Geotechnical Investigation Report

Washington Terrace Subdivision
APN: 508-242-044
McKinleyville, California

Prepared for:

JLF Construction, Inc.

SHN

June 2020
020060

812 W. Wabash Avenue, Eureka, CA 95501-2138 707-441-8855
Civil Engineering, Environmental Services, Geosciences, Planning & Permitting, Surveying

Reference: 020060

June 23, 2020

Jim Furtado
JLF Construction, Inc.
3329 Halfway Avenue
McKinleyville, CA 95519

Subject: Geotechnical Investigation Report, Washington Terrace Subdivision, APN 508-242-044, McKinleyville, California

Dear Jim Furtado:

As requested, SHN is providing this geotechnical investigation report for the proposed development of a 40-lot subdivision on Assessor's parcel number (APN) 508-242-044, west of Washington Avenue in McKinleyville, California. The enclosed report presents our findings, conclusions, and recommendations to assist you and your design consultants with site preparation and grading, and design of the residence foundations.

This report concludes our work on this phase of the project in accordance with our current agreement. If you have any questions, please call either of us at (707) 441-8855.

Sincerely,

SHN

John H. Dailey, PE, GE
Senior Geotechnical Engineer

Paul R. Sundberg, PG
Project Geologist

JHD:PRS:ame

Enclosure: Report

Reference: 020060

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REGISTERED PROFESSIONAL ENGINEER
JOHN H. DAILEY
GE 256
EXP. 03/31/22
GEOTECHNICAL
STATE OF CALIFORNIA

6-23-20

John H. Dailey, PE, GE 256
Senior Geotechnical Engineer

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No. 9723
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6-23-20

Paul R. Sundberg, PG 9723
Project Geologist

June 2020

QA/QC:GDS GDS

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Abbreviations and Acronyms

mm	millimeters
pcf	pounds per cubic foot
psf	pounds per square foot
µm	micrometers
$(N_1)_{60}$	soil density/blow count
AAPG	American Association of Petroleum Geologists
APN	Assessor's parcel number
ASCE	American Society of Civil Engineers
ASTM	ASTM-International
BGS	below ground surface
CBC	California Building Code
CDMG	California Division of Mines and Geology
CGS	California Geological Survey
H:V	horizontal to vertical
M#	magnitude number
ML	sandy silt
NR	no reference
OSHA	U.S. Occupational Safety and Health Administration
OSHPD	California Office of Statewide Health Planning and Development
PVC	polyvinyl chloride
SE	sand equivalent
SEAOC	Structural Engineers Association of California
SM	silty sand
SP	poorly graded sand
SPT	standard penetration test
TP-#	test pit-number
USGS	United States Geological Survey

1.0 Introduction

1.1 General

This geotechnical investigation report presents the results of a field and laboratory investigation by SHN to support the development of a proposed 40-lot residential subdivision by JLF Construction, Inc. The project is located on Assessor's parcel number (APN) 508-242-044, west of Washington Avenue and north of School Road in McKinleyville, California (Figure 1). The latitude and longitude of the site are 40.935886°N and -124.108102°W, respectively. This report was prepared for the sole use of JLF Construction, Inc. and their design consultants. The report is intended to satisfy the requirements set forth by the Humboldt County Planning and Building Department and the criteria presented in Chapter 18 of the *2019 California Building Code* (CBC).

The conclusions and recommendations presented in this report are provided to assist the project design consultants in addressing the design and construction of the new structures. This report is based on a review of historical aerial photographs, a review of published geologic literature and mapping in the vicinity of the project site, the data obtained from our field investigation, and the results of laboratory testing performed on samples obtained from the exploratory test pits.

