Survey[2]. The surficial geology at the location of the subject site and adjacent areas is mapped as "Permian Sedimentary Rocks (270-280 Ma)" (Map Unit P). No fill has been mapped at the location of the site on the geologic map. Unit P is described on the referenced map as "Gray to tan, cherty limestone of Kaibab and Toroweap Formations, and underlying white to tan, fine-grained Coconino Sandstone. Limestone was deposited in a shallow sea, and sandstone was deposited in near-shore dunes and beach settings." Refer to the **Geologic Map** shown on the following page.

2 Arizona Geological Survey Interactive Geologic Map: http://data.azgs.az.gov/geologic-map-of-arizona/#



Geologic Map

4.2 Faulting

No surface fault traces are shown on the referenced geologic map crossing or projecting toward the subject site. The nearest mapped active fault trace is the Bright Angel fault zone, shown as a red line in the geologic map above, located about 7 miles northwest of the site.

4.3 Seismicity

4.3.1 Site Class

Arizona has adopted the International Building Code (IBC) 2015. IBC 2015 determines the seismic hazard for a site based upon 2008 mapping of bedrock accelerations prepared by the United States Geologic Survey (USGS) and the soil site class. The USGS values are presented on maps incorporated into the IBC code and are also available based on latitude and longitude coordinates (grid points). For site class definitions, IBC 2015 (Section 1613.3.2) refers to Chapter 20, Site Classification Procedure for Seismic Design, of ASCE[3] 7. Given the subsurface soils at the site, including our projection of soils within the upper 100 feet of the soil profile, it is our opinion the site best fits Site Class D – Stiff Soil Profile, which we recommend for seismic structural design.

[3]American Society of Civil Engineers

4.3.2 Ground Motions

The 2008 USGS mapping utilized by the IBC provides values of peak ground, short period and long period accelerations for the Site Class D boundary and the Maximum Considered Earthquake (MCE). This Site Class D boundary represents average bedrock values for the Western United States and must be corrected for local soil conditions. The following table summarizes the peak ground, short period and long period accelerations for the MCE event, and incorporates the appropriate soil correction factor for a Site Class D soil profile at site grid coordinates of 35.9528 degrees north latitude and -112.0859 degrees west longitude:

Spectral Acceleration Value, T	Site Class B Boundary [mapped values] (g)	Site Coefficient	Site Class D [adjusted for site class effects] (g)	Design Values (g)
Peak Ground Acceleration	0.188	F_a = 1.425	0.267	0.178
Short Period Acceleration (0.2 Seconds)	S_S = 0.469	F_a = 1.425	S_{MS} = 0.668	S_{DS} = 0.445
Short Period Acceleration (1.0 Second)	S_1 = 0.131	F_v = 2.276	S_{M1} = 0.298	S_{D1} = 0.199

4.3.3 Liquefaction

Liquefaction is defined as the condition when saturated, loose, sandy soils lose their support capabilities because of excessive pore water pressure which develops during a seismic event. Clayey soils, even if saturated, will generally not liquefy during a major seismic event.

Subsurface soils encountered consisted primarily of Sandy Lean CLAY (CL) and Sandy Silty CLAY (CL-ML) soils. Groundwater was not encountered in any of the bore holes. Based upon these conditions we estimate a low susceptibility to liquefaction at this site for the soils we encountered.

4.4 Other Geologic Hazards

No landslide deposits or features, including lateral spread deposits, are mapped on or adjacent to the site. The site is not located within a currently known or mapped potential debris flow, stream flooding, or rock fall hazard area.

5.0 SITE CONDITIONS

5.1 Surface Conditions

The site is currently vegetated by grasses, some shrubs, and mature forest trees. The site grade slopes slightly downward to the northwest. There are some surface disturbances from prior ranching activities in the form of berms, a drainage tank, and a couple of former structures. There are areas of shallow and surface bedrock

outcrops. A wide wash (now dry) runs from the south toward the north-northwest along the western portion of the site. Based upon aerial photos dating back to 1992 the site appears to have remained relatively unchanged since that time. The site is bordered on the north by NF 303 and hilly forest terrain, on the east by hilly forest terrain, on the south by flat land and NF 302, and on the west by NF 302 and hilly forest terrain (see **Vicinity Map** in **Section 1.1** above).

5.2 Subsurface Soils

At the locations of most of the bore holes we encountered a very thin layer of organic material (topsoil) on the surface. Below the topsoil we encountered primarily natural Sandy Lean CLAY (CL) and Sandy Silty CLAY (CL-ML) soils, extending to the bottom of the bore holes. Some bore holes encountered Clayey SAND (SC), Silty SAND (SM), and Silty GRAVEL with Sand (GM) layers. Auger refusal was encountered in several of the bore holes, ranging from 6 inches to 4 ft below existing grades, while one of the bore holes was advanced to a depth of 26.5 ft. The natural soils were light brown to dark brown in color, damp, with the cohesive soils having soft to hard consistencies, and the granular soils in a loose to very dense states.

For a more descriptive interpretation of subsurface conditions, please refer to the bore hole logs, **Figures 2 through 22**, which graphically represent the subsurface conditions encountered. The lines designating the interface between soil types on the logs generally represent approximate boundaries; in situ, the transition between soil types may be gradual.

5.3 Groundwater

Groundwater was not encountered in any of the bore holes. Groundwater levels in wells in the general vicinity of the site (in and around Tusayan) are more than 400 feet below the local ground surfaces. Groundwater levels can fluctuate as much as 1.5 to 2 feet seasonally. Numerous other factors such as heavy precipitation, irrigation of neighboring land, and other unforeseen factors, may also influence ground water elevations at the site. The detailed evaluation of these and other factors, which may be responsible for ground water fluctuations, is beyond the scope of this study.

5.4 Site Subsurface Variations

Based on the results of the subsurface explorations and our experience, variations in the continuity and nature of subsurface conditions should be anticipated. Due to the heterogeneous characteristics of natural soils, care should be taken in interpolating or extrapolating subsurface conditions between or beyond the exploratory locations.

