GEOTECHNICAL REPORT

PROPERTY AT BRUCE ROAD & HIGHWAY 32
CITY OF CHICO, CALIFORNIA

Prepared For:

FIFTH SUN, LLC

CGI TECHNICAL SERVICES INC.

Attachment B

CGI Technical Services Inc.

August 31, 2015
CGI: 15-2109.02

Mr. Daniel Gonzales
Fifth Sun, LLC
495 Ryan Avenue
Chico, CA 95973

Subject: **IBC/CBC Soils Report**
Property at Bruce Road and Deer Creek Highway (Hwy 32)
Chico, Butte County, California

Dear Mr. Gonzales:

CGI Technical Services, Inc.'s (CGI), is pleased to present this geotechnical study for a property at the intersection of Bruce Road and Deer Creek Highway (Hwy 32) in Chico, California, as shown on Plate 1 – Site Location Map. The purpose of our investigation was to observe site geologic conditions, evaluate the materials observed, and provide recommendations related to soils aspects of future project design and construction in accordance with requirements of portions of Chapter 16 and Chapter 18 of the 2012 International Building Code (IBC) and 2013 California Building Code (CBC). Our scope of work only includes items specifically addressed within this letter.

1.1 PROJECT UNDERSTANDING

The final proposed development scheme for the project is unknown at the time of preparation of this report. However, we understand that the development will consist of mixed use development/office buildings. Also, we understand any future development will consist of up to two-story, steel or wood framed structures with slab-on-grade. Associated with development of the structures will be construction of parking area, sidewalks and hardscaping, landscaping and other ancillary improvements.

Foundation loads for the structure are unknown; however, those loads are anticipated to be relatively light. It is assumed that the structure will be constructed on shallow foundations (spread footings) and that foundation loads will not exceed about 5 kips per lineal foot and 15 kips for continuous and isolated foundations, respectively.

1.2 PREVIOUS WORK PERFORMED

CGI knows of no previous geotechnical reports that have been prepared for this site.

1.3 SCOPE OF SERVICES

Our scope of services for this project included the following:

- Reconnaissance of the site surface conditions, topography, soils and geology, and existing drainage features.

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Attachment B

- Excavation of eleven exploratory test pits at selected locations on the project property, as shown on Plate 2. Exploration procedures and Logs of Test Pits are presented in Appendix A;
- Performance of laboratory testing on selected samples obtained during our field investigation. Laboratory test procedures and results of those tests are presented in Appendix B – Laboratory Testing;
- Preparation of this report, which includes:
    - A description of the proposed project;
    - A description of site geological conditions encountered during our site observation;
    - Recommendations for:
        - Site preparation, engineered fill, subdrains, and subgrades;
        - Suitability of on-site materials for use as engineered fill;
        - 2013 CBC seismic design criteria;
        - Temporary excavations, shoring, and trench backfill;
        - Allowable bearing capacities and class of soil type for foundation design and construction; and
        - Structural pavement design.
    - Appendices that present a summary of our field investigation procedures and laboratory testing programs.

2.0 SITE CONDITIONS

2.1 SURFACE CONDITIONS

The project site is currently fallow, covered with seasonal grasses and weeds. The site is bounded to the east by a private property, to the north and west by City streets, and to the south by Highway 32. Trees and shrubs exist along the property limits, mainly at the western side. Concrete box inlets were observed along the southern property margins of the property.

A stockpile of soil, about 275 feet long, 125 feet wide and approximately 12 to 15 feet high exists at the middle of the property. Boulders of volcanic rock are present at the western side of the soil stockpile and along the southern and western property lines.

A drainage channel along the western and southern margin of the property appears to be an overflow to the man-made California Park Lake located to the north of the property.

Review of available aerial photographs indicates that the site was not developed or occupied by any structures and took its actual shape sometime between 1984 and 1998 after the construction of California Park Lake. The existing stockpile of soils was placed in the center of the property around

2006 and the soils could be generated during the construction of Butte Regional Transit across the street (Sierra Sunrise Terrace) to the north.

The overall site gradient slopes gently to the southeast where it drains under Highway 32 into the Little Chico Creek. The site elevation is approximately 252 feet above mean sea level (MSL).

2.2 REGIONAL GEOLOGIC SETTING

The project site is located in the northern Sacramento Valley within the Great Valley Physiographic province. The Great Valley province is bordered to the north by the Klamath and Cascade Physiographic provinces, to the east by the Cascade and Sierra Nevada Physiographic provinces, to the west by the Klamath and Coast Ranges Physiographic provinces, and to the south by the Transverse Ranges Physiographic province.

The Great Valley Physiographic province is about 50 miles wide and 400 miles long. The Sacramento Valley, which forms the northern portion of the province, is about 150 miles long and 40 miles wide (Hinds, 1952). According to Hackel (1966), "The Great Valley is a large elongate northwest-trending asymmetric structural trough that has been filled with a tremendously thick sequence of sediments ranging from Jurassic to recent." Sediment thicknesses of up to 10 miles are reported within the Sacramento Valley; however, in the project area, being at the eastern margin of the valley, those thicknesses have been projected to be less than one mile (Hackel, 1966). Sediments within the Great Valley consist of both marine and continental deposits, with most of the sediments underlying the project area consisting of continental deposits.

2.3 SUBSURFACE SOIL CONDITIONS

As shown on Plate 3 – Regional Geologic Map, the project site has been mapped as being underlain by the Modesto Formation (Helley & Harwood, 1985). However, the site exploration indicates that the site is underlain by the Tuscan Formation. This difference is most likely related to the scale of the map and the location of the site near the transition from one formation to another. The Pliocene-age Tuscan Formation at this location consists of lahar deposits, which are volcanic mudflows carrying soil, volcanic rock, and debris as a viscous mass. It is thought that lahar deposits of the Tuscan Formation are derived from the ancestral Mt. Tehama, which was the ancestral taller and more volumous volcanic center residing in the area of the current Lassen Peak. Artificial fill was encountered in the middle of the property.

The subsurface soil conditions were explored by CGI on July 14, 2015, by excavating eleven test pits to a maximum depth of approximately 10 feet beneath the existing ground surface. Seven test pits (TP-1 through TP-7) were excavated to explore the onsite materials and four test pits (TP-8/F1 through TP-11/F4) were excavated to explore the existing stockpile of soils in the middle of the property. The test pit locations excavated for this study are shown on Plate 2. The onsite soils were low to medium plasticity, dark brown gravelly clay with cobbles and scattered boulders. The soils in the stockpile are similar to the onsite material and appear to be derived from a nearby site, most likely the Butte Regional Transit site across the street (Sierra Sunrise Terrace) to the north. Logs of test pits are included in Appendix A of this report.

2.4 GROUNDWATER

Groundwater was not encountered in the test pits that were excavated for this study. Groundwater elevations can vary throughout the year and from year to year. Intense and long duration precipitation, modification of topography, and cultural land use changes at the site and at surrounding properties, such as irrigation, water well usage, on site waste disposal systems, utility/pond leakage, and water diversions can contribute to fluctuations in groundwater levels. Localized saturated conditions or perched groundwater conditions near the ground surface could be present during and following periods of heavy precipitation or if on-site sources contribute water. If groundwater is encountered during construction, it is the Contractor's responsibility to install mitigation measures for adverse impacts caused by groundwater encountered in excavations.

2.5 SEISMIC SETTING AND CBC SEISMIC DESIGN PARAMETERS

The State of California designates faults as active, potentially active, and inactive depending on the recency of movement that can be substantiated for a fault. Fault activity is rated as follows:

Fault Activity Ratings

Fault Activity Rating	Geologic Period of Last Rupture	Time Interval (Years)
Active	Holocene	Within last 11,000 Years
Potentially Active	Quaternary	11,000 to 1.6 Million Years
Inactive	Pre-Quaternary	Greater than 1.6 Million Years

The California Geologic Survey (CGS) evaluates the activity rating of a fault in fault evaluation reports (FER). FERs compile available geologic and seismologic data and evaluate if a fault should be zoned as active, potentially active, or inactive. If an FER evaluates a fault as active, then it is typically incorporated into a Special Studies Zone in accordance with the Alquist-Priolo Earthquake Hazards Act (AP). AP Special Studies Zones require site-specific evaluation of fault location and require a structure setback if the fault is found traversing a project site.

The site is not located within an Alquist-Priolo Earthquake Fault Zone and no active faults are known to pass through the project site (Jennings, 1994; Hart & Bryant, 1997). However, a number of regional and local faults traverse the project region. The most significant of these faults is the potentially active Chico Monocline fault, located about 1.5 miles east of the site (Jennings, 1994). The closest active fault, as zoned by the State, is the Cleveland Hill Fault, located about 25 miles southeast of the site.

Historically over the last 100 years, one earthquake with local magnitudes (ML) equal or greater than 5.0 has occurred within about 60 miles of the site, based on a search of selected earthquake catalogs (Real, 1978 and USGS, 1973 to present). The most recent significant earthquake to affect the project area was an earthquake with a moment magnitude (Mw) of 5.7 that occurred on August 1, 1975 about 25 miles southeast of the site.

At a minimum, structures should be designed in accordance with the 2013 California Building Code (CBC) criteria. CBC-based design requires the definition of the following seismic parameters: Site

Class Designation; Site Coefficients (F_a and F_v); Mapped spectral accelerations for short periods (S_s); and Mapped spectral accelerations for a 1-second period (S_1).

CBC SEISMIC DESIGN PARAMETERS

Parameter	CBC Designation
Site Class Designation	D
Mapped Spectral Acceleration, S_s	0.616g
Mapped Spectral Acceleration, S_1	0.271g
Site Coefficient, F_a	1.307
Site Coefficient, F_v	1.858

2.6 LANDSLIDING

The site is located on a relatively flat lot. Short and gently inclined slopes exist along the edges of the drainage channel at the western and southern margins of the property. No signs of landsliding, either former or incipient, were observed on or adjacent to the project property. It is our opinion that natural landslides pose a low risk to the project.

2.7 LIQUEFACTION

Liquefaction is described as the sudden loss of soil shear strength due to a rapid increase of soil pore water pressures caused by cyclic loading from a seismic event. In simple terms, it means that a liquefied soil acts more like a fluid than a solid when shaken during an earthquake. In order for liquefaction to occur, the following are needed:

- Granular soils (sand, silty sand, sandy silt, and some gravels);
- A high groundwater table; and
- A low density in the granular soils underlying the site.

If those criteria are present, then there is a potential that the soils could liquefy during a seismic event.

Soils encountered during this study are estimated to have a low potential for liquefaction. This opinion is made based on the following:

1. The soils have high fines content; and
2. The soils are stiff/dense.

2.8 SOIL CHEMISTRY

Two selected samples of near-surface soils encountered at the site was subjected to chemical analysis for the purpose of assessment of corrosion and reactivity with concrete. The sample was tested for soluble sulfates and chlorides, pH and resistivity. Testing was conducted by HDR of Claremont and results are presented below, as well as included in the appendix of laboratory results.

SOIL CHEMISTRY RESULTS

Sample	Sample Depth	Sulfates (ppm)	Chlorides (ppm)	pH	Resistivity (ohms-cm)
TP-5	0 to 3'	6.2	9.9	7.4	2,880
TP-9 (F2)	3' to 5'	15	7.5	6.7	3,720

According to the American Concrete Institute ([ACI], 2011), a sulfate concentration below 0.10 percent by weight (1,000 ppm) is negligible. A chloride content of less than 500 ppm is generally considered non-corrosive to reinforced concrete.

Saturated resistivity testing performed on the soil sample indicated the soils are considered to be moderately corrosive to buried metal objects. A commonly accepted correlation between soil resistivity and corrosivity towards ferrous metals (NACE, 1984) is provided below:

RESISTIVITY & CORROSION CORRELATION

Minimum Resistivity (ohm-cm)	Corrosion Potential
0 to 1000	Severely Corrosive
1,000 to 2,000	Corrosive
2,000 to 10,000	Moderately Corrosive
Over 10,000	Mildly Corrosive

Thus, according to the table above, the soils are estimated to be moderately corrosive based upon the soil resistivity.

It is our understanding that engineered fill materials will be placed to establish grades. We recommend that verification samples be tested to confirm that soils in contact with concrete and steel have similar or lower corrosion potential characteristics as the sample tested for this study.

2.9 EXPANSIVE SOILS

There is a direct relationship between plasticity of a soil and the potential for expansive behavior, with expansive soil generally having a high plasticity. Thus, granular soils typically have a low potential to be expansive, whereas, clay-rich soils can have a low to high potential to be expansive. Atterberg limit testing performed on two selected samples recorded plasticity indices (PI) ranging from 12 to 23. Soils with PIs in that range correlate to soils having low to medium expansion potential (Day, 1999).