1.2 Project Description

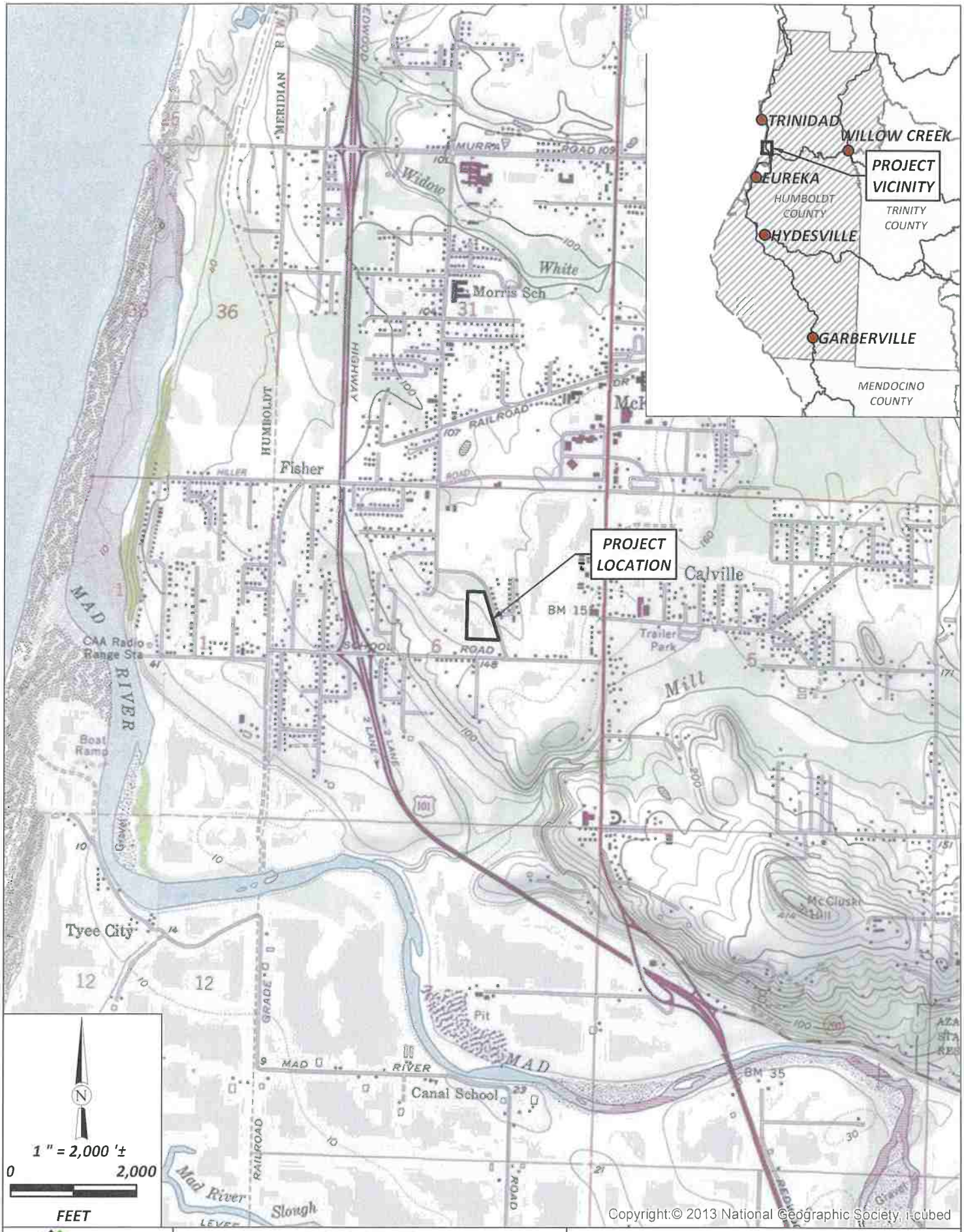
We understand the project will consist of the development of 40 single-family residential lots (Figure 2). We understand the proposed residences will be one- or two-story wood-frame structures with slab-on-grade driveways and garage floors, and the residences will have raised floors with crawlspaces beneath the living spaces. Two roads, named Washington Court and Ascent Place (Figure 2), will be developed to provide access to the residential lots.

2.0 Scope of Work

The scope of SHN's services included reviewing historical aerial photographs, reviewing available geologic and subsurface information; supervising the excavation of 12 geotechnical test pits; performing laboratory tests on selected soil samples; and providing geotechnical recommendations to aid in project planning, design, and construction.

Specifically, the following information, recommendations, and design criteria are presented in this report:

- Description of site terrain and local geology
- Description of soil and groundwater conditions, interpreted based on our field exploration, laboratory testing, and review of existing geotechnical information
- Logs of the geotechnical test pits (Appendix 1) and results of laboratory tests conducted for this investigation (Appendix 2)
- Assessment of potential earthquake-related geologic/geotechnical hazards (for example, strong earthquake ground shaking, surface fault rupture, liquefaction, settlement)
- Seismic design parameters in accordance with the applicable portions of the 2019 CBC and American Society of Civil Engineers (ASCE) 7-16 Standard, including site soil classification, seismic design category, and spectral response accelerations
- Recommendations for new site improvements, including site and subgrade preparation, fill material, placement and compaction requirements, and slab-on-grade and foundation support