6.0 SITE PREPARATION AND GRADING

6.1 General

We understand that the existing trees within structural areas of the project will be removed. Removal should include all root systems and loose soils caused by the removal process. All deleterious materials should be

stripped from the site surface prior to commencement of construction activities. This includes loose and disturbed soils, topsoil, vegetation, etc. Based upon the conditions observed in the borings there is a thin layer of topsoil on the surface of the site which we estimated to be less than 6 inches in thickness. When stripping and grubbing, topsoil should be distinguished by the apparent organic content and not solely by color; thus we estimate that topsoil stripping will need to include the upper 4 inches.

The site should be examined by a CMT geotechnical engineer to assess that suitable natural soils have been exposed and any deleterious materials, loose, and/or disturbed soils have been removed, prior to placing site grading fills, footings, slabs, and pavements. Due to the collapse potential of some of the site soils, we recommend that all residential footings be founded upon a minimum of 2 ft of engineered fill, and tank footings on a minimum of 3 ft of engineered fill. We recommend a minimum of 1 ft of engineered fill beneath all street pavement sections.

Fill placed over large areas to raise overall site grades can induce settlements in the underlying natural soils. If more than 5 feet of site grading fill is anticipated over the natural ground surface, we should be notified to assess potential settlements and provide additional recommendations as needed. These recommendations may include placement of the site grading fill far in advance to allow potential settlements to occur prior to construction.

6.2 Temporary Excavations

Groundwater is not anticipated to impact construction activities at this site.

For cohesionless (sandy/gravelly) soils, temporary construction excavations not exceeding 4 feet in depth should be no steeper than one-half horizontal to one vertical (0.5H:1V). For excavations up to 8 feet, side slopes should be no steeper than one horizontal to one vertical (1H:1V). Excavations encountering saturated cohesionless soils will be very difficult to maintain, and will require very flat side slopes and/or shoring, bracing and dewatering.

In cohesive (clayey) soils, temporary construction excavations not exceeding 4 feet in depth may be constructed with near-vertical side slopes. Temporary excavations up to 8 feet deep, may be constructed with side slopes no steeper than one-half horizontal to one vertical (0.5H:1V). Excavations deeper than 8 feet are not anticipated at the site, with the exception of the planned septic tank and some buried utility trenches.

To reduce disturbance of the natural soils during excavation, we recommend that smooth edge buckets/blades be utilized.

All excavations must be inspected periodically by qualified personnel. If any signs of instability or excessive sloughing are noted, immediate remedial action must be initiated. All excavations should be made following OSHA safety guidelines.

6.3 Fill Material

Following are our recommendations for the various fill types we anticipate will be used at this site:

Fill Material Type	Description/Recommended Specification
Structural Fill ≤ 2 ft	Placed below structures, flatwork and pavement (limited to 2 feet in thickness). On-site soils or imported soils, with a maximum particle size of 4 inches, including clay soils not containing excessive amounts of degradable/organic material (see discussion below).
Structural Fill > 2 ft	Placed below structures, flatwork and pavement (more than 2 feet in thickness). Imported well-graded sand/gravel mixture, with maximum particle size of 4 inches, minimum 70% passing 3/4-inch sieve, maximum 30% passing the No. 200 sieve, and maximum Plasticity Index of 15.
Non-Structural Fill	Placed below non-structural areas, such as landscaping. On-site soils or imported soils, with a maximum particle size of 8 inches, including clay soils not containing excessive amounts of degradable/organic material (see discussion below).
Stabilization Fill	Placed to stabilize soft areas prior to placing structural fill and/or site grading fill. Coarse angular gravels and cobbles 1 inch to 8 inches in size. May also use 1.5- to 2.0-inch gravel placed on stabilization fabric, such as Mirafi RS280i or 600X, or equivalent (see **Section 6.6**).

On-site clay soils may be used as structural fill and non-structural fill, but are inherently more difficult to work with in proper moisture conditioning (they are very sensitive to changes in moisture content), requiring very close moisture control during placement and compaction. This will be very difficult, if not impossible, during wet and cold periods of the year. If used, we also recommend that the site grading fill thickness using on-site clay soils not exceed 2 feet below structures, to minimize potential settlements.

All fill material should be approved by a CMT geotechnical engineer prior to placement.

6.4 Fill Placement and Compaction

The various types of compaction equipment available have their limitations as to the maximum lift thickness that can be compacted. For example, hand operated equipment is limited to lifts of about 4 inches and most "trench compactors" have a maximum, consistent compaction depth of about 6 inches. Large rollers, depending on soil and moisture conditions, can achieve compaction at 8 to 12 inches. The full thickness of each lift should be compacted to at least the following percentages of the maximum dry density as determined by ASTM D-698 (or AASHTO[4] T-99) in accordance with the following recommendations:

[4] American Association of State Highway and Transportation Officials

Location	Total Fill Thickness (feet)	Minimum Percentage of Maximum Dry Density
Conventional Footings: Beneath an area extending at least 3 feet beyond the perimeter of structures, and below flatwork and pavement (structural fill)	0 to 5 5 to 8 8+	95 98 100
Utility trenches within structural areas	-	95
Roadbase and subbase	-	95
Non-structural fill	0 to 5 5 to 8 8+	90 92 95

For best compaction results, we recommend that the moisture content for structural fill/backfill be within 2% of optimum. Field density tests should be performed on each lift as necessary to verify that proper compaction is being achieved.

6.5 Utility Trenches

For the bedding zone around the utility, we recommend utilizing sand bedding fill material that meets current APWA[5] requirements.

All utility trench backfill material below structurally loaded facilities (foundations, floor slabs, flatwork, parking lots/drive areas, etc.) shall be placed at the same density requirements established for structural fill in the previous section.

Most utility companies and local governments are requiring Type A-1a or A-1b (AASHTO Designation) soils (sand/gravel soils with limited fines) be used as backfill over utilities within public rights of way, and the backfill be compacted over the full depth above the bedding zone to at least 95% of the maximum dry density as determined by AASHTO T-99 (ASTM D-698). The natural soils at the site do not meet these requirements.

Where the utility does not underlie structurally loaded facilities and public rights of way, on-site native soils may be utilized as trench backfill above the bedding layer, provided they are properly moisture-conditioned and compacted to the minimum requirements stated above in **Section 6.4**.

