GEOTECHNICAL ENGINEERING REPORT
PALM COMMUNITIES – RED BLUFF

321 S. Jackson Street
APN 033-130-028
Red Bluff, California
MPE No. 05694-01
October 20, 2021

MPE
MID PACIFIC ENGINEERING, INC.

GEOTECHNICAL ENGINEERING
EARTHWORK TESTING
MATERIALS ENGINEERING AND TESTING
SPECIAL INSPECTIONS

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INTRODUCTION

GENERAL

We have completed a Geotechnical Engineering investigation for the proposed Palm Communities – Red Bluff project to be located at 321 S. Jackson Street (Assessor Parcel Number [APN] 033-130-028) in Red Bluff, California. The purposes of our study were to investigate the site, soil and groundwater conditions at the proposed project location, and to prepare this Geotechnical Engineering report to provide appropriate recommendations for the design and construction of the planned apartment buildings and associated improvements.

SCOPE OF WORK

Our scope of work included the following:

1. Site reconnaissance;
2. Review of available geologic, seismic, soil, groundwater data containing the site, and historic aerial photographic images from Google Earth;
3. Subsurface investigation, including the excavation, logging, and sampling of seven exploratory test pits to approximate maximum depths of four to 10½ feet below existing ground surface (bgs);
4. Infiltration rate testing;
5. Collection of bulk samples of near surface soils;
6. Laboratory testing of selected soil samples;

7. Engineering analysis; and,
8. Preparation of this report.

This report is specific to the design and construction of the proposed Palm Communities – Red Bluff apartment project and associated improvements to be located at 321 S. Jackson Street (APN 033-130-028) in Red Bluff, California. This report should not be used for design or construction of any other proposed future buildings or structures at the site without review of the proposed improvements by our office. Additional reports and site investigations may be required for future buildings, groups of buildings, or structures, depending on the proposed development.

Figures and Attachments

The following figures and attachments are included in this report.

- Figure 1 – Vicinity Map indicating the project location.
- Figure 2 – Regional Geologic Map showing previously mapped project vicinity geology.
- Figure 3 – Test Pit Location Map showing approximate test pit locations.
- Figures 4 through 7 – Test Pits Logs.
- Figure 8 – Unified Soil Classification System.

Appended to this report are:

- Appendix A – General information regarding project concepts, exploratory methods used during the field phase of our investigation, an explanation of laboratory testing accomplished, and laboratory test results.
- Appendix B – *Guide Earthwork Specifications* that may be used in the preparation of contract plans and documents.

Project Description

Project plans were not available for review at the time this report was prepared. Based on information provided by Palm Communities, it is our understanding the project will consist of two to three, two-to three-story structures containing approximately 60 apartment units. It is anticipated the structures will be wood-framed construction and will be supported by conventional foundations with interior concrete slab-on-grade floors. Structural and floor loads are anticipated to be relatively light to moderate. Associated development is anticipated to include exterior concrete flatwork, asphalt concrete paved parking areas, underground utilities, and typical landscaping.

This report was prepared based on the project information provided by Palm Communities. When final site plans are available, Mid Pacific Engineering should be afforded the opportunity to review the plans and revise and/or update our conclusions and recommendations as necessary.

Based on observations made during our site work, and the relatively level to moderately sloping site topography, we anticipate maximum excavations could be on the order of five to ten feet in the southeastern corner of the project site. In addition, maximum fills on the order of two to three feet across the remainder of the site may be required to reach the majority of finished grade elevations.

FINDINGS

SITE DESCRIPTION

Review of Google Earth images and our site investigation, completed on October 4, 2021, indicates the proposed project will be located within a currently vacant, but previously developed, parcel (APN 033-130-028) at 321 S. Jackson Street in Red Bluff, California. The site is generally bounded to the north and east by multi-family residential developments; to the south by vacant, undeveloped property; and, to the west by S. Jackson Street. On the date of our field investigation, the project site was covered with low, dense grasses and weeds, several mature trees and tree stumps, remnant concrete foundations, and scattered trash and debris. An approximately four to five foot deep drainage runs along the western portion of the parcel.

Review of the United States Geological Survey (USGS) *Red Bluff East Quadrangle, California – Tehama County, 7.5-Minute Series* (2018) indicates an average approximate project site elevation of +280 feet above mean sea level (msl). Site topography is relatively level to moderately sloping.

Review of the historical aerial photographs (https://www.historicaerials.com/viewer) dated 1947, 1969, 1983, 2014, and 2016; and, Google Earth images dated 1998, 2005 through 2007, 2009 through 2013, 2015, 2017, 2018, and 2021 indicates the northern portion of the project site supported an orchard in 1947 (earliest available photograph). The 1969 aerial photograph shows the development of three structures in the northern portion of the site. The project site appears to remain relatively unchanged until 2016 when the three structures are removed. The remnant concrete foundations from these structures are still present. With the exception of removal of some of the orchard trees between 2018 and 2021, the site has remained relatively unchanged since 2016.

Our review of available literature and historical photographs provide a limited site history. Therefore, unknown buried structures (wells, foundations, utility lines, septic systems, etc.) may be present on-site and may be encountered during construction. In addition, the remnant concrete foundations have small, shallow cellars.

Regional geologic setting

The project site lies in the northern portion of the Great Valley geomorphic province of California. The Great Valley is an alluvial plain, approximately 50 miles wide and 400 miles long, between the Coast Ranges and Sierra Nevada. The Great Valley is drained by the Sacramento and San Joaquin rivers, which join and enter San Francisco Bay. The eastern border is the west-sloping Sierran bedrock surface, which continues westward beneath alluvium and older sediments. The western border is underlain by east-dipping Cretaceous and Cenozoic strata that form a deeply buried synclinal trough, lying beneath the Great Valley along its western side. The southern part of the Great Valley is the San Joaquin Valley. Its great oil fields follow anticlinal uplifts that mark the southwestern border of San Joaquin Valley and its southern basin. To the north, the Sacramento Valley plain is interrupted by the Marysville Buttes, an isolated Pliocene volcanic plug approximately 2,000 feet high.

Site Geology

The USGS *Geologic Map of the Red Bluff 30' x 60' Quadrangle, California* compiled by L.A. M.C. Blake, D.S. Harwood, E.J. Helley, W.P. Irwin, A.S. Jayko, and D.L. Jones (2000), indicates the project site is underlain by Pleistocene Modesto Formation, Upper member (Map symbol: Qmu) soils described as gravel, sand, silt, and clay. Based on the soils encountered during our on-site investigation, and our knowledge of the project area, it is our opinion the soils underlying the project site are generally consistent with those mapped as Modesto Formation, Upper member. The distribution of surficial deposits in the vicinity of the project site are shown on the Regional Geologic Map, Figure 2.

The United States Department of Agriculture, Natural Resources Conservation Service website (http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx), maps the site as underlain by Maywood fine sandy loam, 0 to 3 percent slopes and Maywood loam, high terrace, 0 to 3 percent slopes. The Maywood series consists of nearly level, well-drained soils formed in recent alluvium derived mainly from softly consolidated sedimentary rocks. Maywood soils are pale brown, medium textured, and neutral or slightly acid throughout. The soils is found on flood plains west of the Sacramento River. The Maywood fine sandy loam, 0 to 3 percent slopes soil is mainly fine sandy loam throughout the profile. Permeability is moderately rapid, and the available water holding capacity is moderate. The Maywood loam, high terrace, 0 to 3 percent slopes soil is found along streams west of the Sacramento River. These soils possess good drainage, very slow runoff, and moderate permeability.

SUBSURFACE SOIL CONDITIONS

The exploratory test pits excavated during our on-site investigation exposed artificial fill and native Modesto Formation, Upper member soils. As observed in test pit TP-1, the native soils consisted of medium stiff sandy silt with gravel and, medium dense clayey, silty sand to the approximate maximum explored depth of nine feet bgs. Test pit TP-2 exposed native soils consisting of medium stiff, sandy silt with gravel; medium dense clayey sand with gravel; and, medium dense well-graded sand with gravel to the approximate maximum explored depth of nine feet bgs. Test pit TP-3 exposed native soils consisting of medium stiff sandy silt with gravel; and, medium dense clayey, silty sand to the approximate maximum explored depth of 9½ feet bgs. Test Pit TP-4 encountered artificial fill soils comprised of loose to medium dense silty sand with gravel to an approximate depth of two feet bgs. The artificial fill soils overlie native soils consisting of medium stiff sandy silt; and, stiff sandy clay to the approximate maximum explored depth of 10½ feet bgs. Test pit TP-5 exposed native soils consisting of medium stiff sandy silt with gravel; and medium dense well-graded sand with gravel to the approximate maximum explored depth of ten feet bgs. Test Pit TP-6 encountered artificial fill soils comprised of medium dense well-graded sand with silt and gravel to an approximate depth of four feet bgs. The artificial fill soils overlie native soils consisting of medium dense well-graded sand with gravel and cobbles; and medium dense well-graded sand with clay and gravel to the approximate maximum explored depth of nine feet bgs. Test pit TP-7 exposed native soils consisting of medium stiff silty sand to the approximate maximum explored depth of four feet bgs.

Groundwater was not encountered in the test pits excavated on October 4, 2021 to an approximate maximum depth of 10½ feet bgs.

Please refer to Figure 3 for test pit locations, Test Pit Logs (Figures 4 through 7) for further details regarding the soil conditions at a particular location. Please note that subsurface conditions within the test pits are representative of the soil conditions at the time of exploration and at the specific location. It should be expected that soil conditions across the site can and will vary laterally and vertically from the soil encountered during our investigation.

GROUNDWATER

Groundwater was not encountered within the test pits, excavated on October 4, 2021, to an approximate maximum depth of 10½ feet bgs. Data from the California Department of Water Resources (http://wdl.water.ca.gov/waterdatalibrary/index.cfm) closest groundwater monitoring well (27N04W25Q001M), located approximately 1.4 miles west-southwest of the project site indicates groundwater elevations in the project area range from approximately +196 to +240 feet above msl, which corresponds to approximately 40 to 84 feet below existing project site grades assuming an average site elevation of +280 feet msl.

Groundwater levels may fluctuate beneath the site depending on the time of year, and rainfall amounts. In addition, shallow perched water may accumulate above less permeable or cemented on-site soils following periods of heavy rainfall. Therefore, groundwater conditions presented in this report may not be representative of those, which may be encountered during or subsequent to construction.