3.0 CONCLUSIONS AND RECOMMENDATIONS

3.1 CBC/IBC INFORMATION

This section presents relevant information regarding soils as pertaining to Chapter 18 of the 2012 IBC and the 2013 CBC. Chapter 18 in each of these documents are identical, thus, we will refer to the CBC only throughout the remainder of this report. Potential geologic hazards consisting of landsliding, liquefiable soils, and expansive soils, as noted in Section 1802 of the CBC, are discussed above in Sections 2.7, 2.8, and 2.9, respectively, of this report. The following sections present soils information from the CBC that could impact design of the project.

3.1.1 Class of Materials

As previously noted, the soils on site consist of gravelly clay to clayey gravel. In our opinion, those materials correspond to a Class of Materials Type 5 as noted in Table 1806.2 of the CBC. That table presents presumptive foundation design information associated with Class of Materials types.

Isolated and continuous footing elements should be proportioned for dead loads plus probable maximum live load, and a maximum allowable bearing pressure of 1,500 pounds per square foot (psf). The allowable bearing capacity can be increased by 150 psf for every additional foot of embedment beneath the minimum specified CBC foundation depth, up to a maximum allowable bearing capacity of 1.5 times the allowable bearing capacity.

3.1.2 Depth and Width of Foundations

We recommend that minimum foundation depths and widths, unless noted elsewhere herein, be designed in accordance with specified widths and depths noted in Table 1809.7 of the CBC.

We recommend that foundations be founded either entirely in cut or entirely in engineered fill material to reduce differential settlement potentials. **<u>Foundations should not span both cuts and fills.</u>** If proposed foundations span both cuts and fills, and fill materials exceed 1 foot beneath the planned bottom of foundations, we recommend that:

- The area of cuts supporting the proposed foundations should be overexcavated below the planned bottom of footings to a depth of at least 3 times the width of the foundation. CGI should observe and approve the overexcavated area once exposed. Overexcavation limits should extend throughout the cut area and to a minimum of five horizontal feet past the perimeter foundations of the structure. The overexcavated area should then be backfilled in accordance with recommendations presented in Section 3.3 of this report; or

- Proposed foundations should be deepened to extend through engineered fill materials to be supported on competent undisturbed native soils, so that the entire foundation system for the structure rests on undisturbed native soils. If this depth is less than 5 feet below the planned bottom of the foundation, then a two-sack sand-cement slurry can be used as backfill in lieu of structural concrete, from the excavation bottom up to the planned bottom of the proposed foundation. CGI should observe and approve the deepened foundation excavation prior to placement of slurry or structural concrete.

If foundations do not span both cuts and fills, then neither of the two alternatives recommended noted above should be necessary.

3.1.3 Frost Penetration

It should be noted that frost heave is not typically a hazard in the Chico area and is generally not considered in design of foundation systems. Therefore, no recommendations for frost protection have been provided herein.

3.2 SITE PREPARATION AND GRADING

3.2.1 Stripping

Prior to general site grading and/or construction of planned improvements, existing vegetation, organic topsoil, debris, ashes, and deleterious materials should be stripped and disposed of off-site or outside the construction limits. Any tree or shrub root balls encountered during stripping could extend deep below grade and should be removed during stripping. Stripped topsoil (less any debris, boulders or large tree roots) may be stockpiled and reused for landscape purposes; however, this material should not be incorporated into any engineered fill.

3.2.2 Existing Utilities, Wells, and/or Foundations

Below-grade utility lines, cesspools, wells, irrigation ponds and/or foundations encountered during construction should be removed and disposed of off-site. Buried tanks, if present, should be removed in compliance with applicable regulatory agency requirements. Existing, below-grade utility pipelines (if any) that extend beyond the limits of the proposed construction and will be abandoned in-place should be plugged with lean concrete or grout to prevent migration of soil and/or water. All excavations resulting from removal and demolition activities should be cleaned of loose or disturbed material prior to placing any fill or backfill.

3.2.3 Overexcavation

Overexcavation is not anticipated for this site; however, if during construction, areas containing debris, deleterious materials, and concentrations of organics are encountered, they should be overexcavated and replaced with engineered fill to reduce total and/or differential settlement beneath the structure as discussed in Section 3.1.2 of this report.

Overexcavated areas should be observed and approved by a CGI engineering geologist or geotechnical engineer prior to placement of engineered fill materials. Engineered fill materials should be placed and compacted in accordance with recommendations made in Section 3.3.4 of this report.

3.2.4 Scarification and Compaction

Following site stripping and overexcavation, areas to receive engineered fill should be scarified to a depth of 8 inches, uniformly moisture-conditioned to near optimum moisture content, and compacted to at least 90 percent of the maximum dry density as determined using standard test method ASTM D1557[1].

3.2.5 Wet/Unstable Soil Conditions Overexcavation

If site preparation or grading is performed in the winter, spring, or early summer seasons, or shortly after significant precipitation, near-surface on-site soils may be significantly over optimum moisture content. This condition could hinder equipment access as well as efforts to compact site soils to a specified level of compaction. In addition, perched water can be present in subsurface layers throughout the year and contribute to wet soil conditions. If over optimum soil moisture content conditions are encountered during construction, disking to aerate, replacement with imported material, chemical treatment, stabilization with a geotextile fabric or grid, and/or other methods will likely be required to facilitate earthwork operations. The applicable method of stabilization is the contractor's responsibility and will depend on the contractor's capabilities and experience, as well as other project-related factors beyond the scope of this investigation. Therefore, if over-optimum moisture within the soil is encountered during construction, CGI should review these conditions (as well as the contractor's capabilities) and, if requested, provide recommendations for their treatment.

3.2.6 Site Drainage

Finished grading should be performed in such a manner that provides a minimum of 10 horizontal feet of positive surface gradients away from all structures. The ponding of water should not be allowed adjacent to structures or fill slopes. Surface runoff should be directed toward engineered collection systems or suitable discharge areas. Roof downspouts should also be collected, conveyed, and discharged away from all structures and into engineered systems, such as storm drains.

3.3 ENGINEERED FILL

3.3.1 On-Site Soil Materials

It is our opinion that most of the near-surface soils encountered at the site including the stockpile can be used for general engineered fill provided it is free of organics, debris, oversized particles (>3") and deleterious materials. If highly plastic clayey materials (materials having a plasticity index exceeding 25 and a liquid limit in excess of 50) are encountered during grading, those materials should be segregated and excluded from engineered fill, where possible, or thoroughly mixed with granular materials to reduce the plasticity of the soil. The existing artificial fill materials encountered during exploration can also be re-used as engineered fill provided those materials are screened of organics, woody debris, refuse, and deleterious materials. If potentially unsuitable soil is considered for use as engineered fill, CGI should observe, test, and provide recommendations as to the suitability of the material prior to placement as engineered fill.

3.3.2 Imported Fill Materials - General

All imported engineered fill should consist of soil and/or soil-aggregate mixtures generally less than 3 inches in maximum dimension, free of visible organic or other deleterious debris, and essentially non-

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[1] This test procedure applies wherever relative compaction, maximum dry density, or optimum moisture content is referenced within this letter.

plastic. Typically, well-graded mixtures of gravel, sand, non-plastic silt, and small quantities (less than 15 percent) of clay are acceptable for use as imported engineered fill. Imported fill materials should be sampled and tested prior to importation to the project site to verify that those materials meet recommended material criteria noted below. Specific requirements for imported fill materials, as well as applicable test procedures to verify material suitability are as follows:

IMPORTED FILL RECOMMENDATIONS				
GRADATION				
Sieve Size	**General Fill**	**Granular Fill**	**Test Procedures**	
	Percent Passing		**ASTM**	**AASHTO**
3-inch	100	100	D422	T88
¾-inch	70 – 100	70 – 100	D422	T88
No. 200	0 - 30	<5	D422	T88
PLASTICITY				
Liquid Limit	<30	NA	D4318	T89
Plastic Index	<12	Nonplastic	D4318	T90
ORGANIC CONTENT	<3%	<3%	D2974	NA

3.3.3 Granular Fill

All granular fill should consist of imported soil mixtures less than 3 inches in maximum dimension, free of visible organic or other deleterious debris, and essentially non-plastic. Specific requirements for granular fill, as well as applicable test procedures to verify material suitability are noted in the table in Section 3.3.2, above.

3.3.4 Placement and Compaction

Soil and/or soil-aggregate mixtures used for fill should be uniformly moisture-conditioned to within 2 percent of optimum moisture content, placed in horizontal lifts less than 8 inches in loose thickness, and compacted to at least 90 percent relative compaction. It is recommended that the fill slopes be overbuilt by at least one horizontal foot then trimmed to expose a firm, compacted surface. Testing should be performed to verify that the relative compaction is being obtained as recommended herein. Compaction testing, at a minimum, should consist of one test per every 500 cubic yards of soil being placed or at every 1.5-foot vertical fill interval, whichever comes first.

In general, a "sheep's foot" or "wedge foot" compactor should be used to compact fine-grained fill materials. A vibrating smooth drum roller could be used to compact granular fill materials and final fill surfaces.

3.4 SLAB-ON-GRADE DESIGN

All ground-supported slabs should be designed by a Civil Engineer to support the anticipated loading conditions. Reinforcement for slabs should be designed by a Civil Engineer to maintain structural integrity, and should not be less than that required to meet pertinent code, shrinkage, and temperature requirements. Reinforcement should be placed at mid-thickness in the slab with provisions to ensure it stays in that position during construction and concrete placement.

The mat can be designed using a flat slab on an elastic half-space analog. A modulus of subgrade reaction (ks_1) of 100 kcf is recommended for design of mat-type foundations. That modulus of subgrade reaction value represents a presumptive value based on soil classification. No plate-load tests were performed as part of this study. The modulus value is for a 1-foot-square plate and must be corrected for mat size and shape, assuming a cohesive subgrade.

Subgrade soils supporting interior concrete floor slabs should be scarified to a minimum depth of 8 inches, uniformly moisture-conditioned to near the optimum moisture content, and compacted to at least 90 percent relative compaction.

3.4.1 Rock Capillary Break/Vapor Barrier

Interior concrete floor slabs supported-on-grade should be underlain by a capillary break consisting of a blanket of compacted, free-draining, durable rock at least 4 inches thick, graded such that 100 percent passes the 1-inch sieve and less than 5 percent passes the No. 4 sieve.[2] Furthermore, a vapor barrier should be placed beneath all interior concrete floor slabs supported-on-grade that will be covered with moisture-sensitive equipment or floor coverings. This barrier may consist of a plastic or vinyl membrane placed directly over the rock capillary break. The vapor barrier should be sealed around all penetrations, including utilities. If a vapor barrier is not installed, there is a risk of moisture vapors and salts penetrating the slab-on-grade. For this project, equipment and flooring materials on slabs-on-grade are unknown. It is our recommendation that American Concrete Institute (ACI) guidelines ACI 302 and ACI 360 be referred to regarding installation of vapor barriers based on the anticipated flooring materials to be installed.

A capillary break and/or vapor barrier may not be required for some types of construction (such as equipment buildings, warehouses, garages, and other uninhabited structures insensitive to water intrusion and/or vapor transmission through the slab). For these types of structures, the gravel capillary break and/or vapor barrier recommended above may be omitted and the slab placed directly on the prepared subgrade or other approved surface if it is determined by the civil engineer and architect that water vapors will not adversely affect improvements resting on the slab-on-grade. In the event a capillary break and/or vapor barrier is not to be used, CGI should review the planned structure in order to assess the applicability of the approach and provide (if necessary) additional recommendations regarding subgrade preparation and/or support.

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[2] In general, Caltrans Class 2 aggregate base (or similar material) does not meet the requirements provided above for a capillary break. Therefore, we recommend this material <u>not</u> be used for a capillary break beneath interior concrete slabs supported-on-grade.

3.5 PAVEMENT DESIGN

3.5.1 R-Values

One R-value test was on a selected sample of on-site soils. Results of that test reported an R-value of 24. If construction R-values are significantly different than the R-value used, then the pavement design can be modified at that time to reflect the constructed conditions.

3.5.2 Subgrade Preparation

All subgrade soils should be scarified to a minimum depth of 1-foot, moisture conditioned as necessary to near optimum moisture conditions and compacted to a minimum of 95 percent of the maximum dry density as determined by AASHTO (American Association of State Highway and Transportation Officials) Test Method T-180. The subgrade should be smooth and unyielding prior to the placement of aggregate base rock. Density testing and proof rolling of the subgrade using a loaded water truck should be performed with satisfactory results prior to placement of the aggregate base rock. Concrete curbs and landscape planters that border pavement sections should be embedded into the subgrade soils a minimum of 2 inches to reduce the migration of meteoric and irrigation water into the pavement section.

3.5.3 Aggregate Base

The aggregate baserock (AB) should be of such quality as to meet or exceed Caltrans specifications for Class 2 AB and should have a minimum R-value of 78. The AB should be spread in thin lifts restricted to 8 inches in loose thickness or less, moisture conditioned as necessary to near optimum moisture content and compacted to a minimum of 95 percent of the maximum dry density as determined by AASHTO T-180. Density testing and/or proof rolling should be performed prior to placement of the asphalt paving.