6.6 Stabilization

Native clay soils will likely be susceptible to rutting and pumping. The likelihood of disturbance or rutting and/or pumping of the existing native soils is a function of the load applied to the surface, as well as the frequency of the load. Consequently, rutting and pumping can be minimized by avoiding concentrated traffic, minimizing the load applied to the surface by using lighter equipment and/or partial loads, by working in drier times of the year, or by providing a working surface for the equipment. Rubber-tired equipment particularly, because of high pressures, promotes instability in moist/wet, soft soils.

[5] American Public Works Association

If rutting or pumping occurs, traffic should be stopped and the disturbed soils should be removed and replaced with stabilization material. Typically, a minimum of 18 inches of the disturbed soils must be removed to be effective. However, deeper removal is sometimes required.

To stabilize soft subgrade conditions (if encountered), a mixture of course, clean, angular gravels and cobbles and/or 1.5- to 2.0-inch clean gravel should be utilized. Often the amount of gravelly material can be reduced with the use of a geotextile fabric such as Mirafi RS280i or 600X, or equivalent. Its use will also help avoid mixing of the subgrade soils with the gravelly material. After excavating the soft/disturbed soils, the fabric should be spread across the bottom of the excavation and up the sides a minimum of 18 inches. Otherwise, it should be placed in accordance with the manufacturer's recommendation, including proper overlaps. The gravel material can then be placed over the fabric in compacted lifts as described above.

7.0 FOUNDATION RECOMMENDATIONS

The following recommendations have been developed on the basis of the previously described project characteristics, the subsurface conditions observed in the field and the laboratory test data, as well as common geotechnical engineering practice.

7.1 Conventional Foundation Recommendations

Based on our geotechnical engineering analyses, the proposed structures may be supported upon conventional spread and/or continuous wall foundations placed on bedrock, or a minimum of 2 feet of suitable structural fill extending to natural soils or bedrock, but no combination of these. Footings on soil may be designed using a net bearing pressure of 2,000 psf. Footings on bedrock may be designed using a net bearing pressure of 5,000 psf. In no case shall the footings bear on a combination of structural fill and bedrock.

The term "net bearing pressure" refers to the pressure imposed by the portion of the structure located above lowest adjacent final grade, thus the weight of the footing and backfill to lowest adjacent final grade need not be considered. The allowable bearing pressure may be increased by 1/3 for temporary loads such as wind and seismic forces.

We also recommend the following:

1. Exterior footings subject to frost should be placed at least 30 inches below lowest adjacent grade.
2. Interior footings not subject to frost should be placed at least 16 inches below grade.
3. Continuous footing widths should be maintained at a minimum of 16 inches.
4. Spot footings should be a minimum of 24 inches wide.

7.2 Septic Tank

It is our understanding that a large septic tank will be constructed with the bottom of the tank approximately 8 feet below the existing grade. Footings for this tank may be designed using a net bearing pressure of 3,000 psf if in the existing clay soils. If the footings are in the deeper silty gravel soil, or a minimum of 3 feet of engineered fill, a net bearing pressure of 5,000 psf may be used.

7.3 Wastewater Treatment and Water Tanks

It is our understanding that a large water tank and a wastewater treatment tank will be constructed in a portion of the site that is mostly rock outcrops and bedrock. Footings for these tanks may be designed using a net bearing pressure of 5,000 psf if constructed completely on existing bedrock.

7.4 Box Culvert

It is our understanding that a box culvert will be constructed in the western portion of the site beneath the main road into the subdivision, to bridge the wash area. No information was available regarding the depth of the footings for the box culvert, however, based on the terrain, it is not expected to be more than 5 feet below the existing ground surface. Footings for box culvert should rest on a minimum of 2 feet of engineered fill and may be designed using a net bearing pressure of 3,000 psf. Care should be taken to ensure that the sides and bottom of the culvert are protected from erosion and scour. This may be accomplished with concrete wingwalls and aprons, constructed both upstream and downstream. Channel sides should be protected both upstream and downstream of the box culvert with rip rap or other effective erosion protection.

7.5 Installation

Foundations shall not be placed on topsoil with organics, undocumented fill, rubbish, demolition or construction debris, other deleterious materials, frozen soils, or within ponded water.

Deep, large roots may be encountered where trees and larger bushes occupy portions of the site; such large roots should be removed. If unsuitable soils are encountered, they must be completely removed and replaced with properly compacted structural fill. Excavation bottoms should be examined by a qualified geotechnical engineer to confirm that suitable bearing materials soils have been exposed.

All structural fill should meet the requirements for such, and should be placed and compacted in accordance with **Section 6** above. The width of structural replacement fill below footings should be equal to the width of the footing plus 1 foot for each foot of fill thickness. For instance, if the footing width is 2 feet and the structural fill depth beneath the footing is 2 feet, the fill replacement width should be 4 feet, centered beneath the footing.

7.6 Estimated Settlement

Foundations designed and constructed in accordance with our recommendations could experience some settlement, but we anticipate that total settlements of footings founded as recommended above will not exceed 1 inch, with differential settlements on the order of 0.5 inches over a distance of 25 feet. We expect approximately 50% of the total settlement to initially take place during construction.

7.7 Lateral Resistance

Lateral loads imposed upon foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footings and the supporting soils. In determining frictional resistance, a coefficient of 0.30 for natural clay soils, and 0.40 for the natural sand/gravel soils or structural fill, may be utilized for design. Passive resistance provided by properly placed and compacted native soils or structural fill may be considered equivalent to a fluid with a density of 440 pcf. A combination of passive earth resistance and friction may be utilized if the friction component of the total is divided by 1.5.

8.0 CONVENTIONAL FLOOR SLABS

Floor slabs may be established upon a minimum of 2 feet of structural fill extending to suitable native soils (same as for foundations). Under no circumstances shall floor slabs be established directly on any topsoil, loose or disturbed soils, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water. As with foundations, in no case shall floor slabs bear on a combination of structural fill and bedrock.

In order to facilitate curing of the concrete, we recommend that floor slabs be directly underlain by at least 4 inches of “free-draining” fill, such as “pea” gravel or 3/4-inch to 1-inch minus, clean, gap-graded gravel. This layer may be included in the minimum 2 feet of engineered fill. To help control normal shrinkage and stress cracking, the floor slabs should have the following features:

1. Adequate reinforcement for the anticipated floor loads with the reinforcement continuous through interior floor joints;
2. Frequent crack control joints; and
3. Non-rigid attachment of the slabs to foundation walls and bearing slabs.