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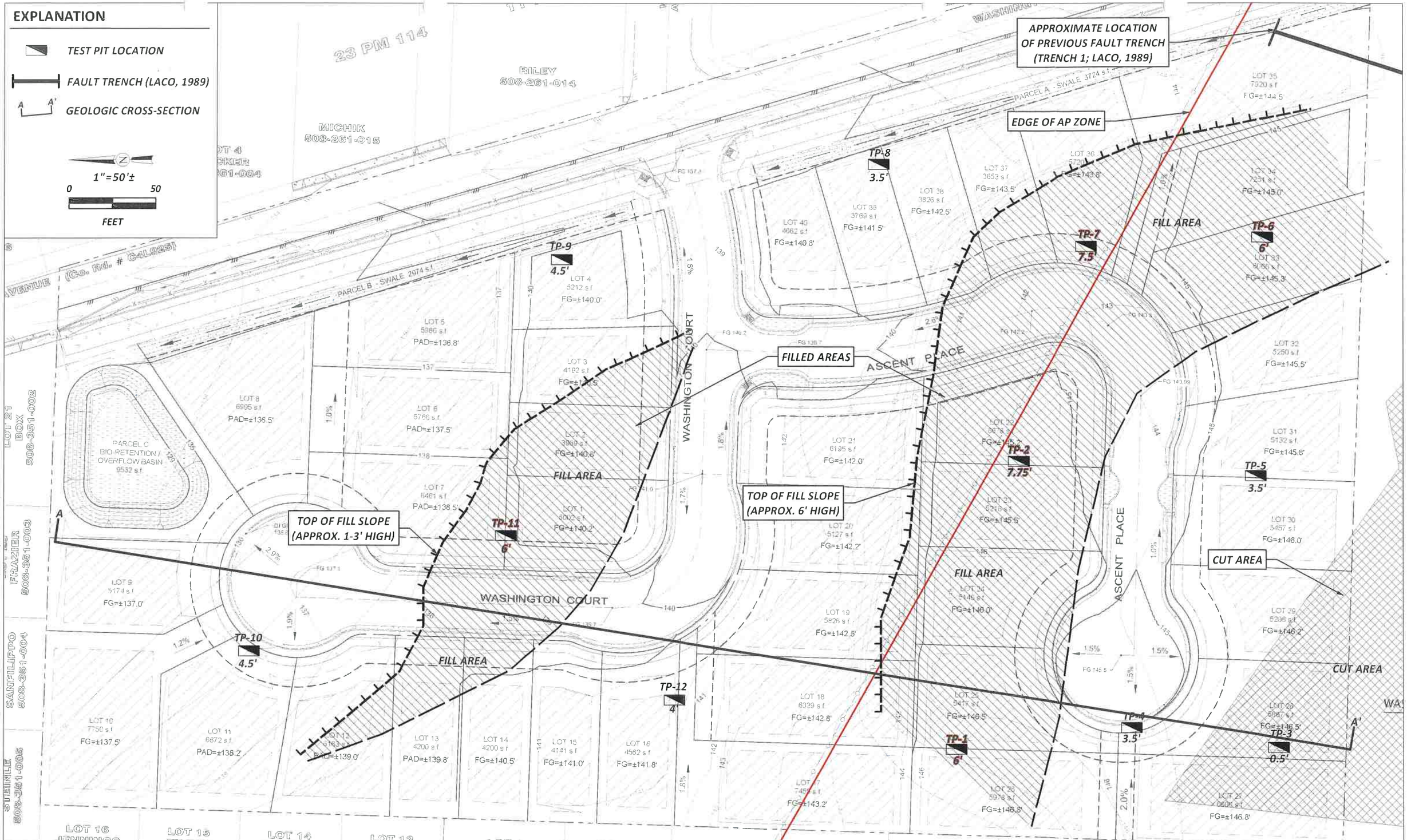
SHN	JLF Construction Washington Terrace Geotech Investigation McKinleyville, California	Project Location Map SHN 020060
	June 2020 | Figure1_ProjectLocationMap	Figure 1



NOTE: DEPTHS SHOWN INDICATE DEPTHS TO SUITABLE LOAD BEARING MATERIAL
LABELS OUTLINED IN RED INDICATED TEST PITS WITH FILL
LACO, 1989 TRENCH LOCATION IS APPROXIMATE
BASEMAP FROM SCHILLINGER ENGINEERING, 2020

JLF Construction
Washington Terrace Geotech Investigation
McKinleyville, California

Site Plan Map Showing Test Pit Locations and Fill Areas
SHN 020060

June 2020 | Figure2_SitePlanMap1 | Figure 2

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- Assessment of foundation load-bearing soil conditions, including:
  - Allowable bearing pressures or capacities (dead, live, and seismic loads)
  - Minimum foundation embedment
  - Estimates of settlement (total and differential)
  - Allowable lateral passive and sliding resistance characteristics for footings
- Recommendations for observation of foundation installation, materials testing and inspection, and other construction considerations

3.0 Field Investigation and Laboratory Testing

The geotechnical field exploration and laboratory testing programs performed for this investigation are summarized below.