3.5.4 Asphalt Concrete Paving

R-value of 24 was used for this study. To provide recommendations for structural pavement sections, we evaluated design criteria for three TIs ranging from 4.0 to 6.0. Using those criteria, we have prepared AC structural pavement section recommendations. Recommendations for full depth AC, and AC and AB sections are provided in the following table:

MINIMUM RECOMMENDED STRUCTURAL PAVEMENT SECTIONS(1)			
Section	**Traffic Index**	**Type B AC Thickness (in)**	**Class 2 AB Thickness (in)**
Full Depth AC	4.0	5.0	- - -
	5.0	6.5	- - -
	6.0	8.0	- - -
AC and AB	4.0	2.0	6.0
	5.0	2.5	8.0
	6.0	3.0	9.5

(1) Asphalt paving materials and equipment should meet or exceed current Caltrans specifications.

4.0 LIMITATIONS

This letter has been prepared in substantial accordance with requirements specified in the 2012 IBC and 2013 CBC. No other warranty, either express or implied, is made. Conclusions and recommendations contained in this letter were based on the conditions encountered during our field observations and are applicable only to those project features described herein (see the Proposed Project section). It is possible subsurface conditions could differ from surface exposures. If conditions are encountered during construction that differ from those described in this letter, or if the scope or nature of the proposed construction changes, we should be notified immediately in order to review and, if deemed necessary, conduct additional studies and/or provide supplemental recommendations.

This letter may be used only by our client and their agents and only for the purposes stated herein, within a reasonable time from its issuance. Land use, site conditions, and other factors may change over time that may require additional studies. In the event a significant period of time elapses between the issuance date of this letter and construction, CGI shall be notified of such occurrence in order to review current conditions. Depending on that review, CGI may require that additional studies be conducted and that an updated or revised letter is issued.

Any party other than our client who wishes to use all or any portion of this letter shall notify CGI of such intended use. Based on the intended use as well as other site-related factors, CGI may require that additional studies be conducted and that an updated or revised letter be issued. Failure to comply with any of the requirements outlined above by the client or any other party shall release CGI from any liability arising from the unauthorized use of this letter.

We appreciate the opportunity to perform this study and assist you with this project. If you have any questions pertaining to this letter, or if we may be of further service, please contact us at (530) 244-6277 at your earliest convenience.

Regards,

CGI Technical Services, Inc.

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Attachments: Plate 1 – Site Location Map
Plate 2 – Geotechnical Map
Plate 3 – Geologic Map

Copies: Client (3) three hardcopies with one PDF file delivered electronically

REFERENCES

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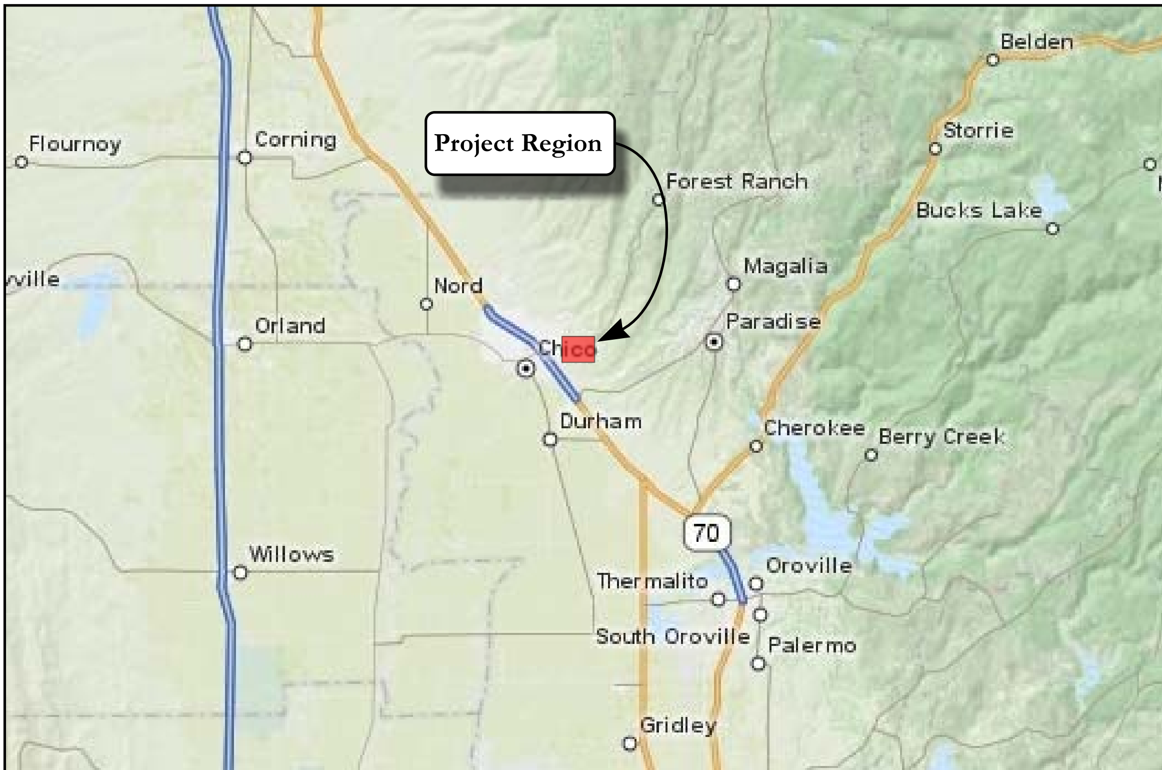
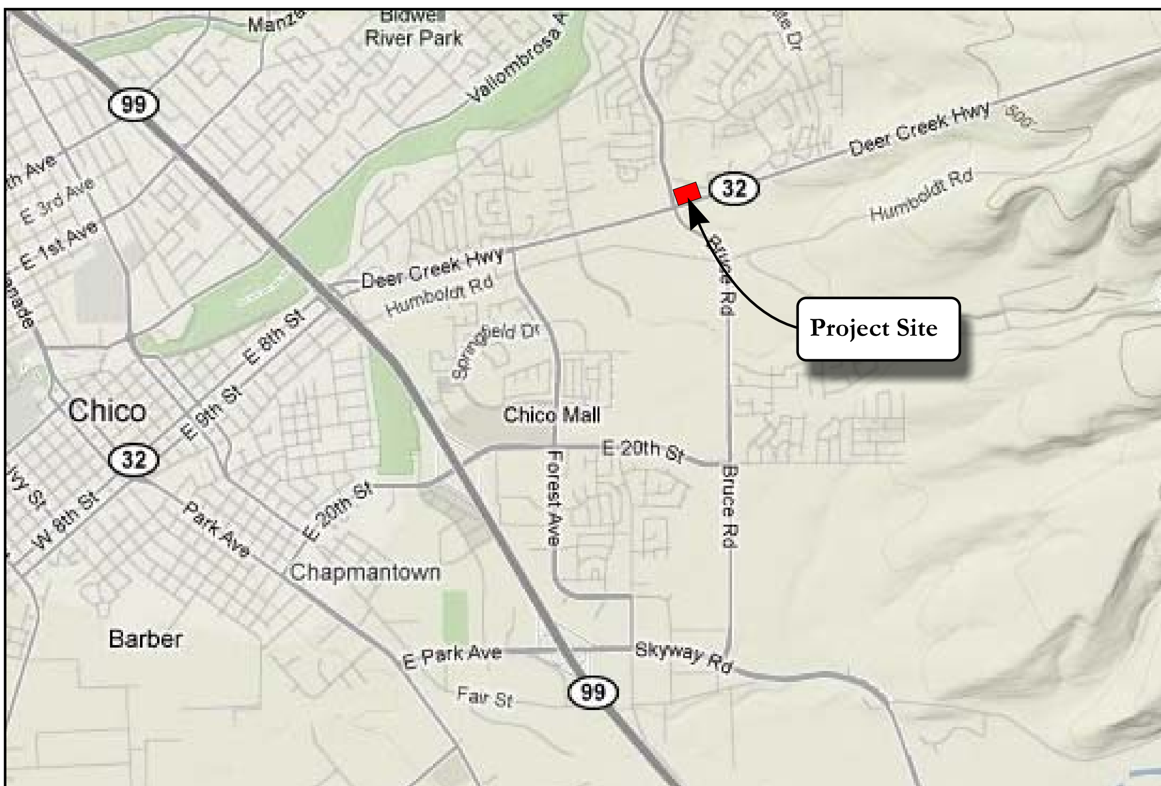




CGI Technical Services Inc.	SITE LOCATION MAP HIGHWAY 32/BRUCE ROAD CITY OF CHICO, CALIFORNIA	Plate 1
Project No.: 15-2109.02		

Attachment B

TP-9 Test Pit Location

TP-11 (F4) Test Pit Location Within Stockpiles

Geologic Contact: dashed where approximate, dotted where covered, queried where uncertain

af Artificial Foll

Tt Tehama Formation

Base imagery from Google Maps

Scale not Determined

CGI TECHNICAL SERVICES INC.

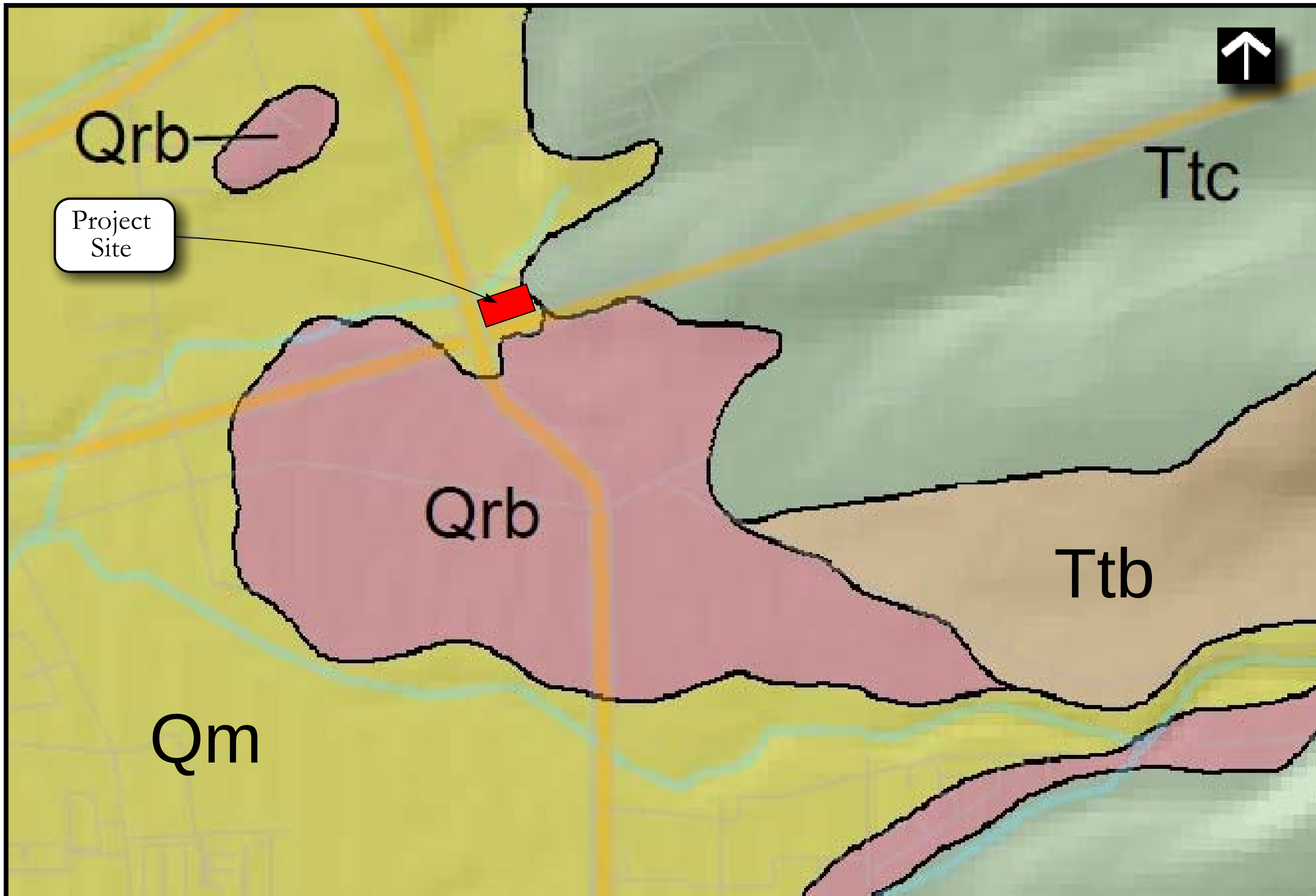
Project No.: 15-2109.02

GEOTECHNICAL MAP
HIGHWAY 32/BRUCE ROAD
CITY OF CHICO, CALIFORNIA

Plate

2

Attachment B



Qm	Modesto Formation
Qrb	Red Bluff Formation
Ttb	Tuscan Formation Unit B
Ttc	Tuscan Formation Unit C

Geologic Contact: dashed where approximate, dotted where covered, queried where uncertain

Base map from Helley & Harwood (1985)

Scale not Determined

CGI Technical Services Inc.