9.0 DRAINAGE RECOMMENDATIONS

It is important to the long-term performance of foundations and floor slabs that water not be allowed to collect near the foundation walls and infiltrate into the underlying soils. We recommend the following:

1. All areas around each structure (residences and tanks) should be sloped to provide drainage away from the foundations. We recommend a minimum slope of 4 inches in the first 10 feet away from the structure. This slope should be maintained throughout the lifetime of the structures.

2. All roof drainage should be collected in rain gutters with downspouts designed to discharge at least 10 feet from the foundation walls or well beyond the backfill limits, whichever is greater.

3. Adequate compaction of the foundation backfill should be provided. We suggest a minimum of 90% of the maximum laboratory density as determined by ASTM D-698. Water consolidation methods should not be used under any circumstances.

4. Landscape sprinklers should be aimed away, and kept at least 4 feet, from the foundation walls. The sprinkling systems should be designed with proper drainage and be well-maintained. Over watering should be avoided.

5. Other precautions that may become evident during construction.

10.0 PAVEMENTS

The new local roads within the subdivision will utilize asphalt pavement. One box culvert crossing is expected. Traffic within the subdivision is projected to consist of mostly automobiles and light trucks, a few medium-weight delivery trucks, a weekly garbage truck and tanker truck, and an occasional fire truck.

We anticipate the native clay soils will exhibit poor pavement support characteristics when saturated or nearly saturated. Based on our laboratory testing experience with similar soils, our pavement design is based upon Design Charts 100A and 101A of the 2017 Maricopa County Department of Transportation Pavement Design Manual.

All pavement areas must be prepared as discussed above in **Section 6.1**. Under no circumstances shall pavements be established over topsoil, non-engineered fills (if encountered), loose or disturbed soils, sod, rubbish, construction debris, other deleterious materials, frozen soils, bedrock, or within ponded water.

In roadway areas, subsequent to stripping and prior to the placement of pavement materials, a minimum of 1 foot of structural fill should be properly compacted.

Based on the site soils, and Design Chart 101A for local streets, we recommend a pavement section consisting of 2½ inches of AC over 7 inches of ABC. For minor collector streets, we recommend a pavement section consisting of 3 inches of AC over 11 inches of ABC. The following pavement thickness options are provided:

Material	Pavement Section Thickness (inches)	
	Local Streets	Minor Collector Streets
Asphaltic Concrete	**2½**	**3**
Aggregate Base Course	**7**	**11**
Total Thickness	**9½**	**14**

If the pavement will be subjected to construction traffic we should be notified to provide additional recommendations. All asphalt surfaces should be properly graded, so that good drainage off the surface and away from the edge of asphalt should be maintained. For better protection against frost damage, the thicker ABC options should be considered.

Aggregate Base Course (ABC) should conform to Town or County specifications, or to ADOT Class 2 Aggregate Base. Material meeting our specification for structural fill can be used for subbase, as long as the fines content (percent passing No. 200 sieve) does not exceed 15%. ABC and subbase materials should be compacted as recommended above in **Section 6.4**.

11.0 PERCOLATION TESTING

It is our understanding that the existing wide wash area along the western portion of the property is to be used to drain the overflow of the on-site treated water. CMT was requested to perform percolation testing on near-surface soils to determine the soil's capacity for infiltration of this water.

CMT utilized the percolation method as described in Subsection F of R18-9-A310 of the Arizona Administrative Code (AAC). This test method is primarily for septic systems, and was easily implemented in the near-surface soils of the site.

Briefly, the R18-9-A310 method begins with excavating a test hole 12 inches square, 12 inches deep into the soil to be tested. The test hole is then filled with 12 inches of clean water, and timed until either the water is fully drained, or 60 minutes, whichever comes first. If fully drained, this is repeated two more times. If 60 minutes passes, and there is still water in the hole, the water level of the test hole is held above 9 inches for a minimum of 4 hours, after which it is allowed to "rest". Within 16 hours of this pre-soaking, the test hole is cleaned of sloughed material, and filled with clean water to 6 inches. The time it takes for the water level to fall exactly 1 inch is recorded. This is repeated until 3 consecutive tests vary by no more than 10 percent, and the highest of the 3 tests is recorded as the stabilized rate, in minutes/inch.

The results of the percolation testing are tabulated below:

Test Location	Soil Type (USGS)	Stabilized Rate (min/in)
P-1	SC	5.0
P-2	CL	54.0
P-3	CL-ML	46.0
P-4	CL	10.0
P-5	CL	11.0

In addition, bore holes were drilled to depths of up to 15 feet in the vicinity of each of these percolation tests. The bore hole logs for P-1 through P-5 are included in the Appendix as Figures 18 through 22.

12.0 QUALITY CONTROL

We recommend that CMT be retained to as part of a comprehensive quality control testing and observation program. With CMT onsite we can help facilitate implementation of our recommendations and address, in a timely manner, any subsurface conditions encountered which vary from those described in this report. Without such a program CMT cannot be responsible for application of our recommendations to subsurface conditions which may vary from those described herein. This program may include, but not necessarily be limited to, the following:

12.1 Field Observations

Observations should be completed during all phases of construction such as site preparation, foundation excavation, structural fill placement and concrete placement.

12.2 Fill Compaction

Compaction testing by CMT is required for all structural supporting fill materials. Maximum Dry Density (Standard Proctor, ASTM D-698) tests should be requested by the contractor immediately after delivery of any fill materials. The maximum density information should then be used for field density tests on each lift as necessary to ensure that the required compaction is being achieved.

12.3 Excavations

All excavation procedures and processes should be observed by a geotechnical engineer from CMT or his representative. In addition, for the recommendations in this report to be valid, all backfill and structural fill placed in trenches and all pavements should be density tested by CMT. We recommend that freshly mixed concrete be tested by CMT in accordance with ASTM designations.