INFILTRATION RATE TESTING

On October 4, 2021, infiltration rate testing was conducted at two locations within or near proposed detention basins. Infiltration rate test depths ranged from approximately three to four feet below existing ground surface bgs.

The double-ring infiltrometer tests were conducted in accordance with ASTM D3385 at the approximate location indicated on Figure 3. The tests were conducted on undisturbed native soils exposed at the bottom of the estimated detention basin elevations.

The infiltration velocity in inches per hour (iph) was calculated based on the volume of liquid added to the inner ring to maintain the liquid at a constant level over the period of the test (three hours). **The stabilized infiltration rates ranged from ¼ to ½ iph.**

Please note that infiltration rates across the site can and will vary from those stated in this letter and also will vary over time as the storm water disposal system comes to equilibrium. Our tests were performed using clean water, it should be anticipated that storm water runoff will likely contain fine grained soil (silt and clay), organic debris, and other deleterious matter that may reduce the percolation characteristics of the near-surface soils. In addition, fine grained soil accumulation and clogging within the bottom of the basins should be anticipated. Therefore, an appropriate safety of factory should be applied to the test results by the storm water system designer.

CONCLUSIONS

GEOLOGIC HAZARDS

Seismic Hazards

Seismic Site Class

The site is underlain by artificial fill and native Pleistocene Modesto Formation, Upper member soils. Based on the soil conditions encountered during our subsurface investigation, it is our opinion the site meets the criteria to be characterized as Site Classification D per the American Society of Civil Engineers (ASCE 7-16)[1]. Site Class D was used in determining seismic design parameters for this project in accordance with Section 1613.2.2 of the 2019 California Building Code (CBC).

Seismic Sources

According to the United States Geological Survey (USGS) 2008 National Seismic Hazard Maps website, (https://earthquake.usgs.gov/cfusion/hazfaults_2008_search/query_main.cfm), five active and/or potentially active faults are mapped within 62 miles (100 kilometers) of the project site. These include the Battle Creek Fault; the Great Valley thrust fault system,

[1] American Society of Civil Engineers (ASCE 7-16), Chapter 20, Section 20.3.3.

Segments 1 and 2; the Hat Creek-McArthur-Mayfield Fault; and, the Bartlett Springs Fault. Our site seismic analysis is based on the faults identified by the USGS geohazards program.

The closest active/potentially active fault is the Battle Creek fault, located approximately 16½ miles (27 kilometers) north-northeast of the project site. The Battle Creek Fault Zone is one of the most prominent structural features in northern California. East of the Sacramento River, the fault zone trends nearly east-west and forms a prominent escarpment rising to the northeast that is buried by late Quaternary flows from the Lassen Peak area. The sense of motion on the dominantly normal fault zone is north-side up. Westward, the Battle Creek Fault Zone probably controls the orientation of Cottonwood Creek valley. Linear geomorphic features that may be related to faulting extend westward along the South Fork of Cottonwood Creek, Mitchel Gulch, Colyear's Spring, Sour Grass Gulch, and finally into the Coast Ranges (Helley and others, 1981). The Maximum Magnitude Earthquake (M_{max}) assumed for the Battle Creek fault in this region is 6.7. The M_{max} is the maximum earthquake believed possible for the fault.

The Great Valley thrust fault system, Segments 1 and 2 are located approximately 34 and 61 miles (55 and 96 kilometers) south of the project site, respectively. The Great Valley thrust fault system is a seismically active blind thrust fault and fold belt that marks the boundary between the Coast Ranges and the Great Valley. The Great Valley thrust fault system can be described as a complex system of east vergent, shallow-dipping blind thrust faults and associated west-vergent shallow to moderately dipping backthrust faults. Quaternary deformation in the western Sacramento Valley is characterized by uplift, tilting, asymmetric folding, and, locally, by both west and east-vergent thrust faulting (Unruh and Moores, 1992). Slip rate estimates for the thrust fault system generally are based on uplift rates of specific stratigraphic horizons and fault dips, which are sometimes measured from deep seismic reflection lines, and sometimes from structural modeling. Estimated late Quaternary dip-slip rates along the Great Valley thrust fault system range from about 0.1 millimeter per year (mm/yr) for the Great Valley 1 section, 1–3 mm/yr for the Mysterious Ridge [28c] section, 0.4–0.6 mm/yr for the Orestimba [28g] section, and about 3 mm/yr for the Kettleman Hills-North Dome [28n] section. The Maximum Magnitude Earthquakes (M_{max}) assumed for the Great Valley, Segment 1 and 2 faults in this region are 6.8 and 6.5, respectively.

The Hat Creek-McArthur-Mayfield Fault Zone is located approximately 55 miles (89 kilometers) northeast of the project site. The Hat Creek-McArthur-Mayfield Fault Zone is comprised of high-angle, down-to-west, left-stepping normal faults that bound the west side of Hat Creek Rim. There is more than 1,640 feet (500 meters) of Quaternary displacement across the fault zone (Muffler and others, 1994). The Hat Creek fault forms a prominent 820 to 1,640-feet-high (250 to 500 meters) compound escarpment that is capped by early Pleistocene basalt. The base of the escarpment is buried by stabilized talus along significant portions of the fault. This talus has been disrupted by scarps and linear troughs and ridges resulting from recent activity. Some individual scarps turn into monoclinal flexures near their ends (Muffler and others, 1994). The Maximum Magnitude Earthquake (M_{max}) assumed for the Hat Creek-McArthur-Mayfield fault in this region is 7.2.

The Bartlett Springs fault system, located approximately 59 miles (95 kilometers) southwest of the project site, is a major northwest-trending zone comprised of discontinuous, steeply dipping dextral strike-slip faults associated with the San Andreas Fault System. The Bartlett Springs Fault System can be mapped for at least 75 miles (120 km) from the southern side of Round Valley southeast to near Clear Lake. North of Round Valley, Herd (1978) suggested that the Lake Mountain fault may by the northern continuation of the Bartlett Springs fault system, indicating a total length of about 103 miles (165 km). Lienkaemper (2010) mapped Holocene active traces of the Bartlett Springs fault system that extend for approximately 109 miles (175 km). Traces of the Bartlett Springs fault system locally are delineated by geomorphic evidence of latest Pleistocene and Holocene strike-slip displacement, especially in the vicinity of Lake Pillsbury (dePolo and Ohlin, 1984; Taylor and Swan, 1986; Swan and Taylor, 1991; Bryant, 1993). Swan and Taylor (1991) reported a Holocene slip rate of 1 to 2 mm/yr for the fault zone near Lake Pillsbury. The Maximum Magnitude Earthquake (M_{max}) assumed for the Bartlett Springs fault in this region is 7.3.

Surface Fault Rupture

The site does not lie within an Alquist-Priolo Earthquake Hazard Fault Zone (AP Fault Zone) as currently designated by the State of California. The closest Earthquake Hazard Fault Zone is the Hat Creek-McArthur-Mayfield fault zone located approximately 55 miles (89 kilometers) east-northeast of the project site. It is our opinion that the potential of fault related surface rupture at the site is low.

Seismic Risk

The primary seismic risks at the site are from earthquakes along the Battle Creek Fault; the Great Valley thrust fault system, Segments 1 and 2; the Hat Creek-McArthur-Mayfield Fault; and, the Bartlett Springs Fault. These faults are considered active and/or potentially active with several fault segments located between approximately 16½ and 61 miles (27 and 96 kilometers) of the subject site.

Secondary Hazards

Liquefaction Potential

Liquefaction is a soil strength and stiffness loss phenomenon that typically occurs in loose, saturated cohesionless sands as a result of strong ground shaking during earthquakes. The potential for liquefaction at a site is usually determined based on the results of a subsurface geotechnical investigation and the groundwater conditions beneath the site. A full liquefaction analysis was beyond our scope of work performed for this project. However, based on the lack of measured groundwater within approximately 40 feet of ground surface and the presence of relatively fine grained, medium dense to stiff Modesto Formation soils underlying the site, it is our opinion the potential for liquefaction occurring beneath this site is low. In addition, to our knowledge there have been no recorded occurrences of seismically induced liquefaction in the site vicinity or the Tehama County region. The site is not located within a State Designated Seismic Hazard Zone for liquefaction.

Site Acceleration and Seismic Coefficients

2019 CBC Seismic Coefficients

The following seismic parameters were determined based on the site latitude and longitude using the web interface developed by the Structural Engineers Association of California (SEAOC) and California Office of Statewide Health Planning and Development (OSHPD) (https://seismicmaps.org/) to retrieve seismic design data from the public domain computer program developed by the USGS. Section 1613 of the 2019 edition of the California Building Code (CBC) references the American Society of Civil Engineers (ASCE) Standard 7-16 for seismic design. The results indicate a mapped S_1 value of 0.39. Per Section 11.4.8, a site-specific ground motion study should be performed in accordance with Section 21.2 of ASCE 7-16 for Site Class D sites with S_1 value greater than or equal 0.2.

Section 11.4.8 of ASCE 7-16 includes an exception from such analysis for specific structures on Site Class D sites where: *Structures on Site Class D sites with S_1 greater than or equal to 0.2, provided the value of the seismic response coefficient C_s is determined by Eq. (12.8-2) for values of $T \le 1.5T_s$ and taken as equal to 1.5 times the value computed in accordance with either Eq. (12.8-3) for $T_L \ge T > 1.5Ts$ or Eq. (12.8-4) for $T > T_L$.*[2]

Provided the Exceptions defined in ASCE 7-16 Section 11.4.8 are satisfied, the 2019 CBC values provided in the following table may be utilized for design of the proposed structure. If the Exceptions defined in Section 11.4.8 are not satisfied, a site-specific ground motion analysis would be required per ASCE 7-16.