3.1 Field Exploration Program

On April 17, 2020, a project geologist from SHN logged and sampled 12 shallow backhoe test pits at the project site. The test pits (Figure 2) were excavated to a maximum depth of 10 feet below (existing) ground surface (BGS). Test pits were intentionally located outside the building footprints in order to avoid disturbance of the footing soils. Approximate locations of the test pits are shown on Figure 2.

The soils encountered in the test pits were logged and field classified in general accordance with the Manual-Visual Classification Method (ASTM-International [ASTM] D 2488). During excavation, the project geologist evaluated the in-situ soil consistency based on equipment performance and level of effort required to advance the test pits. After soils in the test pits were logged, the pits were backfilled with the excavated spoils; however, the backfill was not compacted to the requirements for structural fill. Final test pit logs, presented in Appendix 1, were prepared based on the field logs, examination of samples in the laboratory, and laboratory test results.

3.2 Laboratory Testing

Selected soil samples were tested in SHN's certified soils testing laboratory in Eureka, California, to determine selected index properties of the subsurface materials. Samples were tested for in-place moisture content and dry density, and percent fines (passing the number 200 sieve). Results of the tests are provided at the corresponding sample locations on the test pit logs (Appendix 1) and included as Appendix 2.

4.0 Site Conditions

The following sections describe site conditions, the geologic setting of the site, and subsurface soil and groundwater conditions encountered at the time of our field exploration.

4.1 Site Description

The project site is west of Washington Avenue and north of School Road in McKinleyville, California. The project parcel spans three different elevation surfaces (upper, intermediate, and lower). All three surfaces are generally flat. The upper surface is in the southern portion of the parcel and is at an approximate elevation of 150 feet. The transition to intermediate surface to the north is marked by a 5- to 6-foot-high slope that descends to the north and east. The intermediate surface sits between the upper and lower surfaces in the central portion of the parcel and is at an approximate elevation of 140 feet. The transition to

the lower surface is marked by a 1- to 3-foot-high slope that descends to the northeast. The lower surface is in the northern portion of the parcel at an approximate elevation of 135 feet. See Figure 2 for site features.

We understand, through client discussions and historical aerial photo review, that topographically high surfaces are a result of previous grading activities from the southern portion of the project parcel and the parcel to the south. The graded material was pushed north to create the fill slope at the transition between the upper and lower surfaces.

The project parcel is generally vegetated with grasses; however, trees are present along the eastern and western boundaries of the highest surface in the south.

4.2 Geologic Setting

Basement rock underlying the project site is composed of late Jurassic- to late Cretaceous-age mélange of the Franciscan Complex (McLaughlin and others, 2000; Clarke, 1992). The Franciscan basement rock is overlain by a variety of late Cenozoic age sedimentary rocks, which in coastal northern Humboldt County, includes the Falor formation and a series of late Pleistocene-age marine terraces (Carver et al., 1984). McKinleyville is located on a particularly well-developed flight of marine terraces that extends from the modern coastline to the hills along the eastern margin of town. These terraces typically consist of an abrasion platform cut across bedrock, covered by sediments typically consisting of near-shore marine deposits and terrestrial alluvial, colluvial, and eolian deposits.

The project site is situated within the Mad River fault zone. The Mad River fault zone is characterized by northwest-trending folds and parallel northeast-dipping thrust faults that have deformed Pleistocene deposits (Manning and Ogle, 1950). The thrust faults and folds are the central part of the on-land portion of the southern end of the Cascadia subduction zone fold and thrust belt. The geomorphic features associated with thrust faults are difficult to locate precisely. Rust (1982) notes:

> *The thrust faults do not generate a well-defined linear scarp; they tend to be represented at the surface as a series of faults following a zone, with individual traces dying out along strike; and as they propagate upwards through the thick sequences of terrace deposits, displacement is taken up along multiple faults and associated fractures and folds so that offset at the ground surface becomes diffused.*

Carver, Stephens and Young (1982) suggest that multiple scarps are common (in the thrust fault zone) across zones of up to 500 meters (~1,640 feet) wide.