12.4 Vibration Monitoring

Construction activities, particularly site grading and fill placement, can induce vibrations in existing structures adjacent to the site. Such vibrations can cause damage to adjacent buildings, depending on the building composition and underlying soils. It can be prudent to monitor vibrations from construction activities to maintain records that vibrations did not exceed a pre-defined threshold known to potentially cause damage. CMT can provide this monitoring if desired.

13.0 LIMITATIONS

The recommendations provided herein were developed by evaluating the information obtained from the subsurface explorations and soils encountered therein. The exploration logs reflect the subsurface conditions only at the specific location at the particular time designated on the logs. Soil and ground water conditions may differ from conditions encountered at the actual exploration locations. The nature and extent of any variation in the explorations may not become evident until during the course of construction. If variations do appear, it may become necessary to re-evaluate the recommendations of this report after we have observed the variation.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

We appreciate the opportunity to be of service to you on this project. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at (602) 241-1097. To schedule materials testing, please call (602) 241-1097.

APPENDIX

CMT ENGINEERING LABORATORIES	**Ten X Ranch** Forest Road 302, Tusayan, Arizona	**SITE PLAN**	Date:	27-Mar-2018	Figure:
			CMT No.:	CMT-1079	1

Ten X Ranch

Bore Hole Log

B-1

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 11.5'	Date:	3/8/18
Surface Elev. (approx): 6732	Water Depth: (see Remarks)	Job #:	1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown Sandy Silty CLAY damp, soft to firm												
				1	2 3 3	6	9.0		2	33.4	64.6	24	18	6
5				2	1 2 2	4								
10				3	3 2 3	5								
		END AT 11.5'												
15														
20														
25														

Remarks: Groundwater not encountered during drilling.

Figure: 2

CMT ENGINEERING LABORATORIES

Drilled By: D&S Drilling
Logged By: James Curtis

Ten X Ranch

Bore Hole Log

B-2

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 11.5'	Date:	3/8/18
Surface Elev. (approx): 6732	Water Depth: (see Remarks)	Job #:	1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown Sandy Silty CLAY damp, soft to firm												
				4	3 1 2	3								
5				5	2 2 3	5								
10				6	3 3 4	7								
		END AT 11.5'												
15														
20														
25														

Remarks: Groundwater not encountered during drilling.

Figure: 3

CMT ENGINEERING LABORATORIES

Excavated By: D&S Drilling

Logged By: James Curtis

Ten X Ranch

Bore Hole Log

B-3

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 11.5'	Date:	3/8/18
Surface Elev. (approx): 6733	Water Depth: (see Remarks)	Job #:	1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown Sandy Lean CLAY damp, firm to stiff		7			10.1	88.1	0	32.6	67.4	29	18	11
5				8	2 3 3	6								
10				9	4 6 8	14								
		END AT 11.5'												
15														
20														
25														

Remarks: Groundwater not encountered during drilling.

Figure: 4

CMT ENGINEERING LABORATORIES

Drilled By: D&S Drilling
Logged By: James Curtis

Ten X Ranch

Bore Hole Log

B-4

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 11.5'	Date:	3/8/18
Surface Elev. (approx): 6732	Water Depth: (see Remarks)	Job #:	1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown Sandy Silty CLAY damp, stiff to very stiff												
				10	4 4 6	10								
5				11	5 7 11	18								
10				12	4 7 8	15								
		END AT 11.5'												
15														
20														
25														

Remarks: Groundwater not encountered during drilling.

Figure: 5

CMT ENGINEERING LABORATORIES

Drilled By: D&S Drilling
Logged By: James Curtis

Ten X Ranch

Bore Hole Log

B-5

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 11.5'	Date:	3/8/18
Surface Elev. (approx): 6733	Water Depth: (see Remarks)	Job #:	1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown Sandy Silty CLAY damp, soft to firm												
				13	1 1 2	3								
5				14	2 2 4	6								
10				15	3 3 4	7								
		END AT 11.5'												
15														
20														
25														

Remarks: Groundwater not encountered during drilling.

Figure: 6

CMT ENGINEERING LABORATORIES

Drilled By: D&S Drilling
Logged By: James Curtis

Ten X Ranch

Bore Hole Log

B-6

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 11.5'	Date:	3/8/18
Surface Elev. (approx): 6734	Water Depth: (see Remarks)	Job #:	1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown Sandy Silty CLAY damp, firm to stiff												
				16	3 3 5	8	7.3		3	33.9	63.1	24	18	6
5				17	4 4 5	9								
10				18	2 3 5	8								
		END AT 11.5'												
15														
20														
25														

Remarks: Groundwater not encountered during drilling.

Figure: 7

CMT ENGINEERING LABORATORIES

Drilled By: D&S Drilling
Logged By: James Curtis

Ten X Ranch

Bore Hole Log

B-7

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 11.5'	Date:	3/8/18
Surface Elev. (approx): 6732	Water Depth: (see Remarks)	Job #:	1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown Sandy Lean CLAY damp, stiff to very stiff		19			10.1		0	36.4	63.6	29	17	12
5				20	5 7	9								
10				21	4 8 9	17								
		END AT 11.5'												
15														
20														
25														

Remarks: Groundwater not encountered during drilling.

Figure: 8

CMT ENGINEERING LABORATORIES

Drilled By: D&S Drilling
Logged By: James Curtis

Ten X Ranch

Bore Hole Log

B-8

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 11.5'	Date:	3/8/18
Surface Elev. (approx): 6733	Water Depth: (see Remarks)	Job #:	1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown Sandy Lean CLAY damp, firm to very stiff												
				22		7								
5				23	4 6 9	15								
10				24	5 5 8	13								
		END AT 11.5'												
15														
20														
25														

Remarks: Groundwater not encountered during drilling.

Figure: 9

CMT ENGINEERING LABORATORIES

Drilled By: D&S Drilling
Logged By: James Curtis

Ten X Ranch

Bore Hole Log

B-9

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 11.5'	Date:	3/8/18
Surface Elev. (approx): 6734	Water Depth: (see Remarks)	Job #:	1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown Sandy Lean CLAY damp, stiff		25			10.5		0.7	34.3	65	26	17	9
5				26	5 9	10		94.6						
		Brown Silty SAND with Gravel damp, very dense												
10				27	17 22 30	52								
		END AT 11.5'												
15														
20														
25														

Remarks: Groundwater not encountered during drilling.