2019 CBC/ASCE 7-16 Seismic Design Parameters				
Latitude: 40.1660° N Longitude: -122.2371° W	ASCE 7-16 Table/Figure	2019 CBC Table/Figure	Factor/ Coefficient	Value
Short-Period MCE at 0.2s	Figure 22-1	Figure 1613.2.1(1)	S_S	0.88g
1.0s Period MCE	Figure 22-2	Figure 1613.2.1(2)	S_1	0.39g
Soil Class	Table 20.3-1	Section 1613.2.2	Site Class	D
Site Coefficient	Table 11.4-1	Table 1613.2.3(1)	F_a	1.15
Site Coefficient	Table 11.4-2	Table 1613.2.3(2)	F_v^*	1.91
Adjusted MCE Spectral Response Parameters	Equation 11.4-1	Equation 16-36	S_{MS}	1.01g
	Equation 11.4-2	Equation 16-37	S_{M1}	0.74g
Design Spectral Acceleration Parameters	Equation 11.4-3	Equation 16-38	S_{DS}	0.67g
	Equation 11.4-4	Equation 16-39	S_{D1}	0.50g
Seismic Design Category	Table 11.6-1	Section 1613.2.5(1)	Risk Category I to IV	D
	Table 11.6-2	Section 1613.2.5(2)	Risk Category I to IV	D

* Values calculated by linear interpolation.
MCE – Maximum Considered Earthquake
g – Acceleration due to gravity

[2] T = The fundamental period of the structure, s
$T_o = 0.2(S_{D1}=S_{DS})$
$T_S = S_{D1}/S_{DS}$, and
T_L = Long-period transition period(s)

FOUNDATION AND SLAB SUPPORT

Based on our field investigation, it is our opinion the on-site, near-surface soils are comprised of artificial fill and native soils that possess variable composition, density, and support qualities. In addition, site clearing operations will disturb a majority of the near-surface soils creating variable density and support conditions. Therefore, we will recommend over-excavation of all artificial fill soils and all loose, soft, and/or disturbed native soils within project structural areas, including building pads, exterior concrete flatwork, and pavement areas, and replacement with engineered fill, to promote more uniform support for the planned improvements. Depending on locations of proposed structures and final design site grades, the structural areas should be over-excavated to a depth of one foot below existing site grades. Localized over-excavation depths of up to four feet bgs to remove artificial fill soils may be necessary, depending on final site grades.

Based on our field investigation and laboratory test results, it is our opinion that firm, undisturbed native soils, and engineered fill that is properly placed and compacted, will be capable of supporting the planned apartment buildings, at-grade structures, and pavements provided the following recommendations regarding site preparation and engineered fill placement and compaction are carefully followed. Specific recommendations are presented in the SITE PREPARATION AND OVER-EXCAVATION section of this report.

EXCAVATION CONDITIONS

Based on the subsurface conditions encountered in our test pits, we anticipate the on-site native soils should be readily excavatable with conventional earthmoving and trenching equipment typically used in the area to approximate minimum depths of 10½ feet bgs. The on-site excavations may be subject to sloughing and caving if cohesionless or saturated soils are exposed, requiring sloped excavations to reduce the effects of sidewall stabilities.

Excavations to be entered by workers should be braced or shored in accordance with current OSHA regulations. The contractor must provide an adequately constructed and braced shoring system in accordance with federal, state and local safety regulations for individuals working in an excavation that may expose them to the danger of moving ground. If material is stored or heavy equipment is operated near an excavation, stronger shoring would be needed to resist the extra pressure due to the superimposed loads.

GROUNDWATER

Groundwater was not encountered within the test pits excavated on October 4, 2021 to an approximate maximum depth of 10½ feet bgs. Based on subsurface conditions observed during our investigation and review of existing groundwater data, it is our opinion that groundwater will not be a factor in design, construction, and/or performance of foundations, utilities, and improvements.

Groundwater levels may fluctuate beneath the site depending on the time of year and rainfall amounts. Therefore, groundwater conditions presented in this report may not be representative of those which may be encountered during or subsequent to construction.

SEASONAL WATER

During the wet season, infiltrating surface runoff water can create saturated near-surface conditions where drainage is inhibited. Grading operations attempted following the onset of winter rains and prior to prolonged drying periods may be hampered by high soil moisture contents. Such soils, intended for use as engineered fill, will require considerable aeration and/or drying to reach a moisture content that will permit the soils to be properly compacted.

It should be anticipated that perched water will exist seasonally over the top of denser or less permeable soils, especially during or shortly after periods of rainfall. Seepage may also be present within more permeable soil layers at the site.

In addition, soils located beneath existing pavements and concrete slabs will likely be at elevated moisture contents regardless of the time of year of construction and require drying. Wet soils should be anticipated and considered in the construction schedule for this project.

Seasonal moisture will result in high soil moisture contents below interior floor slabs throughout their lifetime. Moisture vapor penetration resistance should be a significant consideration in design and construction of interior floor slabs.

EROSION AND WINTERIZATION

The near-surface on-site soils generally consist of sandy silt; sandy silt with gravel; clayey silty sand; silty sand; clayey sand with gravel; well-graded sand with gravel; well-graded sand with silt and gravel; well-graded sand with gravel and cobbles; well-graded sand with clay and gravel; and, sandy clay. In our opinion, near-surface soils may be susceptible to erosion by surface run-off that occurs during intense rainfall. As a minimum, erosion control measures including placement of straw bale sediment barriers or construction of silt filter fences in areas where surface run-off may be concentrated would be prudent. The project civil engineer should develop a site-specific erosion and sediment control plan based upon their site grading and drainage plan and the anticipated construction schedule.

All excavation and fill slopes should be protected from concentrated storm water run-off to minimize potential erosion. Control of water over the slopes may be accomplished by constructing small berms at the top of the slope, constructing V-ditches near the top of the slope, or by grading the area behind the top of the slope to drain away from the slope. Ponding of surface water at the top of the slope or allowing sheet flow of water over the top of the slope should be avoided.

EXPANSIVE SOIL

Laboratory test results indicate the on-site, near-surface clayey soils possess a “very low” expansion potential (See Figure A1) when tested in accordance with ASTM D4829. Based on the results of our work, we conclude that expansive soils will not be a factor in site development.

SOIL CORROSION POTENTIAL

Two representative soil samples were submitted to Sunland Analytical Lab, Inc., located in Rancho Cordova, California, for testing to determine pH, resistivity, chloride, and sulfide concentrations to help evaluate the potential for corrosive attack upon reinforced concrete. Results of the corrosion testing performed by Sunland Analytical Lab are summarized in the following table.

SOILS CORROSIVITY TESTING			
Analyte	Test Method	Sample Identification	
		TP-5 (0-3')	TP-2 (2-5')
pH	CA DOT Test #643 Modified (Sm. Cell)	5.9	6.1
Minimum Resistivity		9,380 Ω-cm	2,680 Ω-cm
Chloride	CA DOT 417	0.8 ppm	1.1 ppm
Sulfate	CA DOT 422	0.4 ppm	2.0 ppm

Ω-cm = Ohm-centimeters ppm = Parts per million

The California Department of Transportation Corrosion Technology Section, Office of Materials and Foundations, Corrosion Guidelines Version 3.0, dated March 2018, considers a site to be corrosive to foundation elements if one or more of the following conditions exists for the representative soil samples collected: a minimum resistivity value for soil of less 1,100 ohm-cm, a chloride concentration greater than or equal to 500 ppm, sulfate concentration greater than or equal to 1,500 ppm, or the pH is 5.5 or less. Based on this criterion, the on-site soils tested for this project are not considered corrosive to reinforced concrete. Table 19.3.1.1 – *Exposure Categories and Classes*, American Concrete Institute (ACI) 318, Section 19.3, as referenced in Section 1904.1 of the 2019 CBC, indicates the severity of sulfate exposure for the samples tested is *not a concern*. Ordinary Type I-II Portland cement is considered suitable for use on this project, assuming a minimum concrete cover is maintained over the reinforcement.

Our experience with concrete and steel corrosion is generally based on the Caltrans corrosion guidelines, which have been developed for use by designers for use on public transportation projects, such as bridges. Generally, these structures are more highly sensitive to corrosion of concrete and steel when compared to the proposed development.

Mid Pacific Engineering, Inc. are not corrosion engineers. Therefore, to further define the soil corrosion potential at the site, a corrosion engineer could be consulted to determine the need for cathodic protection or grounding systems.

Import fills, if used for construction, should be sampled and tested to verify the materials have corrosion characteristics within acceptable limits and generally should be similar to the tested on-site soils.

SUITABILITY OF ON-SITE SOILS FOR FILL CONSTRUCTION

The on-site soils are considered suitable for use as engineered fill materials, provided these materials are free from concentrations of roots and organics, expansive clayey soils, over-size rock fragments, rubble, debris, or other deleterious materials and are at the proper moisture content for compaction. Removal of over-size rock, roots, trash, rubble, and debris from on-site soils may require laborers handpicking the fill materials.

PAVEMENT SUBGRADE QUALITY

Laboratory test results indicate the near-surface soils are fair quality materials for the support of asphalt concrete pavements. Based on the results of laboratory testing, a Resistance-value of 20 is considered appropriate for design of pavements. Resistance-value test results are attached as Figure A2.

RECOMMENDATIONS

We consider it essential that our office review final site, grading, and structural foundation plans to verify the applicability of the following recommendations, perform additional investigations, and provide supplemental recommendations, as conditions dictate.

Based on our field investigation, it is our opinion on-site, near-surface is comprised of artificial fill and native soils that possess variable composition, density and support qualities. In addition, site clearing operations will disturb surface and near-surface soils creating variable support conditions. Therefore, we will recommend over-excavation of all artificial fill soils and loose, soft, and/or disturbed native soils within project structural areas including building pads, exterior concrete flatwork, and pavement areas, and replacement with engineered fill, to promote more uniform support for the planned improvements.

The recommendations presented below are appropriate for typical construction in the late spring through fall months. The on-site soils will likely be saturated by rainfall in the winter and early spring months, and will not be compactable without drying by aeration or the addition of lime (or a similar product) to dry the soils. Should the construction schedule require work during wet conditions, additional recommendations can be provided, as conditions dictate. In addition, soils located beneath existing pavements and concrete slabs will likely be at elevated moisture contents regardless of the time of year of construction and require drying. Wet soils should be anticipated and considered in the construction schedule for this project.

Evidence of previously existing structures was observed during our review of historical aerial photographs, Google Earth images containing the site, and during the field investigation phase of our work. Therefore, the contractor should anticipate additional excavation, backfilling and reworking of areas that may contain pre-existing structures.

SITE CLEARING

Initially, all structural areas of the site should be cleared of existing surface and subsurface structures, debris, vegetation, trees, and other deleterious materials to expose firm and stable soil conditions as identified by our on-site representative. Our review of available literature and historical photographs provide a limited site history. Therefore, unknown buried structures (foundations, septic tanks and lines, etc.) may be present on-site and may be encountered during construction. If encountered, these structures should be removed and the resulting cavities or holes should be backfilled with properly moisture conditioned and compacted engineered fill as described in this report.