The Mad River fault cuts across the parcel directly south of the project site and the Earthquake Fault Zone boundary (CGS, 2018) associated with the Mad River fault is in the southwestern portion of the project site.

4.3 Subsurface Soil and Groundwater Conditions

The results of our subsurface investigation indicate the presence of up to 7.75 feet of unsuitable foundation bearing material overlying late-Pleistocene marine terrace deposits. The unsuitable foundation bearing material is non-engineered fill and native low-density topsoil consisting of dark brown and very dark brown, medium dense silty sand (SM), and soft to medium stiff sandy silt (ML). Marine terrace deposits consisted of yellowish-brown, medium dense silty sand (SM), medium dense poorly graded sand with silt (SP-SM), and well-graded sand with silt (SW-SM). Depths to suitable foundation bearing material at the site range from 0

to 7.75 feet BGS. Test pits TP-1 through TP-7 were excavated on the upper surface, test pits TP-8 through TP-10 were excavated on the lower surface, and test pits TP-11 and TP-12 were excavated on the intermediate surface (Figure 2). Soil conditions encountered on the three surfaces are summarized below and shown on the cross-section in Figure 3.

The area with the thickest section of fill and topsoil is at the north and east edge of the upper surface. Fill thickness diminishes to the southwest. Test pits TP-1, TP-2, and TP-7 were excavated along the north edge of the upper surface and revealed fill to depths between 3 and 4 feet BGS. Fill is 1.75 feet deep in TP-6 and 4 feet deep in TP-2. TP-5 encountered native topsoil at the surface. TP-3 was excavated in the southwestern portion of the project site and encountered weathered sandstone bedrock at the ground surface. Marine terrace deposits were encountered on the upper surface at depths ranging from 3.5 feet BGS to 7.75 feet BGS.

Test pits TP-8 through TP-10 were excavated on the lower surface in the north and east. Excavations encountered 3.5 feet to 4.5 feet of native topsoil over marine terrace deposits.

TP-11 was excavated at the north end of the intermediate surface and revealed 2.5 feet of fill over 3.5 feet of native topsoil. Marine terrace deposits were encountered at a depth of 6 feet BGS. TP-12 was excavated at the southwestern portion of the intermediate surface and revealed 0.5 feet of fill over 4.5 feet of native topsoil. Marine terrace deposits were encountered at a depth of 6 feet BGS.

Groundwater was not encountered during our investigation. Soil mottling was observed in the upper marine terrace deposits at the site. It is our experience that the upper terrace deposits are generally slow draining and groundwater can become perched following periods of heavy rain. Mottling within the soil profile represents the historical range of groundwater fluctuation. Groundwater levels are expected to fluctuate seasonally, on the order of several feet in elevation. However, we do not anticipate groundwater to be encountered during excavation of shallow foundations or site grading, assuming this work is conducted during the dry season.