Figure: 10

CMT ENGINEERING LABORATORIES

Drilled By: D&S Drilling
Logged By: James Curtis

Ten X Ranch

Bore Hole Log

B-10

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 11.5'	Date:	3/8/18
Surface Elev. (approx): 6733	Water Depth: (see Remarks)	Job #:	1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown Sandy Lean CLAY damp, stiff to very stiff												
				28		14								
5				29	3 4 7	11								
10				30	8 12 14	26								
		END AT 11.5'												
15														
20														
25														

Remarks: Groundwater not encountered during drilling.

Figure: 11

CMT ENGINEERING LABORATORIES

Drilled By: D&S Drilling
Logged By: James Curtis

Ten X Ranch

Bore Hole Log

B-11

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 0.5'	Date: 3/9/18
Surface Elev. (approx): 6740	Water Depth: (see Remarks)	Job #: 1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown Silty SAND with Gravel												
		END AT 0.5' damp, very dense												
		Auger Refusal Encountered on Bedrock												
5														
10														
15														
20														
25														

Remarks: Groundwater not encountered during drilling.

Figure: 12

CMT ENGINEERING LABORATORIES

Drilled By: D&S Drilling

Logged By: James Curtis

Ten X Ranch

Bore Hole Log

B-12

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 1'	Date: 3/9/18
Surface Elev. (approx): 6734	Water Depth: (see Remarks)	Job #: 1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown Silty SAND with Gravel damp, very dense												
		END AT 1.0' Auger Refusal Encountered on Bedrock												
5														
10														
15														
20														
25														

Remarks: Groundwater not encountered during drilling.

Figure: 13

CMT ENGINEERING LABORATORIES

Drilled By: D&S Drilling

Logged By: James Curtis

Ten X Ranch

Bore Hole Log

B-13

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 4'	Date:	3/9/18
Surface Elev. (approx): 6740	Water Depth: (see Remarks)	Job #:	1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown Sandy Lean CLAY damp, hard												
				31		50+	8.7		7.7	37.7	54.6	27	16	11
		END AT 4.0' Auger Refusal Encountered on Bedrock												
5														
10														
15														
20														
25														

Remarks: Groundwater not encountered during drilling.

Figure: 14

CMT ENGINEERING LABORATORIES

Drilled By: D&S Drilling
Logged By: James Curtis

Ten X Ranch

Bore Hole Log

BC-1

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 16.5'	Date:	3/8/18
Surface Elev. (approx): 6732	Water Depth: (see Remarks)	Job #:	1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown Sandy Lean CLAY damp, firm to stiff		32			8.0		0	42.7	57.3	28	16	12
5				33	3 6	7		95.1						
10				34	3 4 5	9								
15				35	4 5 10	15								
		END AT 16.5'												
20														
25														

Remarks: Groundwater not encountered during drilling.

Figure: 15

CMT ENGINEERING LABORATORIES

Drilled By: D&S Drilling
Logged By: James Curtis

Ten X Ranch

Bore Hole Log

ST-1

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 26.5'	Date: 3/8/18
Surface Elev. (approx): 6734	Water Depth: (see Remarks)	Job #: 1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown Sandy Lean CLAY damp, stiff												
5				36	4 4 5	9								
10				37	10 13 17	30	4.0		45.2	35.2	19.6	NV	NP	NP
		Brown Silty GRAVEL with Sand damp, medium dense to loose												
15				38	12 8 16	24								
20				39	5 6 9	15								
25				40	3 4 5	9								
		END AT 26.5'												

Remarks: Groundwater not encountered during drilling.

Figure: 16

CMT ENGINEERING LABORATORIES

Drilled By: D&S Drilling
Logged By: James Curtis

Ten X Ranch

Bore Hole Log

WW-1

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 1'	Date: 3/9/18
Surface Elev. (approx): 6741	Water Depth: (see Remarks)	Job #: 1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Sand %	Fines %	Atterberg LL	PL	PI
0		Location not accessable due to large rocks at ground surface. It is assumed that shallow refusal would be encountered, similar to boreholes B-11 and B-12.												
5														
10														
15														
20														
25														

Remarks: Location not drilled due to rough terrain

Figure: 17

CMT ENGINEERING LABORATORIES

Drilled By: D&S Drilling

Logged By: James Curtis

Ten X Ranch

Bore Hole Log

P-1

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 9'	Date: 3/8/18
Surface Elev. (approx): 6734	Water Depth: (see Remarks)	Job #: 1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown Clayey SAND damp, medium dense to very dense		1			7.7		1.8	51	47.2	26	16	10
5				2	5 8 7	15								
		Brown Silty GRAVEL with Sand												
		AUGER REFUSAL AT 9.0'												
10														
15														
20														
25														

Remarks: Groundwater not encountered during drilling.
Auger refusal encountered at 9' on bedrock

CMT ENGINEERING LABORATORIES

Drilled By: D&S Drilling
Logged By: James Curtis
Page: 1 of 1

Figure: 18

Ten X Ranch

Bore Hole Log

P-2

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 16.5'	Date:	3/8/18
Surface Elev. (approx): 6730	Water Depth: (see Remarks)	Job #:	1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown Sandy Lean CLAY damp, soft		3			8.9		1.6	44.2	54.2	28	17	11
5				4	2 2 2	4								
		Dark Brown below 6.5'												
10				5	1 2 1	3								
		Light Brown Clayey SAND with Gravel damp, very dense												
15				6	15 28 34	62								
		END AT 16.5'												
20														
25														

Remarks: Groundwater not encountered during drilling.