The contractor should anticipate additional excavation, backfilling and reworking of the areas that may contain former structures. We recommend construction bid documents contain a unit price (price per cubic yard) for additional excavation of unsuitable materials and replacement with engineered fill.

Where practical, the clearing should extend a minimum of five feet beyond the limits of the proposed improvement and structural areas of the site. Existing underground utilities, if encountered, located within proposed building or structural areas should be completely removed and/or rerouted as necessary. Utilities located outside the building or structural areas should be properly abandoned (i.e., fully grouted provided the abandoned utility is situated at least 2½ feet below the final subgrade level to reduce the potential for localized "hard spots").

Trees/stumps and large brush designated for removal should include the entire root ball and all surface roots larger than ½-inch in diameter. Adequate removal of debris, rubble, tree roots, and deleterious material may require laborers and handpicking to clean the subgrade soils to the satisfaction of our on-site representative. Loose, disturbed, soft soil, organic matter and debris, or otherwise unstable materials left within depressions resulting from clearing operations, should be completely removed to expose firm, undisturbed native soils, widened as necessary to allow access with compaction equipment, and backfilled in accordance with the recommendations of this report. It is considered essential that our representative be notified prior to site clearing operations to schedule periodic site visits.

Stripped surface vegetation and organically contaminated topsoil may be stockpiled for later use or disposed of off-site. Strippings should not be used in general fill construction, but may be used in landscaped areas, provided they are kept at least five feet from building pads, structural areas, exterior flatwork and pavements, and are moisture conditioned and compacted. *Strippings should not be used in landscaped berms that will support sound walls, retaining walls, concrete flatwork, or other at-grade structures.* Discing of the organics into the surface soils within the southern portion of the project site may be a suitable alternate to stripping, depending on the condition and quantity of the organics at the time of grading. ***The decision to utilize discing in lieu of stripping should be made by our representative at the time of earthwork construction.*** Discing operations, if approved, should be observed by our representative and be continuous until the organics are adequately mixed into the surface soils to provide a compactable mixture of soil containing minor amounts of organic matter. Pockets or concentrations of organics will not be allowed.

It is essential that our representative be present during clearing operations to verify adequate removal of former structures, as well as trees and roots, and determine the need for over-excavation of disturbed soil areas. Excavations resulting from clearing operations be left as shallow dish-shaped depressions for proper location and to allow proper access with compaction equipment during grading operations. If clearing and removal of structures takes place without direct observation by the Geotechnical Engineer, deeper cross-ripping and/or over-excavation of the disturbed areas and the building pad or structural areas affected will be required.

The test pits excavated for our subsurface investigation were backfilled with on-site soils and compacted to the extent possible using the backhoe bucket, however, the soils were not compacted to engineered fill specifications. The test pits should be identified and located in the field, and the backfill completely removed and replaced as engineered fill. The test pit backfill was left low and slightly depressed so the locations could be identified.

SITE PREPARATION AND OVER-EXCAVATION

Provided MPE is present during clearing operations and the excavations for removal of subsurface elements are left as dish shaped depressions so that our representative can verify adequate and complete removal, pad preparation can proceed as recommended below. If this is not the case and MPE is not present during site clearing operations or if excavations are backfilled without our observation and testing, all building and structural pads (building/structural area plus five feet beyond) will require deeper processing or over-excavation and re-compaction.

Building/Structural Pad Over-Excavation

Our on-site investigation revealed artificial fill soils and indicates site clearing and tree removal will disturb the native soils. All loose/disturbed native soil within building pads and site structural areas should be over-excavated to expose firm, undisturbed native soil as determined by our on-site representative. Over-excavation depths of approximately one foot below existing site grades are anticipated for the majority of the project site. Over-excavation depths of up to four feet below existing site grades are anticipated for areas of the site underlain by artificial fill soils. The over-excavations should extend a minimum of five feet horizontally beyond the proposed structure lines, and should include areas of exterior columns, areas supporting exterior flatwork and pavements, or other areas supporting at-grade structures.

MPE should review the final plans to verify the applicability of these recommendations and determine the need for revised recommendations.

The bottom of all over-excavations should be ripped and cross-ripped to a minimum depth of eight inches, moisture conditioned to at least the optimum moisture content, and compacted to at least 90 percent of the ASTM D1557 maximum dry density. The compacted subgrades must be in a stable and unyielding condition for proper structural support.

All areas that are to remain at-grade, to receive fill, or obtained by excavation should be scarified to a depth of eight inches, uniformly moisture conditioned to achieve at least the optimum moisture content, and compacted to at least 90 percent of the ASTM D1557 maximum dry density. Grades must be properly compacted and stable under compactive loads. It should be anticipated that some over-excavation and/or stabilization could be needed in these areas, if the soils are wet, soft or unstable at the time of construction.

Compaction operations should be undertaken with a heavy, self-propelled, sheepsfoot compactor capable of providing adequate compaction (Caterpillar CS78B or equivalent sized compactor) and should be performed in the presence of our representative who will evaluate the performance of the subgrade under compactive load and identify loose or unstable soils that could require additional excavation and/or compaction. Loose, soft, or unstable soils, as identified by our representative in the field, should be cleaned out to firm, undisturbed and stable soils, as determined by our representative, and should be restored to grade with engineered fill compacted in accordance with the recommendations of this report. Difficulty in achieving subgrade compaction or unusual soil instability may be indications of loose fill associated with past subsurface items. Should these conditions exist, the materials should be excavated to check for subsurface structures and the excavations backfilled with engineered fill. We recommend construction bid documents contain a unit price (price per cubic yard) for all excess excavation due to loose, soft, or unsuitable materials and replacement with engineered fill.

ENGINEERED FILL CONSTRUCTION

Engineered fill should be placed in horizontal lifts not exceeding six inches in compacted thickness. Engineered fill should be brought to at least the optimum moisture content and compacted to at least 90 percent of the maximum dry density as determined by ASTM D1557. Compaction operations should be undertaken with a heavy, self-propelled, sheepsfoot compactor (Caterpillar CS78B or equivalent sized compactor) capable of providing adequate compaction. Additional passes with the compactor shall be added, as required by the Geotechnical Engineer, to achieve a firm, stable and unyielding subgrade condition. Compactive effort should be applied uniformly across the full width of fill construction. Care must be taken when compacting at the edges of the over-excavations to ensure the fills are uniformly tied into the adjacent sloping ground by benching into undisturbed native soil. Each lift of fill should be benched into the side slope to remove loos or disturbed soils. Each lift of engineered fill should be properly benched into adjacent side slopes, if present, to remove loose soils and promote uniformity. Fills greater than five feet below finish grade elevations should be compacted to at least 95 percent of the ASTM D1557 maximum dry density.

The on-site soils are considered suitable for use as engineered fill provided the materials are at a workable moisture content and free of rubbish, rubble, debris and concentrations of organics, are non-expansive, and have a maximum particle size of three inches or less for fill within the upper 18 inches of the final building pad elevation. Fills soils at depths greater than 18 inches below final building pad elevation may contain maximum particle sizes of six inches or less. Hand picking of exposed roots, rubbish, debris, and over-sized rock should be performed by the Contractor to adequately clear the grades and properly prepare and clear the soils proposed as fill, prior to use.

Imported fill material, if required, should consist of well-graded granular soils or well-graded aggregates with a Plasticity Index of 15 or less, an Expansion Index of 20 or less, an R-value of ten or greater, and should have no particles greater than three inches in maximum dimension. Clean, open graded gravels (such as crushed rock or pea gravel) and other such materials are *not* acceptable for fill construction. The contractor also should supply appropriate documentation for imported fill materials indicating the materials are free of known contamination and have corrosion characteristics within acceptable limits. The imported materials should be sampled, tested, and approved before being transported to the project site. Samples should be submitted to the Geotechnical Engineer at least two weeks prior to planned importation to the site.

The upper eight inches of final building and structural pads subgrades should be scarified, brought to at least the optimum moisture content, and uniformly compacted to not less than 90 percent of the maximum dry density, as determined by ASTM D1557, regardless of whether final grade is completed by excavation, filling, or left at-grade.

The upper six inches of pavement subgrades and exterior slab subgrades supporting vehicle loadings should be scarified, moisture conditioned to at least the optimum moisture content and uniformly compacted to at least 95 percent of the ASTM D1557 maximum dry, and must be stable under construction traffic prior to placement of aggregate base. Final subgrade processing and compaction should be performed just prior to placement of aggregate base, after construction of underground utilities is complete.

Site preparation should be accomplished in accordance with the recommendations of this section and the *Guide Earthwork Specifications* provided in Appendix B. It is essential that a representative from our office be present on a nearly full-time basis during site preparation and all grading operations to verify complete removal of undocumented fills and/or unstable soil deposits, to observe the earthwork construction, perform compaction testing and verify compliance with our recommendations and the job specifications.

UTILITY TRENCH BACKFILL

Utility trench backfill should be mechanically compacted in maximum six-inch lifts. Trench backfill should be brought to uniform moisture content above the optimum moisture and each lift mechanically compacted to at least 90 percent of the maximum dry density. The upper six inches of trenches in pavement areas should be compacted to at least 95 percent of the maximum dry density. Jetting of trench backfill as a means of compaction is not acceptable. We recommend that native soil be used as trench backfill within the perimeter of building foundations to help minimize soil moisture variations beneath the structures. The native soil backfill should extend at least three feet horizontally beyond perimeter foundation lines. Utility trenches within the building perimeters should be backfilled with compactable material matching the upper 12 inches of building subgrade material.

We recommend that underground utility trenches that are aligned nearly parallel with foundations be at least three feet laterally from the outer edge of foundations, wherever possible. As a general rule, trenches should not encroach into the zone extending outward at a 1:1 (horizontal to vertical) inclination below the bottom of the foundations.

In addition, trenches parallel to foundations should not remain open longer than 72 hours. The intent of these recommendations is to prevent loss of both lateral and vertical support of foundations, resulting in possible settlement.

Pipe bedding, shading and trench backfill and compaction within municipal streets should conform to jurisdictional requirements.

FOUNDATION DESIGN

We are providing design soil values for the analysis of the foundations, and suggested minimums for dimensions, but only from a Geotechnical Engineering perspective. The project Structural Engineer should determine final foundation design width and depth dimensions and reinforcing requirements, based on their specific structural design, which should include an appropriate factor of safety applied to the overall design.