REGIONAL GEOLOGIC MAP
HIGHWAY 32/BRUCE ROAD
CITY OF CHICO, CALIFORNIA

Plate 3

Project No.: 15-2109.02

Attachment B

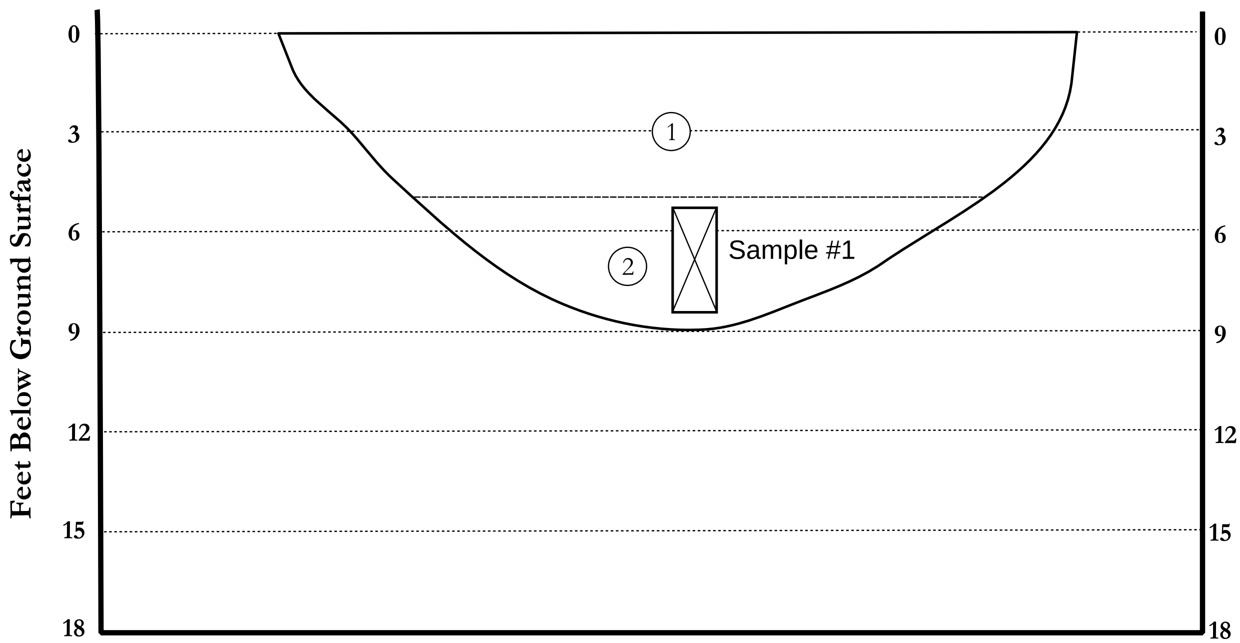
APPENDIX A
SUBSURFACE EXPLORATION

The subsurface exploration program for the proposed project consisted of excavating and logging of eleven exploratory test pits. Test pit locations are shown on Plate 2.

The test pits were excavated on July 14, 2015 using a John Deere 310SG backhoe equipped with a 24-inch wide bucket. The test pits were excavated to depths ranging from approximately 6 to 10 feet below the existing ground surface. Select samples of surficial soils were collected from the test pits for laboratory classification and testing. The results of the testing procedures are attached within Appendix B.

The exploration logs describe the earth materials encountered. The logs also show the location, exploration number, date of exploration, and the names of the logger and equipment used. A CGI engineer, using ASTM 2488 for visual soil classification, logged the explorations. The boundaries between soil types shown on the log are approximate because the transition between different soil layers may be gradual and may change with time. Excavation logs for this study are presented as Plate A-1.1 through A-1.11. A legend to the terms noted on the test pits is included at Plate A-2 – Legend of Terms and Conditions.

LOG OF TEST PIT



Soil Descriptions	
1	Clayey GRAVEL to Gravelly CLAY (GC/CL), dark brown, dry to moist, very dense to hard, medium to coarse grained with subrounded medium to coarse gravel, cobbles, and boulders up to at least 36 inches in diameter.
2	Clayey GRAVEL to Gravelly CLAY (GC/CL), dark reddish brown, moist, very dense to hard, slightly plastic, medium to coarse grained with subrounded medium to coarse gravel, cobbles.
3	

Date Logged:	July, 14, 2015	Excavated With:	John Deere 310 SG
Logged by:	Ed Cortez	Backfilled With:	Excavated Cuttings
Excavator:	Larry Rogers	Depth to Water (ft):	Not Encountered

CGI TECHNICAL SERVICES INC.

Project No.: 15-2109.02

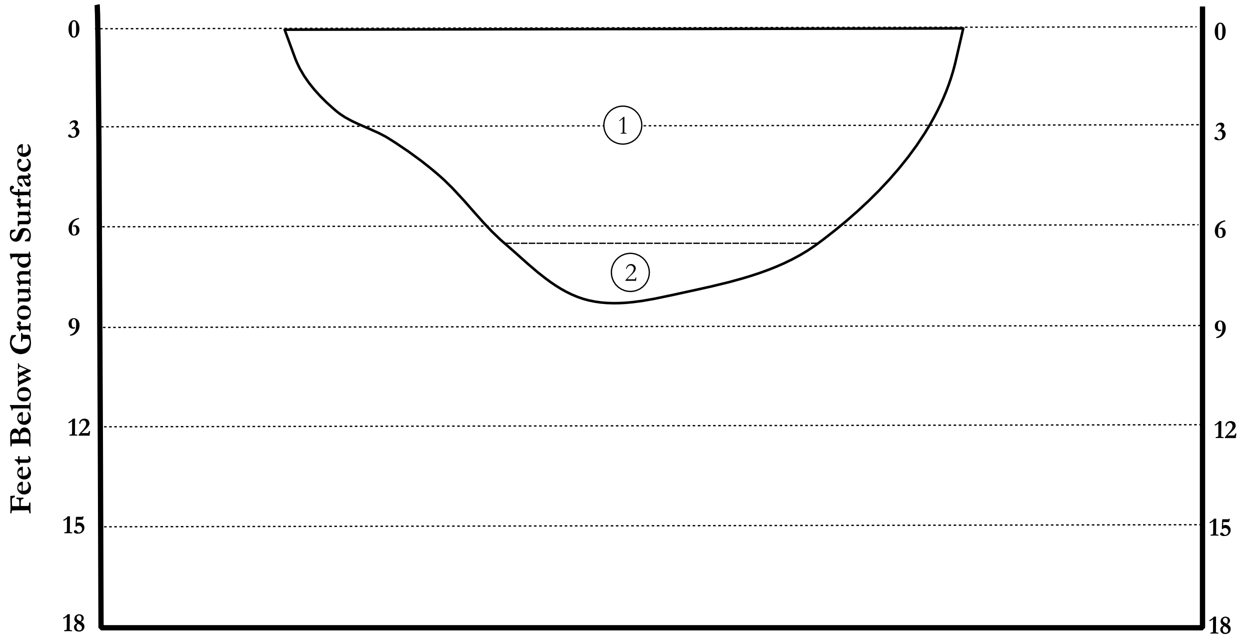
TEST PIT TP-1
HIGHWAY 32/BRUCE ROAD
CITY OF CHICO, CALIFORNIA

Plate No.

A-1.1

Attachment B

LOG OF TEST PIT



Soil Descriptions	
1	Gravelly CLAY (CL), dark brown, dry to moist, very dense to hard, medium to coarse grained with subrounded medium to coarse gravel and cobbles and trace to moderate fine to coarse roots. Reddish brown below 2 feet. Less gravel and trace cobbles below 4 feet.
2	SANDSTONE (rx), reddish brown, moderately to highly weathered, moderately hard, moderately indurated, fine to coarse grained.
3	

Date Logged:	July, 14, 2015	Excavated With:	John Deere 310 SG
Logged by:	Ed Cortez	Backfilled With:	Excavated Cuttings
Excavator:	Larry Rogers	Depth to Water (ft):	Not Encountered

CGI Technical Services Inc.

Project No.: 15-2109.02

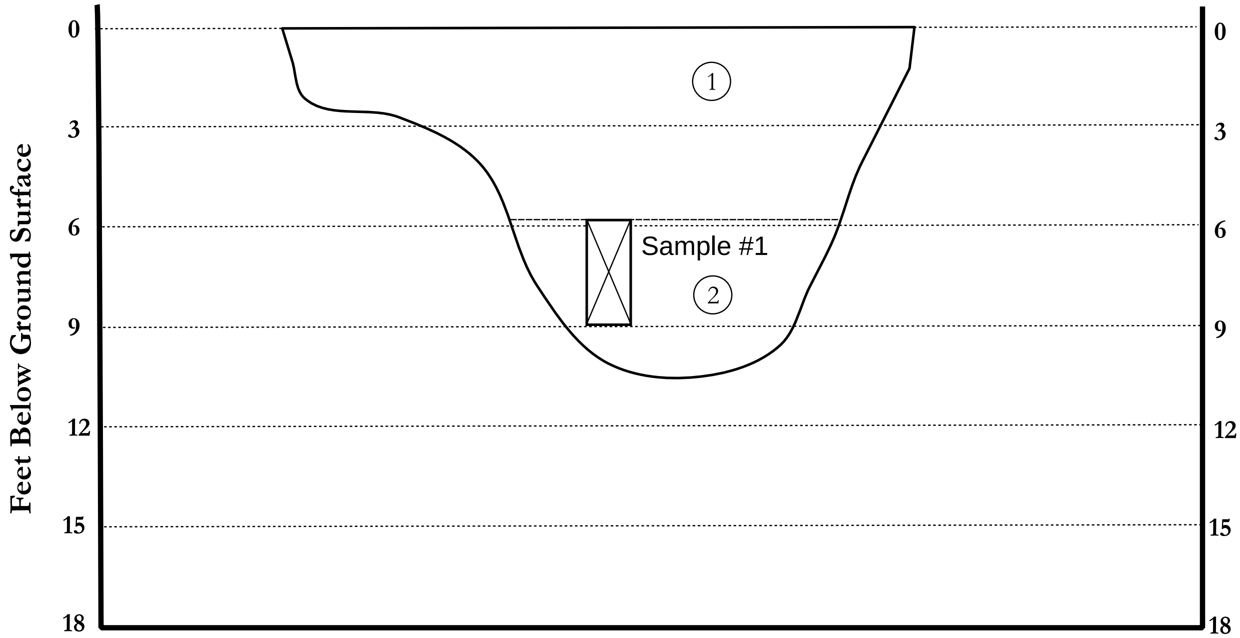
TEST PIT TP-2
HIGHWAY 32/BRUCE ROAD
CITY OF CHICO, CALIFORNIA

Plate No.

A-1.2

Attachment B

LOG OF TEST PIT



	Soil Descriptions
1	Clayey GRAVEL to Gravelly CLAY (GC/CL), dark brown, dry to moist, very dense to hard, medium to coarse grained with subrounded medium to coarse gravel and cobbles and trace to moderate fine to coarse roots. Reddish brown and moist below 2 feet. With fine to medium sand at 4 feet.
2	Gravelly CLAY (CL), dark greyish brown, dry to moist, very dense to hard, medium to coarse grained with subrounded medium to coarse gravel and cobbles and few boulders up to 3 feet in diameter
3	

Date Logged:	July, 14, 2015	Excavated With:	John Deere 310 SG
Logged by:	Ed Cortez	Backfilled With:	Excavated Cuttings
Excavator:	Larry Rogers	Depth to Water (ft):	Not Encountered

CGI Technical Services Inc.