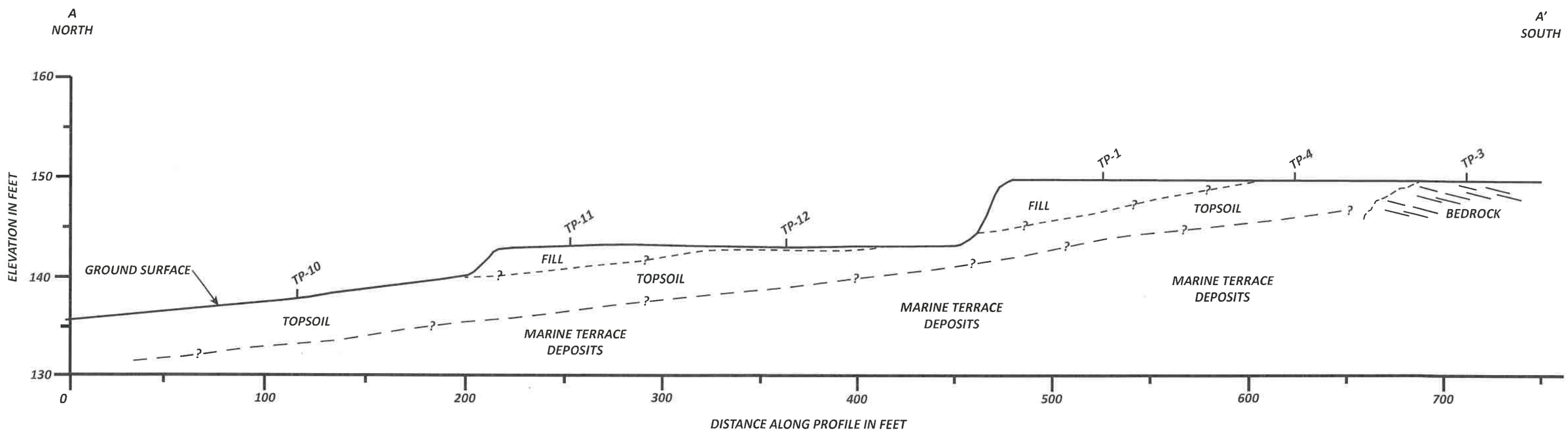
4.4 Geologic Hazards

Potential geologic/geotechnical hazards common to the local area include seismic ground shaking, surface fault rupture, seismically induced ground deformation (liquefaction and seismic compaction), and slope instability. Our assessment of these potential hazards is presented below.

4.4.1 Seismic Ground Shaking

The entire North Coast region is a seismically active area where strong seismic shaking presents a significant hazard. That hazard is present at the project site on Washington Avenue; however, it may be greater than present elsewhere in the region due to the close proximity to the Mad River fault (less than 100 feet), which is considered active by the State of California. The McKinleyville fault, which is also considered active by the State of California, is approximately 1.5 miles northeast of the project site. An additional fault known as the Widow White fault is mapped approximately 0.9 miles to the northeast of the project site but is not considered active by the State of California. The Cascadia subduction zone is located about 41 miles west of the project site, offshore. Cascadia earthquakes occur roughly every 300 to 500 years and may have magnitudes (M) ranging from M8.5 to M9.0. A rupture event originating on any one of these nearby faults would generate very strong ground shaking at the site.

WASHINGTON TERRACE SUBDIVISION
STATIGRAPHIC CROSS-SECTION



SCALE:
VERTICAL: 1" = 10'
HORTIZONAL: 1" = 50'
V.E. = 5x

FEATURES ARE APPROXIMATE

JLF Construction Washington Terrace Geotech Investigation McKinleyville, California		Stratigraphic Cross-Section SHN 020060
June 2020	Figure3_CrossSection	Figure 3

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4.4.2 Surface Rupture

The project site is less than 100 feet north of the Mad River fault, which is considered active by the State of California. The Earthquake Fault Zone (CGS, 2018) associated with the Mad River fault traverses the southwest portion of the project parcel. The Mad River fault has been studied through various subsurface investigations spanning decades. Two investigations were conducted on properties adjacent to the project parcel and are discussed below.

A fault rupture hazard evaluation was conducted by LACO Associates in 1989 for the subject parcel and the parcel directly to the south. At that time, the two parcels (current configuration) were one contiguous parcel extending from School Road to the northern boundary of the current project parcel. Two trenches (Trench 1 and Trench 2) were excavated as a part of that study with the approximate northeastern portion of Trench 1 extending into the southeastern corner of the current project site (Figure 2). Trench 2 was excavated across the topographic escarpment to the south that defines the Mad River fault. The 1989 investigation found that a trace of the Mad River fault was exposed in Trench 2 and determined that it crosses the parcel south of the current project parcel, immediately north of School Road. The fault has a strike of N66W, and the trace of the fault is projected to the surface about 40 feet beyond the base of the scarp at School Road. However, the investigation found no direct expression of a surface trace where trenched.

A fault rupture hazard evaluation for the School Ridge subdivision, directly west of the project parcel, was conducted by SHN in 2006. The 2006 investigation found that a principal trace of the Mad River fault passes obliquely through the southern portion of the subdivision. At that time, it was determined that the fault had experienced a rupture event during the Holocene. The fault, as exposed in the trenches in that investigation, has a strike between N60W and N70W, essentially parallel to the topographic scarp north of School Road. Based on the fault strike, the fault does not pass through the project parcel.

Two north- and northeast-facing slopes are present on the project parcel. These slopes are associated with previous site grading and fill activities. Due to the close proximity to the zoned active Mad River fault, we believe the risk associated with the hazard of surface rupture to be low.

4.4.3 Liquefaction

Liquefaction is the sudden loss of soil shear strength due to a rapid increase of soil pore water pressure caused by cyclic loading from a seismic event.

Generally, in order for liquefaction to occur, the following soil conditions are typically needed:

- Non-plastic granular soils (sand, silty sand, sandy silt, and some gravels)
- A shallow depth to groundwater (less than 50 feet BGS)
- Low relative density soil (standard penetration test [SPT] blow count $[N_1]_{60}$ less than 30, usually associated with materials of young geologic age)

The adverse effects of liquefaction include localized ground settlement, ground cracking and expulsion of water and sand (sand boils), the partial or complete loss of bearing and confining forces used to support loads, amplification of seismic shaking, and lateral spreading.