The proposed apartment structures may be supported upon continuous and/or isolated spread foundations extending a minimum of 18 inches into the prepared building pad or at least 18 inches below lowest adjacent soil grade, whichever is deeper. Continuous foundations should be at least 12 inches wide; isolated foundations should be at least 18 inches wide. Foundations must be continuous around the perimeter of the buildings to help minimize moisture migration beneath the structure.

Foundations so established may be sized for a maximum allowable soil pressure of 2,000 pounds per square foot (psf) for *Allowable Stress Design* such as using the *Basic Load Combinations* listed in Sections 1605.3.1 or 1605A.3.1 of 2019 CBC. This value can be increased by one-third to consider the short-term effects of seismic or wind forces if they are not factored in the load combinations such as the *Alternative Basic Load Combinations* listed in Sections 1605.3.2 or 1605A.3.2 of 2019 CBC. The weight of the foundation concrete extending below adjacent soil grade may be disregarded in sizing computations.

We recommend that all foundations be adequately reinforced to provide structural continuity, mitigate cracking and permit spanning of local soil irregularities. As a minimum, continuous foundations should contain *at least* two No. 4 steel reinforcing bars placed one each, near the top and bottom of the foundations. The project designer should determine the need for additional reinforcement based on structural requirements.

Resistance to lateral displacement of shallow foundations may be computed using an allowable friction factor of 0.25 multiplied by the effective vertical load on each foundation. Additional lateral resistance may be achieved using an allowable passive earth pressure against the vertical projection of the foundation equal to an equivalent fluid pressure of 250 psf per foot of depth. The allowable values of base friction and passive earth pressure may be combined without further reduction. Allowable passive resistance may be increased by one-third to consider the short-term effects of seismic or wind forces if they are not factored in the load combinations such as the *Alternative Basic Load Combinations* listed in Sections 1605.3.2 or 1605A.3.2 of 2019 CBC.

Passive resistance should be computed below a depth at which at least five feet of engineered fill or native soil is present in front of the foundations, as measured horizontally from the exterior edge of the foundations.

It is an essential requirement that foundation excavations be observed by a representative of MPE to verify competent and uniform bearing conditions and evaluate the need for any *modifications to these recommendations as may be required by specific circumstances. The observations should take place prior to placement of reinforcing steel but following cleaning of the excavations. To account for any re-compaction of foundation bottoms or deepening of foundations that might be required, we suggest bid documents include a unit price for additional compaction or foundation excavation and concrete that may be required.*

INTERIOR FLOOR SLAB SUPPORT

Interior concrete slab-on-grade floors can be suitably supported upon the soil subgrades prepared and constructed in accordance with the recommendations in this report and maintained in that condition (at or near optimum moisture conditions).

Interior concrete slab-on-grade floors within the apartment structures, or where increased floor loads are anticipated, should be at least six inches thick and, as a minimum, contain chaired No. 4 reinforcing bars on 18-inch center-on-center spacing, located at mid-slab depth. This slab thickness and reinforcement is suggested as a guide "minimum" only; final concrete slab thickness, compressive strength, reinforcement, and joint spacing for all slabs should be determined by design professional based on their specific design analysis, anticipated slab loading and uses, and Owner's performance expectations. It is emphasized that thicker slabs with greater reinforcing will be needed in areas supporting higher loads or where increased performance is desired. Temporary loads exerted during construction from vehicle traffic, cranes, forklifts, and storage of palletized construction materials should be considered in the design of the slab-on-grade floors. Proper and consistent location of the reinforcement at mid-slab is essential to its performance. The risk of uncontrolled shrinkage cracking is increased if the reinforcement is not properly located within the slab.

In addition, for increased support and if heavier floor loads are anticipated within the proposed structures, the interior slab-on-grade floors should be underlain by Class 2 aggregate base (minimum of six inches) compacted to at least 95 percent of the maximum dry density as determined by ASTM D1557.

Moisture protection maybe provided by placing a plastic water vapor retarder membrane (at least 10-mils thick) directly over the aggregate base. If used, the vapor retarder membrane should generally conform to ASTM E1745 specifications. Consideration should be given to using a thicker, higher quality membrane for additional moisture protection such as a 15-mil thick Stego vapor barrier or other product. The membrane should be installed so that there are no holes or uncovered areas. All seams should overlap and be sealed with manufacturer-approved tape, continuous at the laps to create vapor tight conditions. All perimeter edges of the membrane, such as pipe penetrations, interior and exterior footings, joints, etc., should be sealed or caulked per manufacturer's recommendations. An optional, thin layer of clean sand above the membrane is acceptable, as an aid to curing of the slab concrete.

Floor slab construction over the past 25 years or more has included placement of a thin layer of sand over the vapor retarder membrane. The intent of the sand is to aid in the proper curing of the slab concrete. However, recent debate over excessive moisture vapor emissions from floor slabs includes concern for water trapped within the sand. As a consequence, we consider the use of the sand layer as optional. The concrete curing benefits should be weighed against efforts to reduce slab moisture vapor transmission. It has been our experience that slab concrete placed directly on the vapor barrier may be more susceptible to non-uniform curing and shrinkage, bleeding, and curling; therefore, it is our opinion that the concrete mix and curing methods used for construction should take into account these potential issues.

The recommendations presented above are intended to mitigate any significant soils related cracking of the slab-on-grade floors. More important to the performance and appearance of a Portland cement concrete slab is the quality of the concrete, the workmanship of the concrete contractor, the curing techniques utilized and the spacing of control joints.

Floor Slab Moisture Penetration Resistance

It is considered likely that floor slab subgrade soils will become wet to near-saturated at some time during the life of the structures. This is a certainty when slab subgrades are constructed during the wet seasons or when constantly wet ground or poor drainage conditions exist adjacent to structures. For this reason, it should be assumed that all slabs in occupied areas, as well as those intended for moisture-sensitive floor coverings or materials, require protection against moisture or moisture vapor penetration. Standard practice includes the gravel and water vapor retarder as suggested above. However, the gravel and plastic membrane offer only a limited, first-line of defense against soil-related moisture. Recommendations contained in this report concerning foundation and floor slab design are presented as *minimum* requirements, only from the geotechnical engineering standpoint.

It is emphasized that the use of sub-slab crushed rock and water vapor retarder will not "moisture proof" the slab, nor does it assure that slab moisture transmission levels will be low enough to prevent damage to floor coverings or other building components. If increased protection against moisture vapor penetration of slabs is desired, a concrete moisture protection specialist should be consulted. The architect and design team should consider all available measures for slab moisture protection. It is commonly accepted that maintaining the lowest practical water-cement ratio in the slab concrete is an effective way to help reduce future moisture vapor penetration of the completed slabs.

EXTERIOR FLATWORK CONSTRUCTION

Areas to receive exterior concrete flatwork should be scarified, moisture conditioned and properly compacted just prior to placement of concrete, as recommended in this report, and maintained in that condition. Exterior flatwork subgrades should consist of on-site or imported granular (non-expansive) soils. Uniform moisture conditioning of subgrade soils is important to reduce the risk of non-uniform moisture withdrawal from the concrete and the possibility of plastic shrinkage cracks. Practices recommended by the Portland Cement Association and American Concrete Institute for proper placement and curing of concrete should be followed during exterior concrete flatwork construction. Some seasonal movement of flatwork should be anticipated.

The architect or structural engineer should determine the final thickness, strength, reinforcement, and joint spacing of exterior slab-on-grade concrete; however, we offer the following suggested minimum guidelines. Exterior flatwork should be at least four inches thick and be constructed independent of perimeter building foundations and isolated column foundations by the placement of a layer of felt material between the flatwork and the foundation. Reinforcement should consist of at least heavy duty welded wire fabric (flat sheets), or equivalent steel reinforcing bars, placed mid-depth of the slab. Thicker slabs constructed with thickened edges to at least twice the slab thickness should be constructed where light wheeled traffic or intermittent light loading is expected over the slabs. Public sidewalk design, thickness and construction should conform to local jurisdiction requirements.

SITE DRAINAGE

Final site grading should be accomplished to provide positive drainage of surface water away from buildings and structures and prevent ponding of water adjacent to foundations, slabs or pavements. The grade adjacent to structures should be sloped away from the foundations at a minimum two percent slope for a distance of at least five feet, where possible. Landscape berms, if planned, should be constructed in such a manner as to promote drainage away from the buildings. Proper control of surface water drainage is essential to the performance of foundations, slabs-on-grade, and pavements. We recommend using full-roof gutters, with downspouts from roof drains connected to rigid non-perforated piping directed to an appropriate drainage point away from the structures, or discharging onto paved surfaces leading away from the structures and foundations. Concentrated storm water discharge collected from roof downspouts or surface drains should not be allowed to drain on unprotected slopes adjacent to structures.

The ground should be graded to drain positively away from all flatwork and building structures. Ponding of surface water should be avoided near pavements, foundations, and flatwork.

All excavations and fill slopes should be protected from concentrated storm water run-off to minimize potential erosion. Control of water over the slopes may be accomplished by constructing V-ditches near the top of slopes or behind the top of retaining walls, or by grading the area behind the top of slope to drain away from the slope. Ponding of surface water or allowing sheet flow of water over any open excavation must be avoided.

PAVEMENT DESIGN

Traffic indices (TI's) were not specified for the project; therefore, we are providing a range of typical traffic indices. The project civil engineer should determine the appropriate pavement section based on anticipated traffic conditions and traffic index; we can provide alternative pavement sections based on different TI's, if necessary.

The following pavement sections presented below have been calculated based on the assumed traffic indices, Resistance ("R") -value laboratory test results, and the procedures contained within applicable portions of Chapters 600 to 670 of the *California Highway Design Manual*. Based on laboratory test results, we have used a Resistance-value of 20 for design of pavement section thicknesses.

Traffic Index	Asphalt Concrete (inches)	Class 2 Aggregate Base (inches)
4.5	2.5	7.0
6.0	2.5	12.0
7.0	3.0	14.0

We emphasize that the performance of pavements is critically dependent upon uniform and adequate compaction of the soil subgrade, as well as all engineered fill and utility trench backfill within the limits of the pavements. Final pavement subgrade preparation, i.e. scarification, moisture conditioning and compaction, should be performed after underground utility construction is completed, just prior to aggregate base placement. The upper six inches of pavement subgrade soils should be compacted to at least 95 percent relative compaction at no less the optimum moisture content and maintained in that condition until covered and protected by aggregate base. Soil subgrades allowed to dry, desiccate or become disturbed must be moisture conditioned and re-compacted prior to placement of aggregate base. All Class 2 aggregate base should be compacted to at least 95 percent of the ASTM D1557 maximum dry density at a moisture content of at least the optimum.