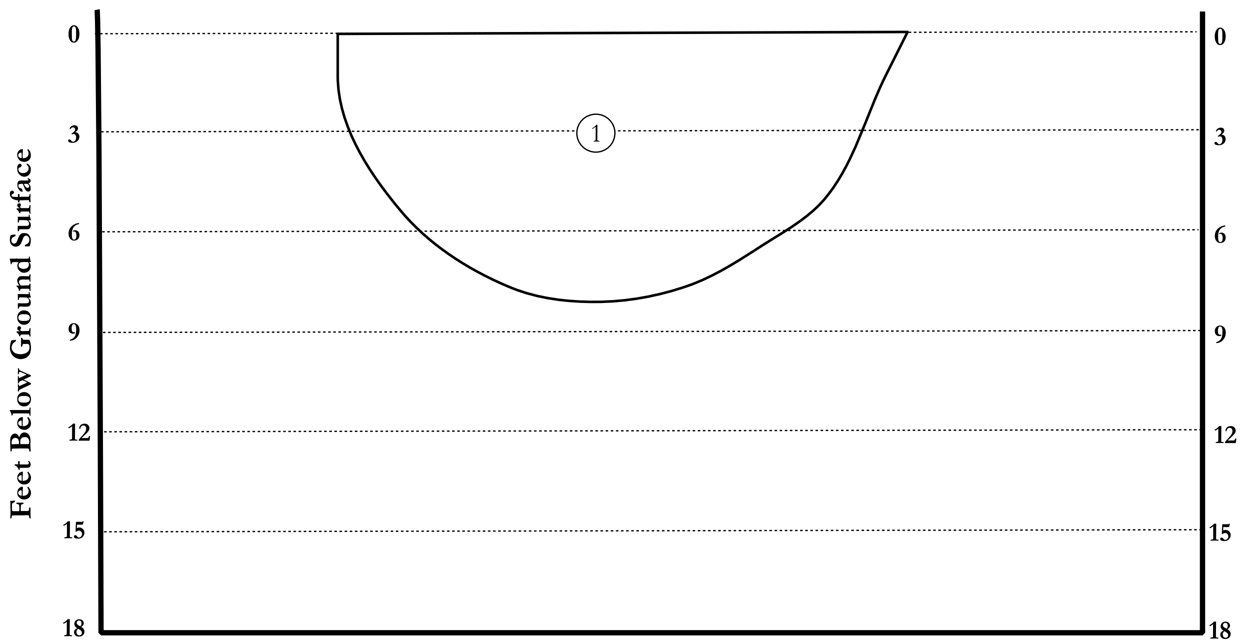
Project No.: 15-2109.02

TEST PIT TP-3
HIGHWAY 32/BRUCE ROAD
CITY OF CHICO, CALIFORNIA

Plate No.

A-1.3

LOG OF TEST PIT



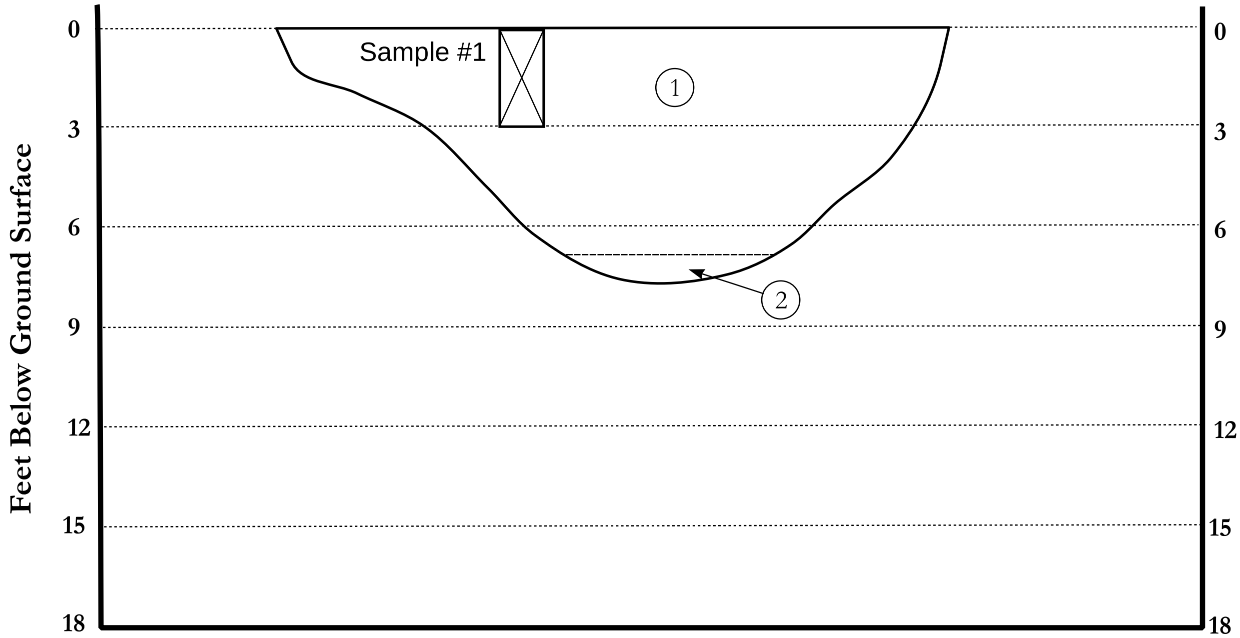
Soil Descriptions	
1	Clayey GRAVEL to Gravelly CLAY (GC/CL), dark reddish brown, moist, very dense, medium to coarse grained with subrounded medium to coarse gravel, cobbles, and boulders up to at least 2 feet in diameter, and roots to a depth of 2 feet.
2	
3	

Date Logged:	July, 14, 2015	Excavated With:	John Deere 310 SG
Logged by:	Ed Cortez	Backfilled With:	Excavated Cuttings
Excavator:	Larry Rogers	Depth to Water (ft):	Not Encountered

CGI TECHNICAL SERVICES INC.	TEST PIT TP-4 HIGHWAY 32/BRUCE ROAD CITY OF CHICO, CALIFORNIA	Plate No. A-1.4
Project No.: 15-2109.02		

Attachment B

LOG OF TEST PIT



Soil Descriptions	
1	Gravelly CLAY (CL), dark reddish brown, moist, hard, medium to coarse grained with subrounded medium to coarse gravel, cobbles, and boulders up to at least 2 feet in diameter, and roots to a depth of 7 feet.
2	CONGOLMERATE (rx), moderate brown, weathered, dry, hard, moderately indurated. Practical refusal for backhe.
3	

Date Logged:	July, 14, 2015	Excavated With:	John Deere 310 SG
Logged by:	Ed Cortez	Backfilled With:	Excavated Cuttings
Excavator:	Larry Rogers	Depth to Water (ft):	Not Encountered

CGI Technical Services Inc.

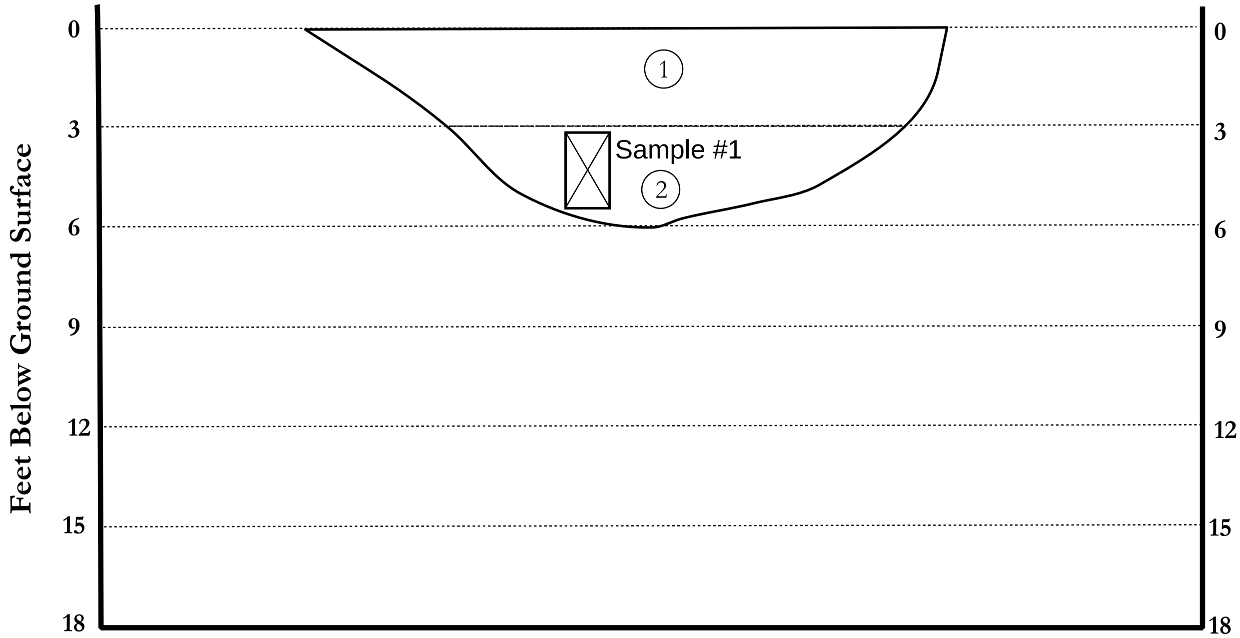
Project No.: 15-2109.02

TEST PIT TP-5
HIGHWAY 32/BRUCE ROAD
CITY OF CHICO, CALIFORNIA

Plate No.
A-1.5

Attachment B

LOG OF TEST PIT



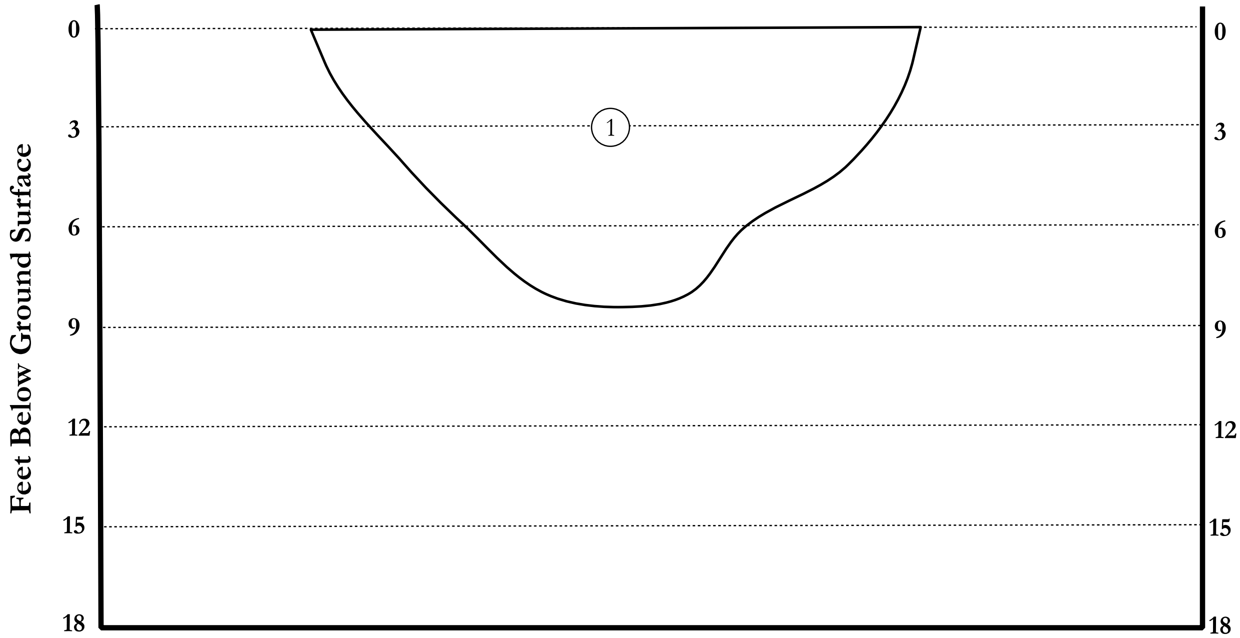
	Soil Descriptions
1	Gravelly CLAY (CL), dark brown, moist, hard, medium to coarse grained with subrounded medium to coarse gravel, cobbles, and boulders up to at least 2 feet in diameter, and roots to a depth of 3 feet.
2	Gravelly CLAY (CL), dark reddish brown, moist, hard, medium to coarse grained with subrounded medium to coarse gravel and cobbles, and organic (charcoal) fragments.
3	

Date Logged:	July, 14, 2015	Excavated With:	John Deere 310 SG
Logged by:	Ed Cortez	Backfilled With:	Excavated Cuttings
Excavator:	Larry Rogers	Depth to Water (ft):	Not Encountered

CGI TECHNICAL SERVICES INC.	TEST PIT TP-6 HIGHWAY 32/BRUCE ROAD CITY OF CHICO, CALIFORNIA	Plate No. A-1.6
Project No.: 15-2109.02		

Attachment B

LOG OF TEST PIT



Soil Descriptions	
1	Gravelly CLAY (CL), dark brown, dry to moist, hard, medium to coarse grained with subrounded medium to coarse gravel, cobbles, and boulders up to at least 2 feet in diameter, and roots to a depth of 3 feet. Increased plasticity and reduced gravel volume below 6 feet.
2	
3	

Date Logged:	July, 14, 2015	Excavated With:	John Deere 310 SG
Logged by:	Ed Cortez	Backfilled With:	Excavated Cuttings
Excavator:	Larry Rogers	Depth to Water (ft):	Not Encountered

CGI Technical Services Inc.