Susceptibility to liquefaction decreases with increasing geologic age, due to the effects of weathering, and the degree of densification, compaction, and/or cementation. Based on the published results of geotechnical testing and post-earthquake studies, the susceptibility of sediments to liquefaction can be

directly correlated to the type, origin, and age of the deposits. Geologic materials most susceptible to liquefaction are geologically recent (that is, late Holocene age) sand- and silt-rich deposits, located adjacent to streams, rivers, bays, or ocean shorelines. It should be noted that these "most susceptible" conditions do not exist in the late Pleistocene marine terrace deposits at the site. Youd and Hoose (1978) estimated liquefaction susceptibility of Pleistocene-age terraces as "low."

Our subsurface investigation revealed the site to be underlain by medium dense to dense, late Pleistocene-age marine terrace deposits. Based on the age and relative density of the underlying sediments, we conclude the potential for seismically induced liquefaction to occur is low. Based on this preliminary geologic screening, we conclude that additional (quantitative) modeling of liquefaction potential is not warranted.

4.4.4 Co-seismic Compaction

Coseismic compaction is a process of soil densification that occurs during dynamic loading of poorly to moderately consolidated, cohesionless soil above or below the groundwater level. Shaking or vibration during an earthquake can cause these granular soils to become denser, resulting in settlement of the ground surface. The potential for coseismic compaction is highest during the first episodes of seismic shaking following deposition and becomes reduced during subsequent shaking events due to the densification that occurred during previous events.

The age of the sediments at the site suggests they have been subjected to many moderate- and large-magnitude earthquakes since their deposition during the late Pleistocene. The relative density of the deposits at the site precludes the potential for significant coseismic compaction to occur as a result of strong earthquake ground shaking. Therefore, we consider the potential for coseismic compaction to occur to be low.

4.4.5 Slope Instability

The project site is situated on relatively-level ground. Two low slopes (less than 8 feet) are present on the site and are associated with fill placement. There are no historical landslides mapped in the project vicinity and no evidence for slope instability. Hence, we conclude the potential for slope instability or creep to affect the development is low.

5.0 Seismic Design Criteria

Based on the subsurface conditions encountered at our exploration locations, laboratory test results, and our interpretation of soil conditions within 100 feet of the ground surface, we classify the site as a Site Class D consisting of a "Stiff Soil" in accordance with Chapter 20 of ASCE 7-16. On this basis, the mapped and design spectral response accelerations were determined using the Structural Engineers Association of California (SEAOC) and California Office of Statewide Health Planning and Development (OSHPD) Seismic Design Maps (Accessed 6/19/20) in conjunction with the site class and the site coordinates for the project site (40.935886° N, -124.108102° W). Calculated values for ASCE 7-16 are presented in Table 1.

Table 1. ASCE 7-16 Spectral Acceleration Parameters

Parameter	0.2 Second	1 Second
Maximum Considered Earthquake Spectral Acceleration (MCE_R)	$S_S = 2.571$	$S_1 = 1.082$
Site Class	D	
Site amplification factor	$F_a = 1$	F_v = null – See Section 11.4.8
Site-modified spectral acceleration	$S_{MS} = 2.571$	S_{M1} = null – See Section 11.4.8
Numeric seismic design value	$S_{DS} = 1.714$	S_{D1} = null – See Section 11.4.8
Seismic Design Category (SDC)	null – See Section 11.4.8	
MCE_G peak ground acceleration (PGA)	1.086	
Site amplification factor at PGA (F_{PGA})	1.1	
Site modified peak ground acceleration (PGA_M)	1.15	

The 2019 CBC incorporates procedures outlined in ASCE 7-16. Section 11.4.8 of ASCE 7-16 and other referenced sections provide options for either developing a ground motion hazard analysis or taking exceptions. The applicable exception for this project is Exception 2 because the design Site Class is D and because S_1 is greater than 0.2 g. Exception 2 requires using a seismic response coefficient C_S determined by Eq. 12.8.2 for values of $T \leq 1.5T_S$ and taken as equal to 1.5 times the value computed in accordance with either Eq. 12.8.3 for $T_L \geq T > 1.5T_S$ or Eq. 12.8.4 for $T > T_L$. The intent of the code is to increase the design seismic base shear for longer periods unless a detailed ground motion hazard analysis is performed allowing for lower design base shears for the longer periods.