Pavement subgrades must be stable under construction traffic prior to placement of aggregate base. We recommend subgrades be proof-loaded (i.e. wheel-tested using a loaded water truck) prior to aggregate base placement.

In the summer heat, high axle loads coupled with shear stresses induced by sharply turning tire movements can lead to failure in asphalt concrete pavements. Therefore, we recommend that consideration be given to using a Portland cement concrete (PCC) section in areas subjected to concentrated heavy wheel loading, such as entry driveways, and trash enclosures. Our office should review vehicle loading and frequency prior to finalizing sections. As a minimum, the concrete section should consist of at least six inches of PCC underlain by at least six inches of Class 2 aggregate base compacted to not less than 95 percent relative compaction. We recommend PCC slabs be constructed with thickened edges. Edges should be thickened in accordance with ACI 330R.

For crack control, if desired, slabs should be reinforced with at least No. 3 reinforcing bars placed on maximum 24-inch centers. Reinforcement must be located at mid-slab depth to be effective. Joint spacing and details should conform to the current Portland Cement Association (PCA) or American Concrete Institute (ACI) guidelines. Portland cement concrete should achieve a minimum compressive strength of 3,500 pounds per square inch at 28 days.

Efficient drainage of all surface water to avoid infiltration and saturation of the supporting aggregate base and subgrade soils is important to pavement performance. Consideration may be given to full-depth curbs where pavements abut landscaped areas to serve as a cut-off against water migrating into the pavement base and subgrade materials. Curbs should extend into the soil subgrade. Weep holes also could be provided at drop inlets, located at the subgrade-base interface, to allow accumulated water to drain from beneath the pavements.

Materials quality and construction of the structural section of the pavements should conform to the applicable provisions of the latest edition of the *Caltrans Standard Specifications*.

EARTHWORK TESTING AND OBSERVATION

Site preparation should be accomplished in accordance with the recommendations of this report and the appended *Guide Earthwork Specifications*. Representatives of Mid Pacific Engineering, Inc. must be present during site preparation and all grading operations to observe and test the fills to verify compliance with our recommendations and the job specifications. In the event that MPE is not retained to provide geotechnical engineering observation and testing services during construction, the Geotechnical Engineer retained to provide this service should indicate in writing that they agree with the recommendations of this report, and prepare supplemental recommendations as necessary.

A final report by the "Geotechnical Engineer" should be prepared upon completion of the project indicating compliance with or deviations from this report and the project plans and specifications. Please be aware that the title Geotechnical Engineer is restricted in the State of California to a Civil Engineer authorized by the State of California to use the title "Geotechnical Engineer."

FUTURE SERVICES

We recommend that our firm be given the opportunity to review the final plans and specifications to verify that the intent of our recommendations has been implemented in those documents.

LIMITATIONS

Our recommendations are based upon the information provided regarding the proposed construction, combined with our analysis of site conditions revealed by the field exploration and laboratory testing programs. We have used our best engineering judgment based upon the information provided and the data generated from our investigation. This report has been prepared in accordance with generally accepted standards of practice existing in northern California at the time of the report. No warranty, either expressed or implied, is provided.

If the proposed construction is modified or re-sited; or, if it is found during construction that subsurface conditions differ from those we encountered at the test pit locations, we should be afforded the opportunity to review the new information or changed conditions to determine if our conclusions and recommendations must be modified. Mid Pacific Engineering, Inc., should be retained to review the final plans and specifications to verify that the intent of our recommendations has been implemented in those documents.

We emphasize that this report is applicable only to the proposed construction and the investigated site and should not be utilized for construction on any other site. The conclusions and recommendations of this report are considered valid for a period of two years. If design is not completed and construction has not started within two years of the date of this report, the report must be reviewed and updated, as necessary.

Mid Pacific Engineering, Inc.

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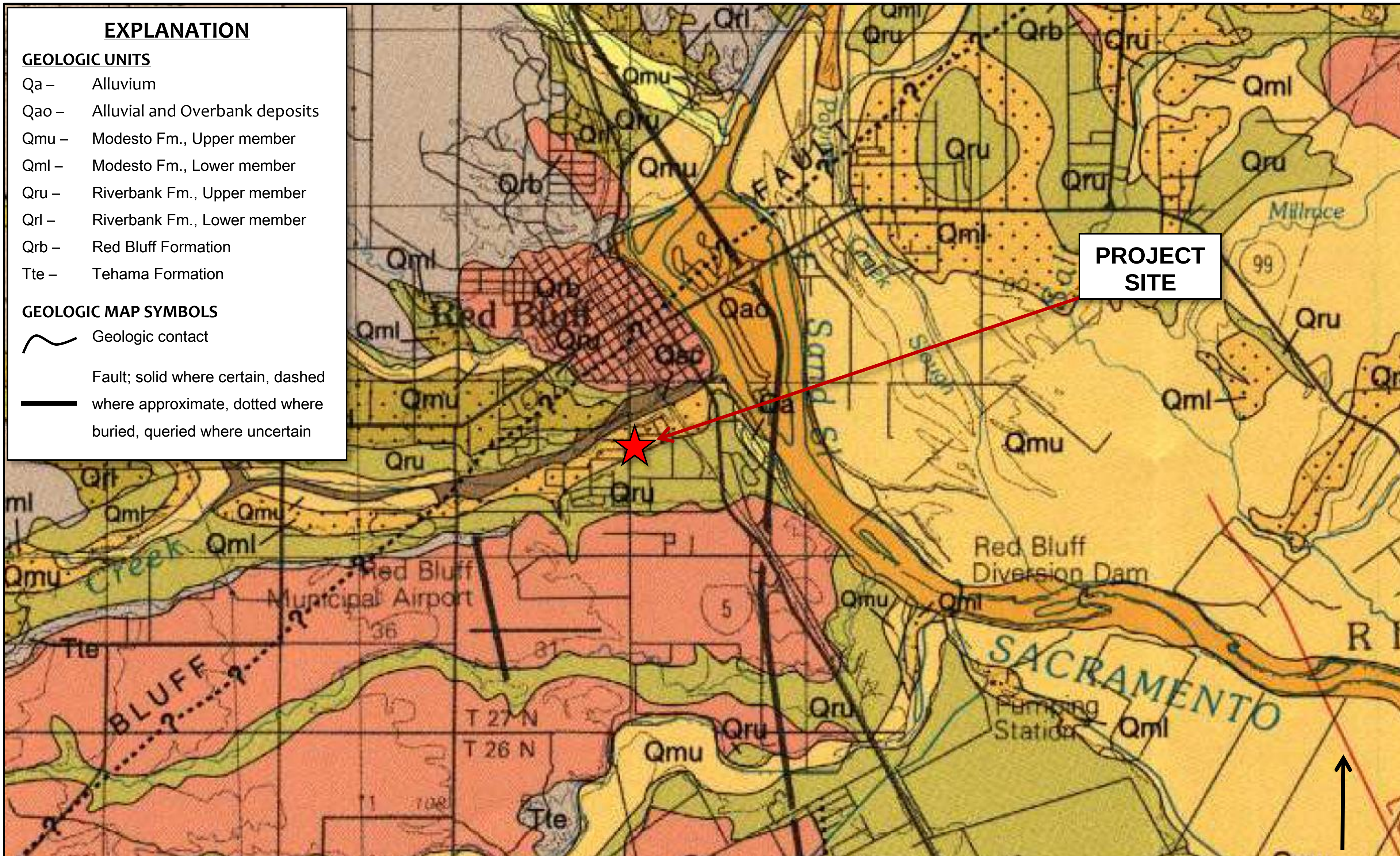
FIGURES

NOTES: Adapted from USGS *Red Bluff East Quadrangle, California – Tehama County*, 7.5-Minute Series, 2018.

MPE
Mid Pacific Engineering, Inc.

VICINITY MAP
PALM COMMUNITIES – RED BLUFF
321 S. Jackson Street
Red Bluff, California

FIGURE 1
Date: 10/21
MPE No. 05694-01



Adapted from: M.C. Blake, D.S. Harwood, E.J. Helley, W.P. Irwin, A.S. Jayko, and D.L. Jones, 2000, *Geologic Map of the Red Bluff 30' x 60' Quadrangle, California*, United States Geological Survey, Geologic Investigations Series, Map No. I-2542, scale 1:100,000.

MPE
MID PACIFIC ENGINEERING, INC.

REGIONAL GEOLOGIC MAP

PALM COMMUNITIES – RED BLUFF
321 S. Jackson Street
Red Bluff, California

FIGURE 2
Date: 10/21
MPE No. 05694-01

MPE
Mid Pacific Engineering, Inc.

TEST PIT LOCATION MAP

PALM COMMUNITIES – RED BLUFF

321 S. Jackson Street

Red Bluff, California

FIGURE 3

Date: 10/21

MPE No. 05694-01

LOGS OF TEST PITS 1 and 2

Volvo BL60B with a 24-inch Bucket

October 4, 2021

Test Pit 1

Depth (bgs)

	Modesto Formation, Upper member
0 – 2½'	Upper six inches disturbed. Medium stiff, dry to slightly moist, light gray-brown, fine sandy silt (ML) with some coarse sand and fine to coarse gravel.
2½ – 9'	Medium dense, slightly moist, light gray-brown, clayey, silty fine sand (SM).

Total depth = 9 feet.
Groundwater not encountered.
Backfilled with excavated soil.

Test Pit 2

Depth (bgs)

	Modesto Formation, Upper member
0 – 2'	Upper six inches disturbed. Medium stiff, dry to slightly moist, light gray-brown, fine sandy silt (ML) with some coarse sand and fine to coarse gravel.
2 – 6'	Medium dense, slightly moist, light orange-brown, clayey fine sand (SC) with fine gravel.
6– 9'	Medium dense, dry to slightly moist, light brown-orange, well-graded fine to coarse sand (SW) with fine to coarse gravel.

Total depth = 9 feet.
Groundwater not encountered.
Backfilled with excavated soil.

LOGS OF TEST PITS 3 and 4

Volvo BL60B with a 24-inch Bucket

October 4, 2021

Test Pit 3

Depth (bgs)

Modesto Formation, Upper member

0 – 2½' Upper six inches disturbed. Medium stiff, dry to slightly moist, light gray-brown, fine sandy silt (ML) with some fine to coarse gravel.