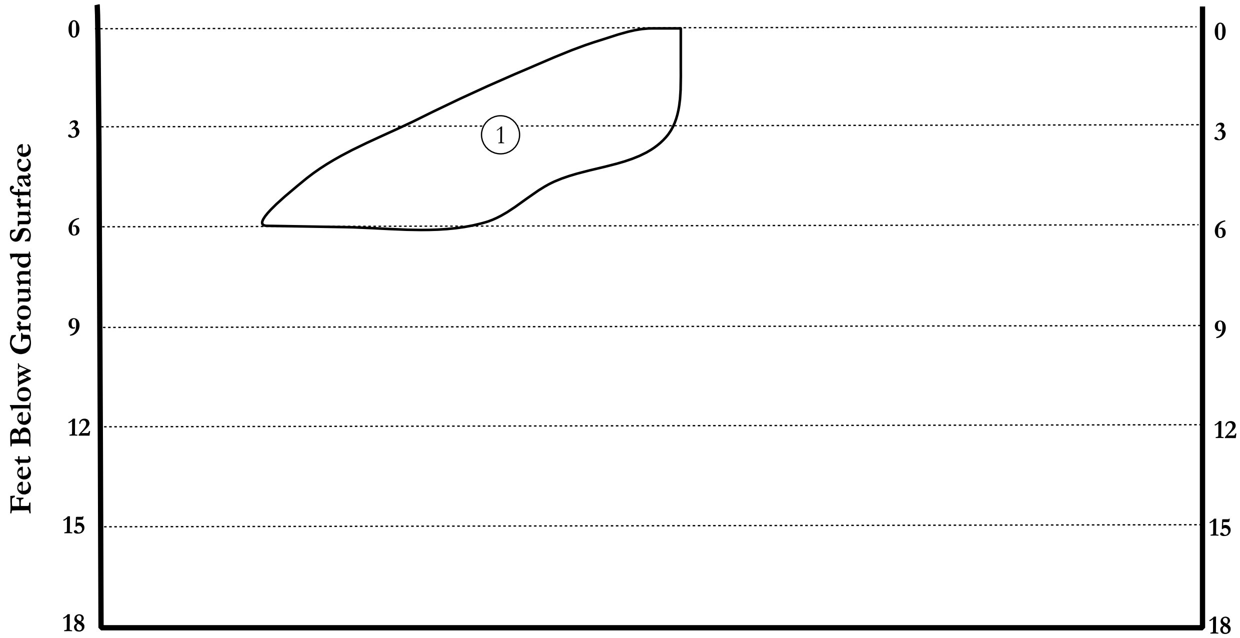
Project No.: 15-2109.02

TEST PIT TP-7
HIGHWAY 32/BRUCE ROAD
CITY OF CHICO, CALIFORNIA

Plate No.
A-1.7

Attachment B

LOG OF TEST PIT

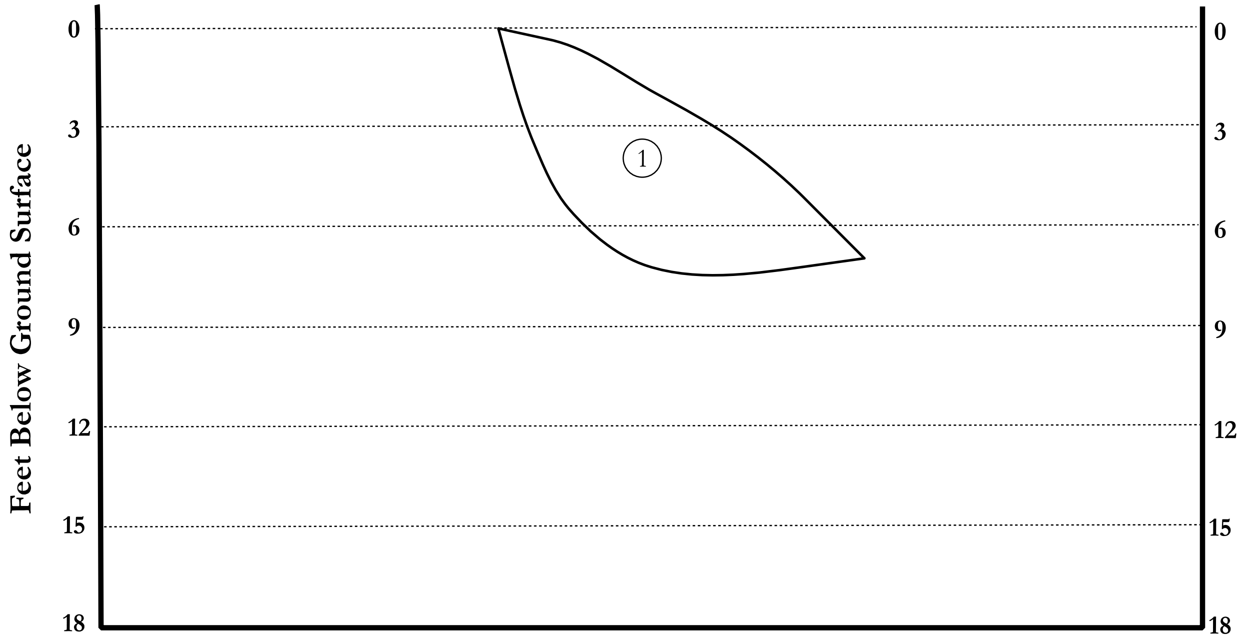


Soil Descriptions	
1	Gravelly CLAY (CL), dark brown, moist, hard, medium to coarse grained with rounded to subrounded medium to coarse gravel and cobbles.
2	
3	

Date Logged:	July, 14, 2015	Excavated With:	John Deere 310 SG
Logged by:	Ed Cortez	Backfilled With:	Excavated Cuttings
Excavator:	Larry Rogers	Depth to Water (ft):	Not Encountered

CGI TECHNICAL SERVICES INC.	TEST PIT TP-8/F1 HIGHWAY 32/BRUCE ROAD CITY OF CHICO, CALIFORNIA	Plate No. A-1.8
Project No.: 15-2109.02		

LOG OF TEST PIT



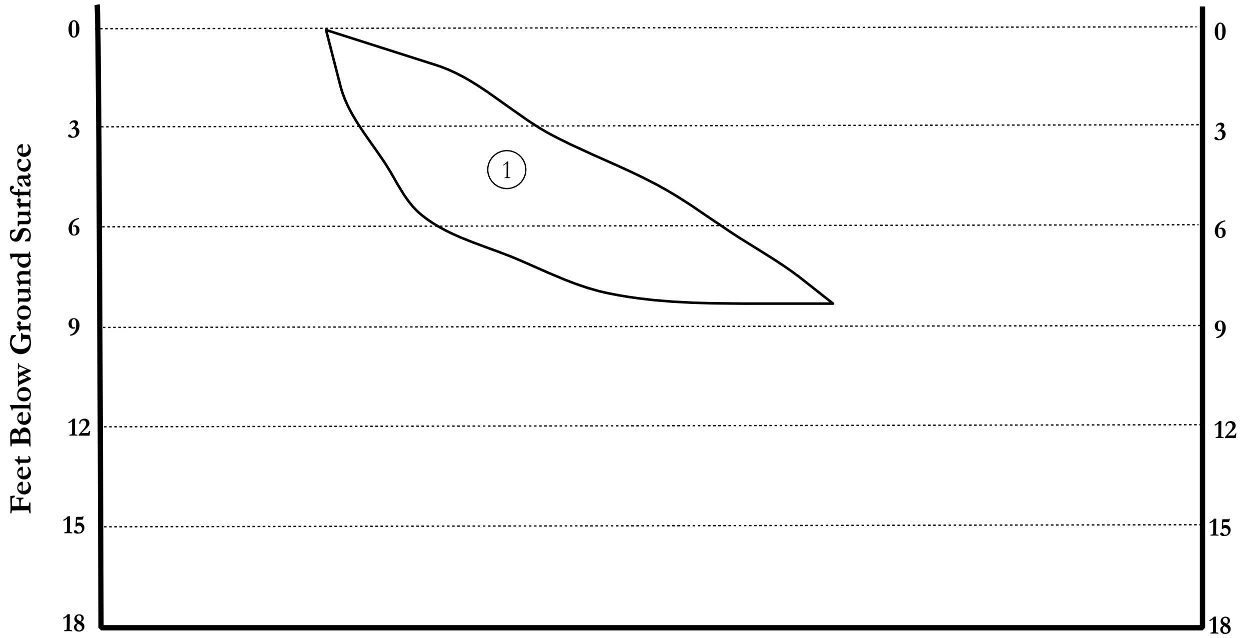
Soil Descriptions	
1	Gravelly CLAY (CL), dark brown, moist, very stiff to hard, medium to coarse grained with rounded to subrounded medium to coarse gravel and cobbles, and roots.
2	
3	

Date Logged:	July, 14, 2015	Excavated With:	John Deere 310 SG
Logged by:	Ed Cortez	Backfilled With:	Excavated Cuttings
Excavator:	Larry Rogers	Depth to Water (ft):	Not Encountered

CGI Technical Services Inc.	TEST PIT TP-9/F2 HIGHWAY 32/BRUCE ROAD CITY OF CHICO, CALIFORNIA	Plate No. A-1.9
Project No.: 15-2109.02		

Attachment B

LOG OF TEST PIT



Soil Descriptions	
1	Gravelly CLAY (CL), dark brown, moist, very stiff to hard, medium to coarse grained with rounded to subrounded medium to coarse gravel, cobbles, and boulders up to at least 1.5' in diameter, and roots.
2	
3	

Date Logged:	July, 14, 2015	Excavated With:	John Deere 310 SG
Logged by:	Ed Cortez	Backfilled With:	Excavated Cuttings
Excavator:	Larry Rogers	Depth to Water (ft):	Not Encountered

CGI TECHNICAL SERVICES INC.

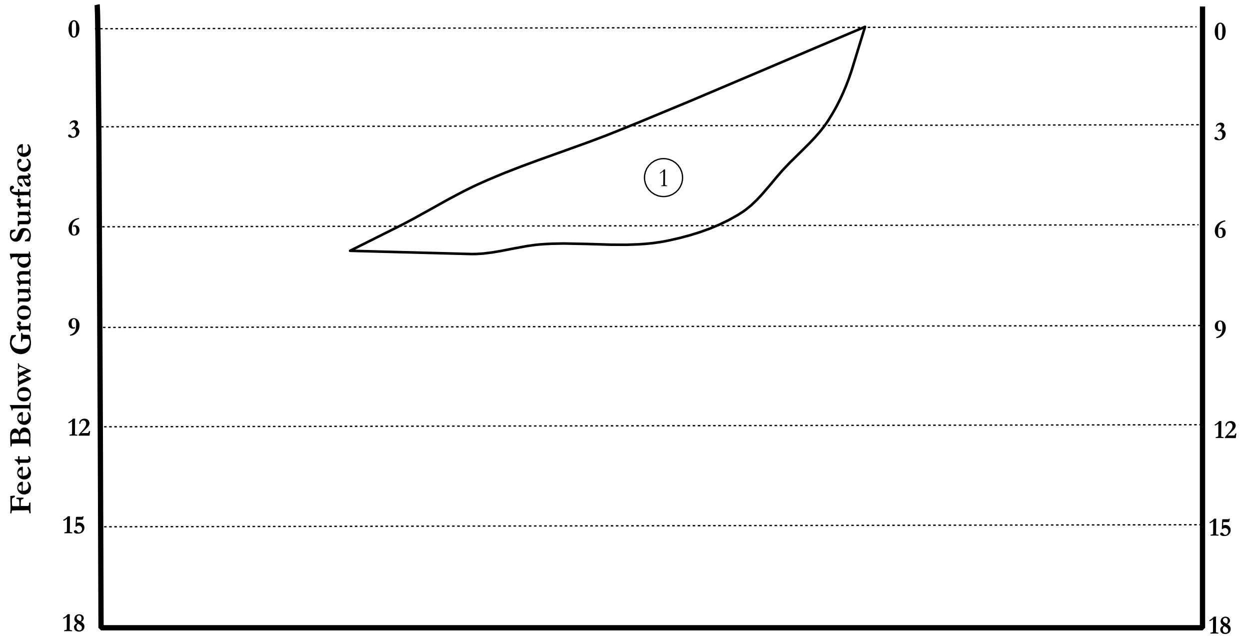
Project No.: 15-2109.02

TEST PIT TP-10/F3
HIGHWAY 32/BRUCE ROAD
CITY OF CHICO, CALIFORNIA

Plate No.
A-1.10

Attachment B

LOG OF TEST PIT



Soil Descriptions	
1	Gravelly CLAY (CL), dark brown, moist, very stiff to hard, medium to coarse grained with rounded to subrounded medium to coarse gravel, cobbles, and trace boulders up to at least 1.5’ in diameter, and roots.
2	
3	

Date Logged:	July, 14, 2015	Excavated With:	John Deere 310 SG
Logged by:	Ed Cortez	Backfilled With:	Excavated Cuttings
Excavator:	Larry Rogers	Depth to Water (ft):	Not Encountered

CGI TECHNICAL SERVICES INC.	TEST PIT TP-11/F4 HIGHWAY 32/BRUCE ROAD CITY OF CHICO, CALIFORNIA	Plate No. A-1.11
Project No.: 15-2109.02		