Figure: 19

CMT ENGINEERING LABORATORIES

Excavated By: D&S Drilling
Logged By: James Curtis

Ten X Ranch

Bore Hole Log

P-3

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 1'	Date:	3/8/18
Surface Elev. (approx): 6732	Water Depth: (see Remarks)	Job #:	1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown Sandy Silty CLAY damp, hard		7			10		4.3	33.8	61.9	25	19	6
		AUGER REFUSAL AT 1.0'												
5														
10														
15														
20														
25														

Remarks: Groundwater not encountered during drilling.
Auger refusal encountered at 1' on bedrock

Figure: 20

CMT ENGINEERING LABORATORIES

Drilled By: D&S Drilling
Logged By: James Curtis

Ten X Ranch

Bore Hole Log

P-4

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 16.5'	Date:	3/8/18
Surface Elev. (approx): 6732	Water Depth: (see Remarks)	Job #:	1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Brown Sandy Lean CLAY damp, soft to stiff		8			8.9		0	33.1	66.9	27	16	11
5				9	1 2 1	3								
10				10	3 5 7	12								
15				11	6 7 7	14								
		END AT 16.5'												
20														
25														

Remarks: Groundwater not encountered during drilling.

Figure: 21

CMT ENGINEERING LABORATORIES

Drilled By: D&S Drilling
Logged By: James Curtis

Ten X Ranch

Bore Hole Log

P-5

Forest Rd 302, Tusayan

Boring Type: Hollow-Stem Auger	Total Depth: 16.5'	Date: 3/8/18
Surface Elev. (approx): 6733	Water Depth: (see Remarks)	Job #: 1079

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Sand %	Fines %	Atterberg LL	PL	PI
0		Brown Sandy Lean CLAY damp, stiff		12			9.5		0	36	64	24	17	7
5				13	4 4 6	10								
10				14	7 6 9	15								
15				15	4 5 8	13								
		END AT 16.5'												
20														
25														

Remarks: Groundwater not encountered during drilling.

Figure: 22

CMT ENGINEERING LABORATORIES

Drilled By: D&S Drilling
Logged By: James Curtis

Ten X Ranch

Forest Rd 302, Tusayan

Key to Symbols

Date: 3/8/18

Job #: 1079

① Depth (ft)	GRAPHIC LOG	③ Soil Description	④ Sample Type	⑤ Sample #	Blows(N) ⑥	Total ⑦	⑧ Moisture (%)	⑨ Dry Density(pcf)	⑩ Gradation Gravel %	Sand %	Fines %	Atterberg LL	PL	PI

COLUMN DESCRIPTIONS

Depth (ft.): Depth (feet) below the ground surface (including groundwater depth - see water symbol below).

Graphic Log: Graphic depicting type of soil encountered (see below).

Soil Description: Description of soils encountered, including Unified Soil Classification Symbol (see below).

Sample Type: Type of soil sample collected at depth interval shown; sampler symbols are explained below-right.

Sample #: Consecutive numbering of soil samples collected during field exploration.

Blows: Number of blows to advance sampler in 6" increments, using a 140-lb hammer with 30" drop.

Total Blows: Number of blows to advance sampler the 2nd and 3rd 6" increments.

Moisture (%): Water content of soil sample measured in laboratory (percentage of dry weight of sample).

Dry Density (pcf): The dry density of a soil measured in laboratory (pounds per cubic foot).

Gradation: Percentages of Gravel, Sand and Fines (Silt/Clay), obtained from lab test results of soil passing the No. 4 and No. 200 sieves.

Atterberg: Individual descriptions of Atterberg Tests are as follows:

LL = Liquid Limit (%): Water content at which a soil changes from plastic to liquid behavior.

PL = Plastic Limit (%): Water content at which a soil changes from liquid to plastic behavior.

PI = Plasticity Index (%): Range of water content at which a soil exhibits plastic properties (= Liquid Limit - Plastic Limit).

STRATIFICATION	
Description	**Thickness**
Seam	Up to ½ inch
Lense	Up to 12 inches
Layer	Greater than 12 in.
Occasional	1 or less per foot
Frequent	More than 1 per foot

MODIFIERS
Trace
<5%
Some
5-12%
With
> 12%

MOISTURE CONTENT
Dry: Absence of moisture, dusty, dry to the touch.
Moist: Damp / moist to the touch, but no visible water.
Saturated: Visible water, usually soil below groundwater.

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			USCS SYMBOLS	TYPICAL DESCRIPTIONS
COARSE-GRAINED SOILS More than 50% of material is larger than No. 200 sieve size.	**GRAVELS** The coarse fraction retained on No. 4 sieve.	**CLEAN GRAVELS** (< 5% fines)	GW	Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
			GP	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
		GRAVELS WITH FINES (≥ 12% fines)	GM	Silty Gravels, Gravel-Sand-Silt Mixtures
			GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	SANDS The coarse fraction passing through No. 4 sieve.	**CLEAN SANDS** (< 5% fines)	SW	Well-Graded Sands, Gravelly Sands, Little or No Fines
			SP	Poorly-Graded Sands, Gravelly Sands, Little or No Fines
		SANDS WITH FINES (≥ 12% fines)	SM	Silty Sands, Sand-Silt Mixtures
			SC	Clayey Sands, Sand-Clay Mixtures
FINE-GRAINED SOILS More than 50% of material is smaller than No. 200 sieve size.	**SILTS AND CLAYS** Liquid Limit less than 50%		ML	Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands or Clayey Silts with
			CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean
			OL	Organic Silts and Organic Silty Clays o f Low Plasticity
	SILTS AND CLAYS Liquid Limit greater than 50%		MH	Inorganic Silts, Micacious or Diatomacious Fine Sand or Silty Soils
			CH	Inorganic Clays of High Plasticity, Fat Clays
			OH	Organic Silts and Organic Clays of Medium to High Plasticity
HIGHLY ORGANIC SOILS			PT	Peat, Humus, Swamp Soils with High Organic Contents

Note: Dual Symbols are used to indicate borderline soil classifications (i.e. GP-GM, SC-SM, etc.).

SAMPLER SYMBOLS

- Block Sample
- Bulk/Bag Sample
- Modified California Sampler
- 3.5" OD, 2.42" ID D&M Sampler
- Rock Core
- Standard Penetration Split Spoon Sampler
- Thin Wall (Shelby Tube)

WATER SYMBOL

- Encountered Water Level
- Measured Water Level

(see Remarks on Logs)

1. The results of laboratory tests on the samples collected are shown on the logs at the respective sample depths.
2. The subsurface conditions represented on the logs are for the locations specified. Caution should be exercised if interpolating between or extrapolating beyond the exploration locations.
3. The information presented on each log is subject to the limitations, conclusions, and recommendations presented in this report.