2½ – 9½' Medium dense, slightly moist, light gray-brown, clayey, silty fine sand (SM). Clay content decreases with depth.

Total depth = 9½ feet.
Groundwater not encountered.
Backfilled with excavated soil.

Test Pit 4

Depth (bgs)

Artificial Fill

0 – 2' Upper six inches disturbed. Loose to medium dense, dry to slightly moist, gray-brown, silty fine to coarse sand (SM) and fine to coarse gravel, some fine roots.

Modesto Formation, Upper member

2 – 7½' Medium stiff, dry to slightly moist, light gray-brown, fine sandy silt (ML), few roots to five foot depth.

7½ – 10½' Stiff, slightly moist, mottled orange-brown, dark brown, and gray, fine sandy clay (CL).

Total depth = 10½ feet.
Groundwater not encountered.
Backfilled with excavated soil.

LOGS OF TEST PITS 5 and 6

Volvo BL60B with a 24-inch Bucket

October 4, 2021

Test Pit 5

Depth (bgs)

	Modesto Formation, Upper member
0 – 5'	Upper six inches disturbed. Medium stiff, dry to slightly moist, light gray-brown, fine sandy silt (ML) with some fine roots and scattered fine to coarse gravel.
5 – 10'	Medium dense, dry to slightly moist, light brown-orange, well-graded fine to coarse sand (SW) with fine to coarse gravel.

Total depth = 10 feet.
Groundwater not encountered.
Backfilled with excavated soil.

Test Pit 6

Depth (bgs)

	Artificial Fill
0 – 4'	Upper six inches disturbed. Medium dense, dry to slightly moist, light brown, well-graded fine to coarse sand with silt (SW-SM) with fine to coarse gravel, some fine roots and debris (concrete, asphalt).
	Modesto Formation, Upper member
4 – 7'	Medium dense, dry to slightly moist, brown-orange, well-graded fine to coarse sand (SW) with fine to coarse gravel, few cobbles.
7 – 9'	Medium dense, dry to slightly moist, well-graded fine to coarse sand with clay (SW-SC) and fine gravel.

Total depth = 9 feet.
Groundwater not encountered.
Backfilled with excavated soil.

MPE MID PACIFIC ENGINEERING, INC.	**LOGS OF TEST PITS 5 and 6** **PALM COMMUNITIES – RED BLUFF** 321 S. Jackson Street Red Bluff, California	**FIGURE 6** Date: 10/21 MPE No. 05694-01

LOG OF TEST PIT 7

Volvo BL60B with a 24-inch Bucket

October 4, 2021

Test Pit 7

Depth (bgs)

<u>Modesto Formation, Upper member</u>

0 – 4’ Upper six inches disturbed. Medium stiff, dry to slightly moist, light brown, fine sandy silt (ML) with some coarse sand, some porosity.

Total depth = 4 feet.
Groundwater not encountered.
Backfilled with excavated soil.

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS		SYMBOL	CODE	TYPICAL NAMES
COARSE GRAINED SOILS (More than 50% of soil > no. 200 sieve size)	GRAVELS (More than 50% of coarse fraction > no. 4 sieve size)	GW		Well graded gravels or gravel - sand mixtures, little or no fines
		GP		Poorly graded gravels or gravel - sand mixtures, little or no fines
		GM		Silty gravels, gravel - sand - silt mixtures
		GC		Clayey gravels, gravel - sand - silt mixtures
	SANDS (50% or more of coarse fraction < no. 4 sieve size)	SW		Well graded sands or gravelly sands, little or no fines
		SP		Poorly graded sands or gravelly sands, little or no fines
		SM		Silty sands, sand - silt mixtures
		SC		Clayey sands, sand clay mixtures
FINE GRAINED SOILS (More than 50% of soil < no. 200 sieve size)	SILTS & CLAYS LL< 50	ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
		CL		Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays
		OL		Organic silts and organic silty clays of low plasticity
	SILTS & CLAYS LL ≥ 50	MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH		Inorganic clays of high plasticity, fat clays
		OH		Organic clays of medium to high plasticity, organic silty clays, organic silts
HIGHLY ORGANIC SOILS		Pt		Peat and other highly organic soils
ROCK		RX		Rocks, weathered to fresh
FILL		FILL		Artificially placed fill material

OTHER SYMBOLS

= Drive Sample: 2-1/2" O.D. Modified California sampler

= Hand Driven Sample

=SPT Sampler

= Initial Water Level

= Final Water Level

= Estimated or gradational material change line

= Observed material change line

Laboratory Tests
- PI = Plasticity Index
- EI =Expansive Index
- UCC = Unconfined Compression Test
- TR = Triaxial Compression Test
- GR = Gradation Analysis (Sieve)
- K = Permeability Test

GRAIN SIZE CLASSIFICATION

CLASSIFICATION	RANGE OF GRAIN SIZES	
	U.S. Standard Sieve Size	Grain Size in Millimeters
BOULDERS	Above 12"	Above 305
COBBLES	12" to 3"	305 to 76.2
GRAVEL coarse (c) fine (f)	3" to No. 4 3" to 3/4" 3/4" to No. 4	76.2 to 4.76 76.2 to 19.1 19.1 to 4.76
SAND coarse (c) Medium (m) fine (f)	No. 4 to No. 200 No. 4 to No. 10 No. 10 to No. 40 No. 40 to No. 200	4.76 to 0.074 4.76 to 2.00 2.00 to 0.420 0.420 to 0.074
SILT & CLAY	Below No. 200	Below 0.074

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UNIFIED SOIL CLASSIFICATION SYSTEM
PALM COMMUNITIES - RED BLUFF
321 S. Jackson Street

FIGURE 8
Date: 10/21
MPE No. 05694-01

APPENDICES

APPENDIX A

APPENDIX A

A. GENERAL INFORMATION

The performance of a geotechnical engineering investigation for the proposed Palm Communities – Red Bluff project, located at 321 S. Jackson Street (APN 033-013-028) in Red Bluff, California, was authorized by Mr. Danavon L. Horn on September 14, 2021. Authorization was for an investigation as described in our proposal letter (MPE No 21-0329) of August 24, 2020 (revised September 10, 2021) sent to Mr. Erik Halter, Project Manager, Palm Communities.

In performing this investigation, we referenced Google Earth images containing the site, the *United States Geological Survey (USGS) 7.5-Minute Series Topographic Map Red Bluff East Quadrangle, California – Tehama County* (2018), and the *Geologic Map of the Red Bluff 30' x 60' Quadrangle, California* (2000) produced by the United States Geological Survey (USGS).

B. FIELD EXPLORATION

On October 4, 2021, seven exploratory test pits were excavated at the approximate locations indicated on the Test Pit Location Map (Figure 3) utilizing a Volvo BL60B backhoe equipped with a 24-inch bucket. The test pits were excavated to an approximate maximum depth of 10½ feet below existing site grades to obtain bulk samples for laboratory testing and to evaluate the condition of the on-site soils. During test pit excavation, the field engineering geologist logged the exposed soil conditions and visually classified the soils. At various depth intervals, bulk soil samples were recovered from the test pits. Collected soil samples were taken to our laboratory for additional classification and selection of samples for testing. The test pits were backfilled with on-site soils upon completion of excavation.

The Logs of Test Pits, Figures 4 through 7, contain descriptions of the soils encountered in each test pit. A Unified Soil Classification System showing the symbols used on the logs is contained on Figure 8.

C. LABORATORY TESTING

Expansion Index testing (ASTM D4829) was performed on one composite bulk sample of the near-surface soils. Test results are presented on Figure A1.

One representative bulk sample of anticipated pavement subgrade soils was subjected to Resistance-value ("R") testing in accordance with California Test 301. Results of the R-value test, which were used in the pavement design, are presented on Figure A2.

Two representative samples of on-site soil were tested by Sunland Analytical Lab to determine the preliminary corrosion characteristics of the soil (CT 417, 422 & 643). The results of the test are presented in the Geotechnical Engineering Report.

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EXPANSION INDEX TEST RESULTS
(ASTM D4829-03)
(UBC 18-2)

Material Description: Light orange-brown, clayey fine sand (SC) with fine gravel.
Location: TP-2 @ 2 - 5’

Sample Number	Pre-Test Moisture (%)	Post-Test Moisture (%)	Dry Density (pcf)	Expansion Index
Bag #3	9.6	9.8	112	0

CLASSIFICATION OF EXPANSIVE SOIL

EXPANSION INDEX	POTENTIAL EXPANSION
0 - 20	Very Low
21 - 50	Low
51 - 90	Medium
91 - 130	High
Above 130	Very High

RESISTANCE VALUE TEST RESULTS

(California Test 301)

Material Description: Light gray-brown, fine sandy silt (ML) with some coarse sand and fine to coarse gravel.

Location: TP-1 @ 0 – 3'

Specimen No.	Dry Unit Weight (pcf)	Moisture at Compaction (%)	Exudation Pressure (psi)	Expansion Pressure (psi)	R-Value
1	128.7	10.0	583	87	49
2	124.5	11.3	361	65	29
3	122.1	12.3	238	30	25

Resistance-value at 300 psi = 26

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RESISTANCE VALUE TEST RESULTS
PALM COMMUNITIES – RED BLUFF
321 S. Jackson Street
Red Bluff, California

FIGURE A2
Date: 10/21
MPE No. 05694-01

APPENDIX B

APPENDIX B

GUIDE EARTHWORK SPECIFICATIONS

PALM COMMUNITIES – RED BLUFF
321 S. Jackson Street
APN 033-130-028
Red Bluff, California
MPE No. 05694-01-01

PART 1: GENERAL

1.1 SCOPE

A. General Description

This item shall include clearing of all surface and subsurface structures including fences, surface debris, including all trees, vegetation, stockpiled soil, and any other items designated for removal; preparation of surfaces to be filled, including over-excavations, filling, spreading, compaction, observation and testing of the fill; and all subsidiary work necessary to complete the grading of the building area to conform with the lines, grades and slopes as shown on the accepted Drawings.

B. Related Work Specified Elsewhere

1. Trenching and backfilling for sanitary sewer system: Section ______.
2. Trenching and backfilling for storm drain system: Section ______.
3. Trenching and backfilling for underground water, natural gas, and electric supplies: Section ______.