Major Divisions			USCS Symbol	Description
COARSE-GRAINED SOILS More than 50% of sample or material is larger than the No. 200 Sieve (0.0029 inches)	GRAVELS More than 50% of the coarse fraction is retained on No. 4 sieve (0.187 inches)	GRAVELS Clean Gravels, few fines	GW	Well graded gravels and sand mixtures with little to no fines
			GP	Poorly graded gravels & gravel/sand mixtures with little to no fines
		GRAVELS With appreciable fines	GM	Silty gravels and poorly graded gravel/sand/silt mixtures
			GC	Clayey gravels and poorly graded gravel/sand/clay mixtures
	SANDS More than 50% of the coarse fraction passes the No. 4 sieve (0.187 inches)	SANDS Clean Sands, few fines	SW	Well graded sands and gravelly sands with little to no fines
			SP	Poorly graded sands and gravelly sands with little to no fines
		SANDS With appreciable fines	SM	Silty sands and poorly graded sand/gravel/silt mixtures
			SC	Clayey sands and poorly graded sand/gravel/clay mixtures
FINE-GRAINED SOILS More than 50% of sample or material is smaller than the No. 200 Sieve (0.0029 inches)	SILTS & CLAYS Liquid limit less than 50		ML	Inorganic silts with very fine sands, silty and/or clayey fine sands, clayey silts with slight plasticity
			CL	Inorganic clays with low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic silts and clays with low plasticity
	SILTS & CLAYS Liquid limit greater than 50		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts
			CH	Inorganic clays with high plasticity, fat clays
			OH	Orgainic silts and clays with high plasticity
HIGHLY ORGANIC SOIL			PT	Peat, humus, swamp soil with high organic content

Samples

☒ Bulk or disturbed sample

■ Relatively undisturbed sample

Symbols

▼ Groundwater

------ Contact Between Soil/Rock Layers

Caving

GENERAL NOTES
Dual symbols (such as ML/CL or SM/SC) are used to indicate borderline classifications.
In general, USCS designations shown on the logs were evaluated using visual methods. Actual designations (based on laboratory tests) may vary.
Logs represent general soil conditions observed on the date and locations indicated. No warranty is provided regarding soil continuity between locations.
Lines separating soil strata on logs are approximate. Actual transitions may be gradual and vary with depth.

CGI TECHNICAL SERVICES INC.	LEGEND TO TEST PIT LOGS HIGHWAY 32/BRUCE ROAD CITY OF CHICO, CALIFORNIA	Plate No. A-2
Project No.: 15-2109.02		

APPENDIX B
LABORATORY TESTING

Laboratory Analyses

Laboratory tests were performed on selected bulk soil samples to estimate engineering characteristics of the various earth materials encountered. Testing was performed under procedures described in one of the following references:

- ASTM Standards for Soil Testing, latest revision;
- Lambe, T. William, Soil Testing for Engineers, Wiley, New York, 1951;
- Laboratory Soils Testing, U.S. Army, Office of the Chief of Engineers, Engineering Manual No. 1110-2-1906, November 30, 1970.

Plasticity Index Tests

Atterberg Limits (plastic limit, liquid limit, and plasticity index) tests were performed on two selected samples in accordance with standard test method ASTM D4318. Results of the Atterberg Limits tests are presented on the attached *Plasticity Index Test* report.

Moisture Density Relations

The compaction characteristics of a selected bulk soil sample were estimated in accordance with standard test method ASTM D1557. The results of the compaction test are shown on the attached plate labeled *Moisture Density Relationship*.

Resistance R-Value Test

One R-value test was performed on a selected relatively undisturbed sample using standard test method California Test Method 301. The results of the test are presented on the attached plate labeled *R-Value*.

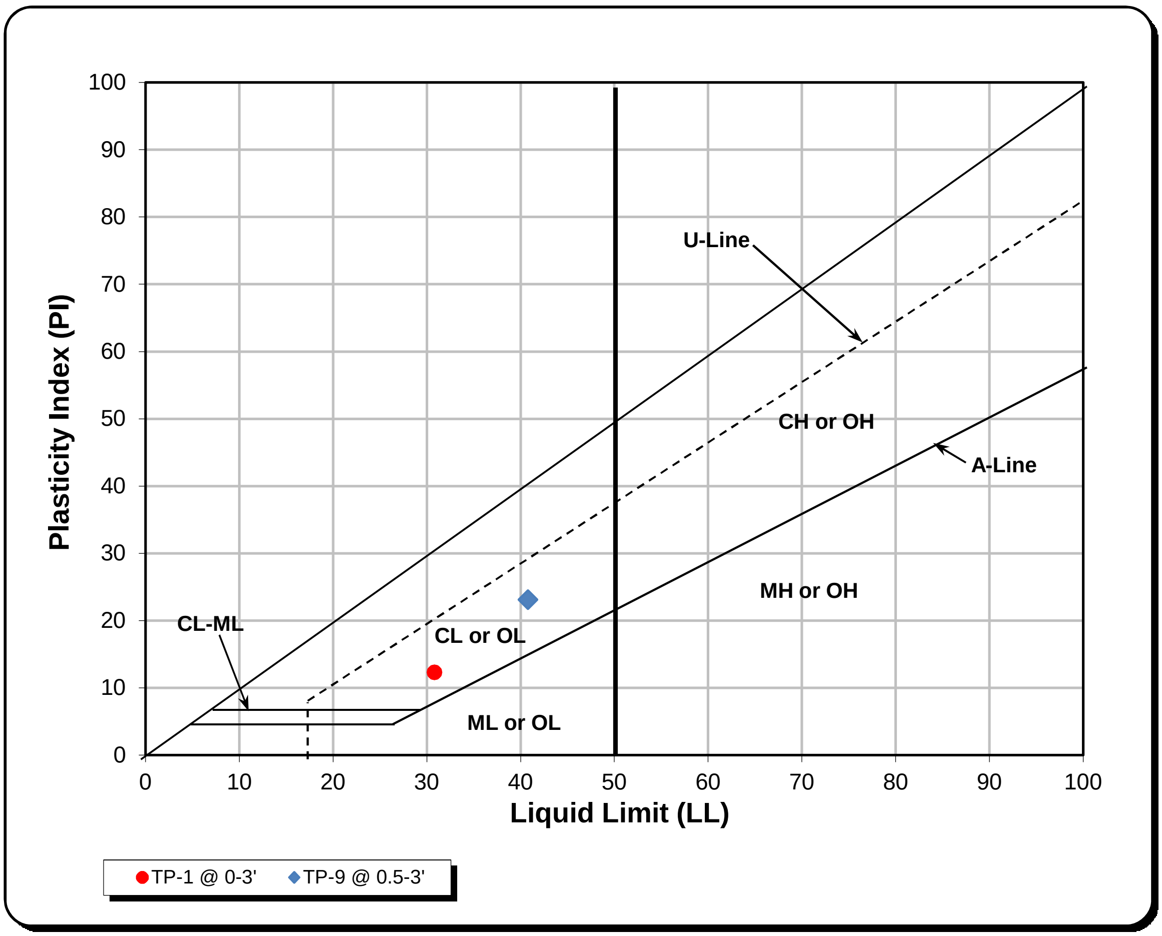
Soil-Chemistry Test

Two selected samples of the near-surface soil encountered at the site was subjected to chemical analysis to evaluate pH, resistivity, chloride and sulfate contents, along with other cations and anions. The results of the test are attached to this appendix.

CGI Technical Services Inc.

ATTERBERG LIMITS TESTS

Client:	Fifth Sun, LLC	**Job No.:**	15-2109.02
Project:	Bruce Road and Highway 32	**Lab No.:**	8227
Location:	Chico, California		
Sampled By:	EC	**Date Sampled:**	14-Jul-15
Received By:	AE	**Date Received:**	14-Jul-15
Tested By:	AE	**Date Tested:**	21-Aug-15
Reviewed By:	AB	**Date Reviewed:**	21-Aug-15



LEGEND			CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS		
Location	Depth, ft	Sample No.		Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
TP-5	0-3'	1	Clayey Sand	31	19	12
TP-9 (F2)	3-5'	2	Clayey Sand	41	18	23

ASTM D4318 & D2487

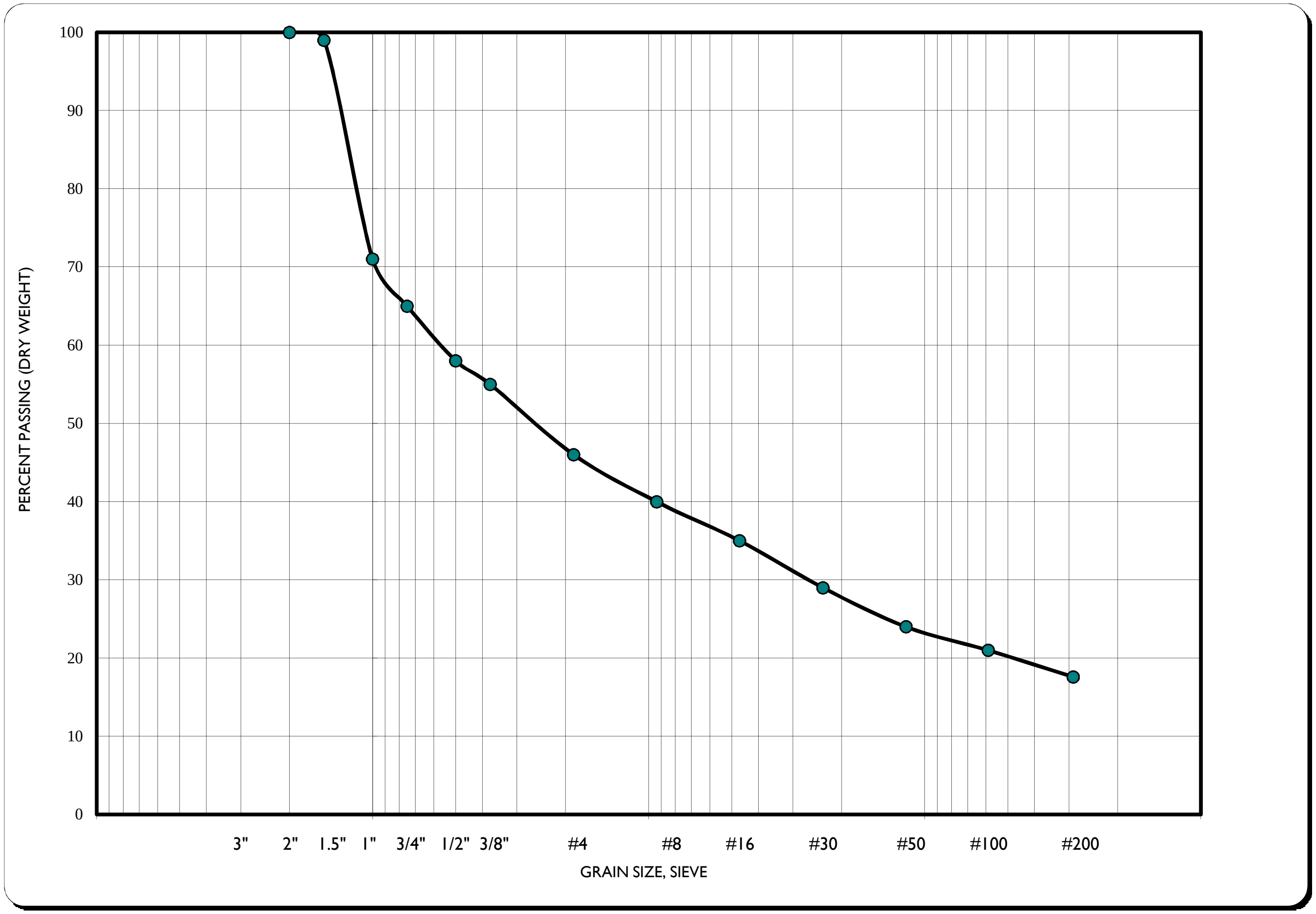
CGi Technical Services, Inc.