CMT ENGINEERING LABORATORIES

Figure: 23

Ten X Residential Housing Project – Request for Proposal

WATER, RECLAIM WATER, AND SEWER UTILITIES

EXHIBIT "C"

INSURANCE REQUIREMENTS

INSURANCE REQUIREMENTS

	Required Coverage	Required Policy Provisions, if any
Workers' Compensation and Employer's Liability Insurance	Subcontractor shall maintain workers' compensation insurance and such other forms of insurance which Subcontractor is required to maintain in order to comply with statutory limits under workers' compensation laws of any applicable jurisdiction in the United States (and any other location in which the Work is to be performed) including USL&H coverage (if any exposure exists), where applicable, and employer's liability (including occupational disease) coverage with limits of One Million Dollars ($1,000,000) per accident, One Million Dollars ($1,000,000) for disease, and One Million Dollars ($1,000,000) for each employee, which shall cover all of Subcontractor's employees, whether full-time, leased, temporary or casual, who are engaged in the Work.	- To provide that the insurer shall waive for the benefit of Contractor and Owner where permitted by law, all rights of subrogation against Contractor, Owner, their respective subsidiaries and Affiliates, co-venturers, or their directors, officers, members, managers, as well as their respective employees and/or agents of each.
Commercial General Liability Insurance	Subcontractor shall maintain commercial general liability insurance written on an occurrence basis in limits of One Million Dollars ($1,000,000) per occurrence and Two Million Dollars ($2,000,000) annual aggregate. Such insurance shall include coverage for products/completed operations, broad form/blanket contractual liability for written contracts, broad form property damage and personal injury liability, mobile equipment liability, premises/operations explosion, independent contractor liability, and collapse, and underground hazards coverage and hostile fire liability.	- To provide that the insurance shall waive any and all right of subrogation or recovery which the insurer may have or acquire against Contractor, Owner, their respective subsidiaries and Affiliates, co-venturers, or their directors, officers, members, managers, as well as the employees and/or agents of each. - To provide a severability of interest and cross liability clause. - That the insurance shall be primary and not excess to or contributing with any insurance or self-insurance maintained by Contractor. - To identify Contractor, Owner, their respective subsidiaries and Affiliates, co-venturers, and their directors, officers, members, managers, as well as the employees and/or agents of each, and any Financing Parties as additional insureds for their legal liability arising out of the operations of Contractor. This additional insured status shall apply regardless of the enforceability of the indemnity provisions in the Agreement. - With respect to coverage for completed operations under the general liability insurance, to be in place throughout the performance of the Work and either during all applicable warranty period(s) or for three (3) years after Final Completion of the Work, whichever is later.

Automobile Liability Insurance	Subcontractor shall maintain automobile liability insurance (including coverage for owned, non-owned, and hired automobiles) covering vehicles used by Subcontractor in connection with the Work in an amount of One Million Dollars ($1,000,000) combined single limit per occurrence for bodily injury and property damage. Subcontractor's automobile liability insurance coverage shall contain appropriate no-fault insurance provisions or other endorsements in accordance with Applicable Laws.	- To provide that the insurance shall waive any and all right of subrogation or recovery which the insurer may have or acquire against Contractor, Owner, their respective subsidiaries and Affiliates, co-venturers, or their directors, officers, members, managers, as well as the employees and/or agents of each. - To provide a severability of interest and cross liability clause. - That the insurance shall be primary and not excess to or contributing with any insurance or self-insurance maintained by Contractor. - To identify Contractor, Owner, their respective subsidiaries and Affiliates, co-venturers, and their directors, officers, members, managers, as well as the employees and/or agents of each, and any Financing Parties as additional insureds for their legal liability arising out of the operations of Contractor. This additional insured status shall apply regardless of the enforceability of the indemnity provisions in the Agreement.

Umbrella or Excess Liability Insurance	Subcontractor shall maintain umbrella/excess insurance on an occurrence basis covering claims in excess of the underlying insurance described in this Exhibit (exclusive of Workers' Compensation and Professional Liability Insurance), in the amount of Five Million Dollars ($5,000,000) per occurrence, and on a following-form basis.	- To provide that the insurance shall waive any and all right of subrogation or recovery which the insurer may have or acquire against Contractor, Owner, their respective subsidiaries and Affiliates, co-venturers, or their directors, officers, members, managers, as well as the employees and/or agents of each. - To provide a severability of interest and cross liability clause. - That the insurance shall be primary and not excess to or contributing with any insurance or self-insurance maintained by Contractor. - To identify Contractor, Owner, their respective subsidiaries and Affiliates, co-venturers, and their directors, officers, members, managers, as well as the employees and/or agents of each, and Financing Parties as additional insureds for their legal liability arising out of the operations of Contractor. This additional insured status shall apply regardless of the enforceability of the indemnity provisions in the Agreement. - To be in place throughout the performance of the Work and either during all applicable warranty period(s) or for three (3) years after Final Completion of the Work, whichever is later.
Sub-subcontractors Equipment, Tools Supplies and Materials	All other supplies, materials, consumables, tools, and equipment required for the Work (a) belonging to Subcontractor or to any of its Sub-subcontractors, whether owned, rented, leased or hired or (b) used by or on behalf of Subcontractor or any of its Sub-subcontractors for its performance hereunder, shall be brought to and kept at the Site at the sole cost, risk and expense of Subcontractor or such Sub-subcontractor, and Contractor shall not be liable for loss or damage thereto. Should such property be insured, said insurers shall waive rights of subrogation against Contractor, and any insurance premium costs for such insurance shall not be passed along to Contractor.	- That the insurance shall be primary and not excess to or contributing with any insurance or self-insurance maintained by Contractor. - To provide a severability of interest and cross liability clause.

Professional Liability Insurance	Subcontractor shall maintain professional liability insurance (errors and omissions) in connection with the Work (including all design and engineering activities) in an amount of Two Million Dollars ($2,000,000)	- To be in place throughout the performance of the Work and either during all applicable warranty period(s) or for three (3) years after final completion of the Work, whichever is later.
Deductibles on all Subcontractor's insurances in excess of Fifty Thousand Dollars ($50,000) shall be subject to Contractor approval (not to be unreasonably withheld or delayed).		