C. Geotechnical Engineer

Where specific reference is made to "Geotechnical Engineer" this designation shall be understood to include either him or his representative.

1.2 PROTECTION

A. Adequate protection measures shall be provided to protect workers and passers-by at the site. Streets and adjacent property shall be fully protected throughout the operations.

B. In accordance with generally accepted construction practices, the Contractor shall be solely and completely responsible for working conditions at the job site, including safety of all persons and property during performance of the work. This requirement shall apply continuously and shall not be limited to normal working hours.

C. Any construction review of the Contractor's performance conducted by the Geotechnical Engineer is not intended to include review of the adequacy of the Contractor's safety measures, in, on or near the construction site.

D. Adjacent streets and sidewalks shall be kept free of mud, dirt or similar nuisances resulting from earthwork operations.

E. Surface drainage provisions shall be made during the period of construction in a manner to avoid creating a nuisance to adjacent areas.

F. The site and adjacent influenced areas shall be watered as required to suppress dust nuisance.

1.3 GEOTECHNICAL REPORT

A. A Geotechnical Engineering Report (MPE No. 05694-01; dated October 20, 2021) has been prepared for this site by Mid Pacific Engineering, Inc., Geotechnical Engineers. A copy is available for review at the office of Mid Pacific Engineering, Inc., 6310 State Highway 273, Anderson, California 96007.

B. The information contained in this report was obtained for design purposes only. The Contractor is responsible for any conclusions he/she may draw from this report; should the Contractor prefer not to assume such risk, he/she should employ their own experts to analyze available information and/or to make additional investigations upon which to base their conclusions, all at no cost to the Owner.

1.4 EXISTING SITE CONDITIONS

The Contractor shall be acquainted with all site conditions. If un-shown active utilities are encountered during the work, the Architect shall be promptly notified for instructions. Failure to notify will make the Contractor liable for damage to these utilities arising from Contractor's operations subsequent to the discovery of such un-shown utilities.

1.5 SEASONAL LIMITS

Fill material shall not be placed, spread or rolled during unfavorable weather conditions. When the work is interrupted by heavy rains or snow, fill operations shall not be resumed until field tests indicate that the moisture contents of the subgrade and fill materials are satisfactory.

PART 2: PRODUCTS

2.1 MATERIALS

A. All fill shall be of approved local materials from required excavations, supplemented by imported fill, if necessary. Approved local materials are defined as local granular soils free from significant quantities of rubble, rubbish and vegetation, and having been tested and approved by the Geotechnical Engineer prior to use. Clods, rocks or hard lumps exceeding three inches (3") in final size shall not be allowed in the upper 18 inches of any fill supporting pavements and structures. Expansive clays shall not be used within the upper twelve inches (12") of the building pad or exterior flatwork subgrades, or subgrades supporting at-grade structures, unless lime-treated.

B. Imported fill materials shall meet the above requirements; shall have plasticity indices not exceeding fifteen (15) when tested in accordance with ASTM D4318 test method; an Expansion Index less than twenty (20) when tested in accordance with ASTM D4829 test method; a Resistance (“R”)-value of ten (10) or greater; shall be of three-inch (3") maximum particle size; and, shall be approved by the Geotechnical Engineer prior to transportation to the project site.

C. Import fill shall be clean of contamination with appropriate documentation and shall have corrosion characteristics within acceptable limits. All imported materials shall be sampled, tested and approved by the Geotechnical Engineer prior to being transported to the site.

D. Asphalt concrete, aggregate base, aggregate subbase, and other paving products shall comply with the appropriate provisions of the *State of California (Caltrans) Standard Specifications*, latest editions.

PART 3: EXECUTION

3.1 LAYOUT AND PREPARATION

Lay out all work, establish grades, locate existing underground utilities, set markers and stakes, set up and maintain barricades and protection of utilities--all prior to beginning actual earthwork operations.

3.2 CLEARING, GRUBBING AND PREPARING BUILDING PADS AND PAVEMENT AREAS

A. The site shall be cleared of trees, vegetation, stockpiled soil, and structures designated for removal including but not limited to, concrete slabs, retaining walls, septic tanks and leach fields, utilities to be relocated or abandoned including backfill, debris, rubbish, rubble, and other unsuitable materials. Exposed remnants, rubble and debris shall be removed from the subgrades. Hand picking of exposed roots, rubble and debris shall be performed by the Contractor to adequately clear the grades. Subsurface utilities to be relocated or abandoned shall be removed from within and to at least five feet beyond the perimeter of the proposed structural areas; utilities located outside the building area should be properly abandoned (i.e., fully grouted provided the abandoned utility is situated at least 2½ feet below the final subgrade level to reduce the potential for localized "hard spots). Excavations and depressions resulting from the removal of such items, as well as any existing excavations or loose soil deposits, as determined by the Geotechnical Engineer, shall be cleaned out to firm, undisturbed soil and backfilled with suitable materials in accordance with these specifications.

B. Following site clearing operations, over–excavations shall be performed to the depths and lateral extents as recommended in the Geotechnical Engineering Report. Hand picking and/or screening of roots, rubble and debris shall be performed by the Contractor to adequately clear the soils proposed for use in engineered fill construction.

C. Cut portions of building pads consisting of both cut and fill (cut/fill transitions) should be over-excavated so that the difference in fill depths across the pads is less than five feet in vertical extent.

D. Exposed subgrades shall be scarified to a minimum depth of eight inches as recommended in the Geotechnical Engineering Report and until the surface is free from ruts, hummocks or other uneven features which would tend to prevent uniform compaction by the selected equipment.

E. Subgrade preparation and compaction shall extend at least five feet (5') beyond the proposed structure or fill boundary lines, or as required by the Geotechnical Engineer based on the exposed soil and site conditions.

F. When the moisture content of the subgrade is below that required to achieve the specified density, and that minimum content recommended in the geotechnical report, water shall be added until the proper moisture content is achieved.

G. When the moisture content of the subgrade is too high to permit the specified compaction to be achieved, the subgrade shall be aerated by blading or other methods until the moisture content is satisfactory for compaction.

H. After the foundations for fill have been cleared, plowed or scarified, they shall be disced or bladed until uniform and free from large clods, brought to the proper moisture content and compacted to not less than ninety percent (90%) of the maximum dry density as determined by the ASTM D1557 Compaction

Test. Soils compaction shall be performed using a heavy, self-propelled sheepsfoot compactor capable of providing adequate compaction (Caterpillar CS78B or equivalent size). Compaction operations shall be performed in the presence of the Geotechnical Engineer who will evaluate the performance of the materials under compactive load. Wet, soft or unstable soil deposits, as determined by the Geotechnical Engineer, shall be excavated to depths that expose a firm base and grades restored with engineered fill in accordance with these specifications.

3.3 PLACING, SPREADING AND COMPACTING FILL MATERIAL

A. Engineered fills shall be placed in layers which when compacted shall not exceed six inches (6") in thickness. Each layer shall be spread evenly and shall be thoroughly mixed during the spreading to promote uniformity of material in each layer.

B. When the moisture content of the fill material is below that required to achieve the specified density, and that minimum content recommended in the geotechnical report, water shall be added until the proper moisture content is achieved.

C. When the moisture content of the fill material is too high to permit the specified degree of compaction to be achieved, the fill material shall be aerated by blading or other methods until the moisture content is satisfactory.

D. After each layer has been placed, mixed and spread evenly, soils shall be thoroughly compacted to at least ninety percent (90%) of the ASTM D1557 maximum dry density. Soils compaction shall be performed using a heavy, self-propelled sheepsfoot compactor, to the satisfaction of our on-site representative. Each layer shall be compacted over its entire area until the desired density has been obtained. Fills deeper than five feet (5') below final design grades shall be compacted to at least ninety-five percent (95%) of the ASTM D1557 maximum dry density.

E. Fills placed on or adjacent to sloping ground or where fill slopes are to be constructed shall begin with a base key as required in the Geotechnical Engineering Report. Fills placed on or adjacent to existing slopes, or excavation slopes for over- excavation, shall be properly benched into the side slope, as required by the Geotechnical Engineering Report and as recommended by the Geotechnical Engineer at the time of construction.

F. The filling operations shall be continued until the fills have been brought to the finished slopes and grades as shown on the accepted Drawings.

3.4 FINAL SUBGRADE PREPARATION

A. The upper twelve inches (12") of final building pad subgrade and subgrades supporting exterior concrete flatwork or at-grade structures shall consist of approved on-site or imported granular, non-expansive soils or aggregates placed and compacted as engineered fill. Final building pad and flatwork subgrades slabs shall be brought to a uniform moisture content of at least the optimum, and shall be uniformly compacted to at least ninety percent (90%) relative compaction.

B. The upper six inches (6") of final pavement subgrades and exterior slabs subgrades supporting vehicular traffic shall be brought to a uniform moisture content of at least the optimum moisture content and shall be uniformly compacted to at least ninety-five percent (95%) relative compaction, regardless of whether final subgrade elevations are attained by filling, excavation, or are left at existing grades. Pavement subgrades shall be proof-rolled in the presence of the Geotechnical Engineer prior to placement of aggregate base and shall be stable under construction equipment traffic.

3.5 TRENCH BACKFILL

Utility trench backfill shall be placed in lifts of no more than six inches (6") in compacted thickness. Each lift shall be compacted to at least ninety percent (90%) compaction, as defined by ASTM D1557. The upper six inches (6") of trench backfill supporting pavement sections shall be compacted to at least ninety-five percent (95%) relative compaction. The upper twelve inches (12") of trench backfill shall match the materials used to construct final building pad subgrade and subgrades supporting exterior concrete flatwork or at-grade structures.

3.6 TESTING AND OBSERVATION

A. Grading operations shall be observed by the Geotechnical Engineer, serving as the representative of the Owner.

B. Field density tests shall be made by the Geotechnical Engineer after compaction of each layer of fill. Additional layers of fill shall not be spread until the field density tests indicate that the minimum specified density has been obtained.

C. Earthwork shall not be performed without the notification or approval of the Geotechnical Engineer. The Contractor shall notify the Geotechnical Engineer at least two (2) working days prior to commencement of any aspect of the site earthwork.

D. If the Contractor should fail to meet the technical or design requirements embodied in this document and on the applicable plans, the Contractor shall make the necessary readjustments until all work is deemed satisfactory, as determined by the Geotechnical Engineer and the Project Design Engineer. No deviation from the specifications shall be made except upon written approval of the Geotechnical Engineer or Project Design Engineer.

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