LABORATORY TEST RESULTS

Client: Fifth Sun, LLC
Project: Bruce Road and Highway 32
Material Type: Gravelly Clay
USCS: CL

Sample Location: TP-5
Sampled By: EC
Tested By: AE

Job No.: 15-2109.02
Lab No.: 8227
Date Received: 14-Jul-15
Date Tested: 21-Aug-15
Date Reviewed: 21-Aug-15



SIEVE ANALYSIS

Sieve Size Standard	Grain Size (mm)	Percent Passing
6	150.00	
2	50.00	100
1.5	37.50	99
1"	25.00	71
3/4"	19.00	65
1/2"	12.50	58
3/8"	9.50	55
#4	4.75	46
#8	2.36	40
#16	1.18	35
#30	600um	29
#50	300um	24
#100	150um	21
#200	75um	17.6

CG15GS010

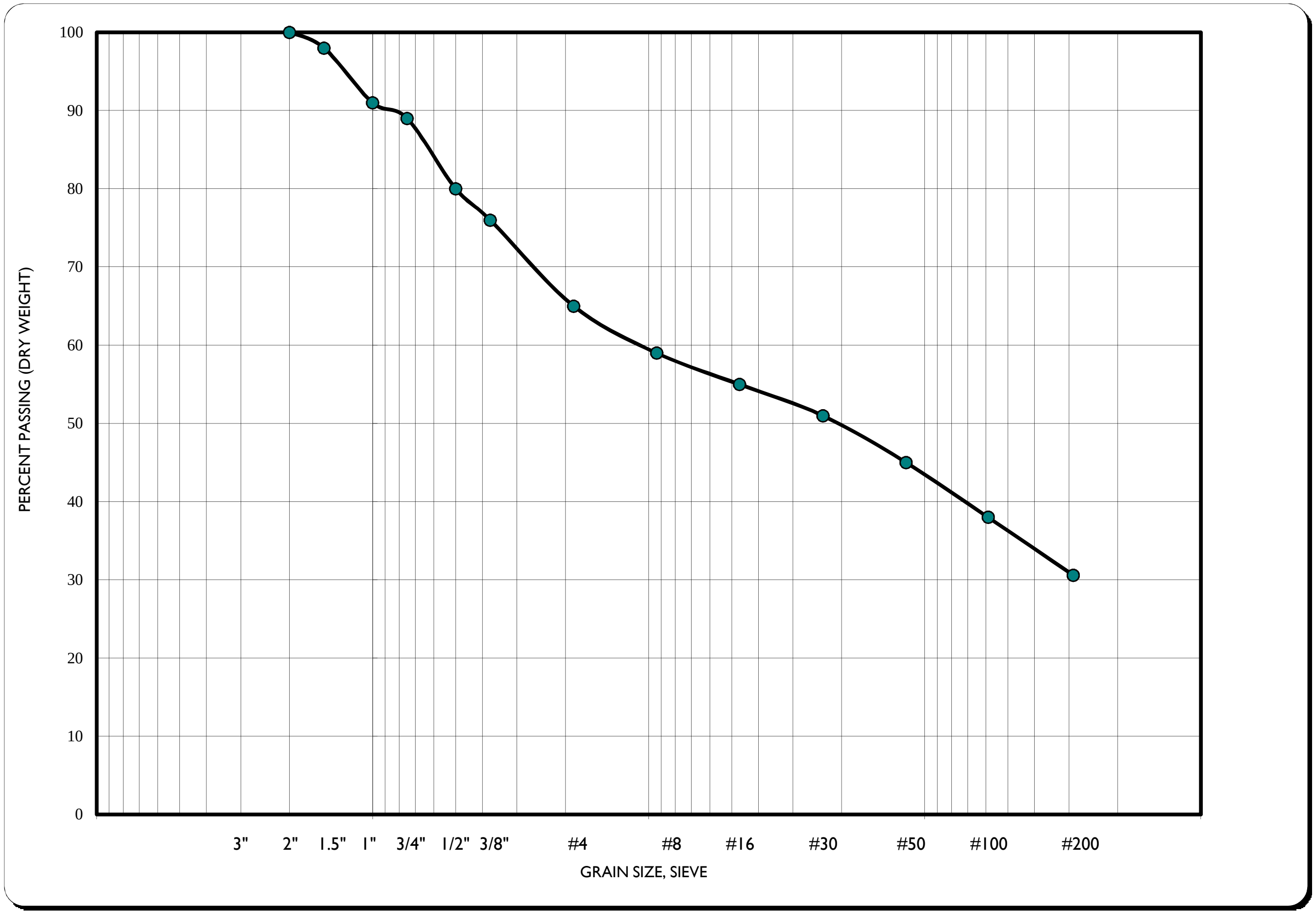
Attachment B

LABORATORY TEST RESULTS

Client: Fifth Sun, LLC
Project: Bruce Road and Highway 32
Material Type: Gravelly Clay
USCS: CL

Sample Location: TP-9 (F2)
Sampled By: EC
Tested By: AE

Job No.: 15-2109.02
Lab No.: 8227
Date Received: 14-Jul-15
Date Tested: 21-Aug-15
Date Reviewed: 21-Aug-15



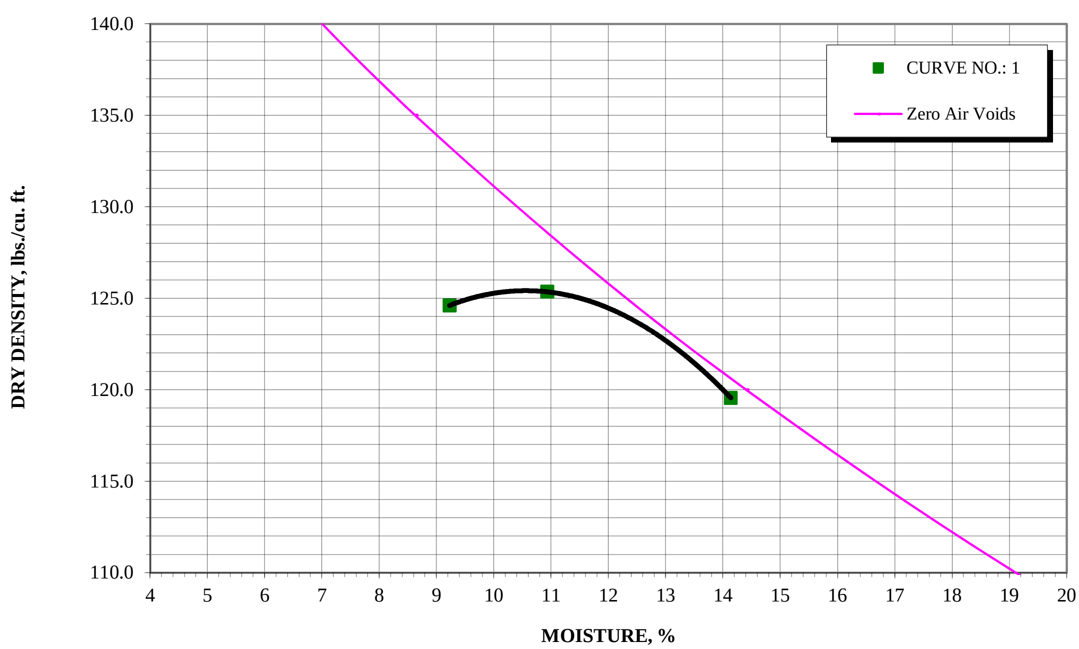
SIEVE ANALYSIS

Sieve Size Standard	Grain Size (mm)	Percent Passing
6	150.00	
2	50.00	100
1.5	37.50	98
1"	25.00	91
3/4"	19.00	89
1/2"	12.50	80
3/8"	9.50	76
#4	4.75	65
#8	2.36	59
#16	1.18	55
#30	600um	51
#50	300um	45
#100	150um	38
#200	75um	30.6

MOISTURE DENSITY RELATIONSHIP

Client:	Fifth Sun, LLC	**Job No.:**	15-2109.02
Project:	Bruce Road and Highway 32	**Lab No.:**	8227
Location:	Chico, California		
Material Description:	Gravelly Clay	**CURVE NO.:**	1
Material Supplier:	On-Site		
Material Type:	Native		
Sample Location:	TP-9/F2 3-5'		
Sampled By:	EC	**Date Sampled:**	14-Jul-15
Received By:	AE	**Date Received:**	14-Jul-15
Tested By:	JFB	**Date Tested:**	21-Aug-15
Reviewed By:	AB	**Date Reviewed:**	24-Aug-15
Test Procedure:	ASTM	**Method:**	D-1557

Oversized Material (%), +3/4": 16.0% **Correction Required:** [X] yes [ ] no



SPECIMEN	A	B	C	D
MOISTURE AT TEST, %	9.2	10.9	14.1	
DRY DENSITY	124.6	125.4	119.6	

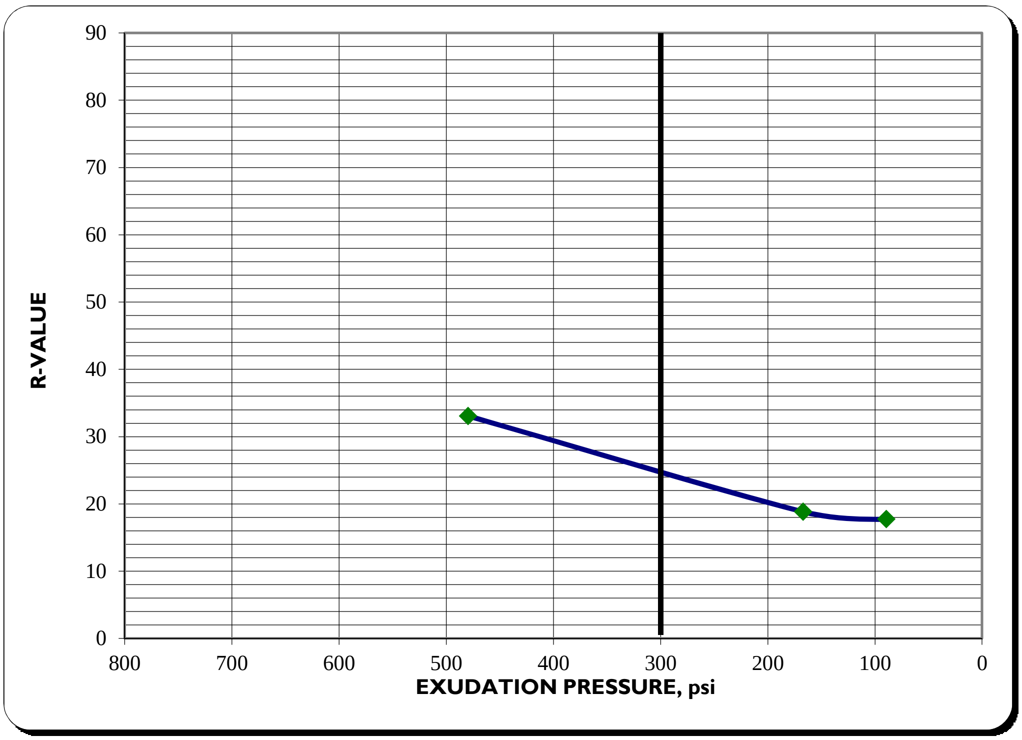
Maximum Dry Density, PCF 125.5 **@ Optimum Moisture, %** 10.5

CGI TECHNICAL SERVICES INC.

Resistance Value

Client:	Fifth Sun, LLC	**Job No.:**	15-2109.02
Project:	Bruce Road and Highway 32	**Lab No.:**	8227
Location:	Chico, California		
Material Type:	Gravelly Clay		
Material Supplier:	On-Site	**Date Sampled:**	7/14/2015
Material Source:	Native	**Date Received:**	7/14/2015
Sample Location:	TP-5	**Date Tested:**	8/17/2015
Sampled By:	EC	**Date Reviewed:**	8/21/2015

Test Procedure: Caltrans **Method:** 301



	A	B	C
Moisture (%):	13.8	14.7	15.7
Dry Density (pcf):	136.6	123.5	127.1
Expansion Pressure (psf):	0.0108	0.0143	0.0143
Exudation Pressure (psi):	479	167	89
Resistance Value:	33	19	18

R - VALUE AT 300 PSI EXUDATION PRESSURE	24

Table 1 - Laboratory Tests on Soil Samples

CGI Technical Services
Hwy 32/ Brug Rd
Your #15-2220.01, HDR Lab #15-0619LAB
11-Aug-15

Sample ID			TP-5 @ 0-3' Gravelly Clay	F2 @ 3-5' Gravelly Clay
Resistivity		**Units**		
as-received		ohm-cm	14,400	46,000
saturated		ohm-cm	2,880	3,720
pH			6.7	7.4
Electrical Conductivity		mS/cm	0.04	0.11
Chemical Analyses				
Cations				
calcium	Ca^{2+}	mg/kg	19	70
magnesium	Mg^{2+}	mg/kg	11	24
sodium	Na^{1+}	mg/kg	21	23
potassium	K^{1+}	mg/kg	1.9	8.3
Anions				
carbonate	CO_3^{2-}	mg/kg	ND	20
bicarbonate	HCO_3^{1-}	mg/kg	73	210
fluoride	F^{1-}	mg/kg	ND	ND
chloride	Cl^{1-}	mg/kg	9.9	7.5
sulfate	SO_4^{2-}	mg/kg	6.2	15
phosphate	PO_4^{3-}	mg/kg	ND	3.8
Other Tests				
ammonium	NH_4^{1+}	mg/kg	ND	ND
nitrate	NO_3^{1-}	mg/kg	15	13
sulfide	S^{2-}	qual	na	na
Redox		mV	na	na

Electrical conductivity in millisiemens/cm and chemical analysis were made on a 1:5 soil-to-water extract.
mg/kg = milligrams per kilogram (parts per million) of dry soil.
Redox = oxidation-reduction potential in millivolts
ND = not detected
na = not analyzed