Section 11.4.8 permits a site response analysis in accordance with Section 21.1 of ASCE 7-16 and/or a ground motion hazard analysis in accordance with Section 21.2 to determine ground motions for any structure. SHN can, however, provide the ground motion hazard analysis if the structural engineer/owner determines that developing one will significantly reduce construction and design costs.

6.0 Conclusions and Recommendations

Based on the results of our current field and laboratory investigation, it is our opinion the project is feasible from a geotechnical standpoint, provided that our recommendations are implemented during design and construction. In addition, we believe the proposed residential structures can be supported on conventional spread footings. The geotechnical considerations for development of the single-family residences include the potential for strong seismic shaking and shallow groundwater conditions, the presence of as much as 7.75 feet of low-density topsoil of medium compressibility and/or old unengineered fill of variable density.

Foundations and concrete slabs placed directly on the low-density topsoil and/or unengineered fill could undergo erratic settlement when loaded. Development of criteria for foundation design and support of concrete flatwork will require consideration of these near-surface soils. The supporting capacity of the low-density topsoils and unengineered fill can be improved by overexcavation and replacement with properly compacted engineered fill within and adjacent to building and exterior slab areas. These overexcavated soils will be suitable for reuse as engineered fill after removal of debris and perishable material.

The site is likely to experience strong seismic ground shaking resulting from earthquakes on active faults in the region during the design life of the proposed structures. The intensity of ground shaking from

earthquakes will depend on several factors, including the distance from the site to the earthquake focus, the magnitude and duration of the earthquake, and the response of the underlying soil and bedrock. At a minimum, it will be necessary to design and construct the proposed structures in accordance with the earthquake-resistant provisions of the governing code.

6.1 Site Preparation and Grading

Site preparation includes removal of debris, organics, organic topsoil, loose soil, and any other unsuitable material. Site preparation operations should extend at least 5 feet beyond the limits of improvements. We anticipate that stripping to a depth of about 2 to 4 inches will be required to remove the organics. Deeper stripping may be locally required to remove concentrations of vegetation, such as brush and tree roots. Where the removal of large tress is required, it will be necessary to remove all major root systems, then fill the excavations with properly placed engineered fill compacted to at least 90 percent relative compaction[1]. The cleared vegetation and debris should be removed from the site, but the strippings can be stockpiled for reuse in landscape areas.

Any vegetation and organic topsoil with more than 2 percent organic material by dry weight should be removed. The geotechnical engineer should observe and approve the prepared site prior to any excavation, subgrade preparation, and placement of fill or improvements.

In areas intended to support new foundations and engineered fill, and for a horizontal distance of at least 5 feet beyond, the low-density topsoils and unengineered fill should be over-excavated down to the underlying yellow-brown terrace sediments. The overexcavated subgrade should be scarified to a depth of 6 inches, moisture conditioned or aerated and recompacted to 90 percent relative compaction. The geotechnical engineer or qualified representative should observe and approve the overexcavation, prior to subgrade preparation and placement of engineered fill or improvements. The approved surface may then be brought to pad grade with properly placed engineered fill compacted to at least 90 percent relative compaction.

Site grading during and shortly after the rainy season is typically difficult and/or uneconomical. Onsite soils will have moisture contents well above optimum and will require greater than normal spreading, mixing, and/or aeration to achieve near-optimum moisture content suitable for required compaction.

6.2 Excavations

Temporary unbraced construction excavations should be made no steeper than 1.5H:1V (horizontal to vertical). This recommendation is applicable where construction loads are at least two times the excavation depth away with a minimum of 5 feet from the excavation.

Groundwater can be expected to be encountered at depths as shallow as about 5 feet, depending on the time of the year. Consideration should be given to performing the overexcavation during the summer or early fall months. Excavated slopes encountering groundwater seepage into the excavation should be examined immediately by the geotechnical engineer or qualified representative to determine whether the slope should be flattened.

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[1] Relative compaction refers to the in-place dry density of a soil expressed as a percentage of the maximum dry density of the same soil, as determined by the ASTM D1557 compaction test procedure. Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density.

The top of unbraced excavations should not be subject to surcharge loads (such as construction traffic, stockpiled building materials, or excavation spoils).

The contractor shall be responsible for the stability of all temporary excavations and should comply with applicable Occupational Safety and Health Administration (OSHA) regulations (California Construction Safety Orders, Title 8).

All open excavations should be regularly monitored for evidence of incipient instability.

6.3 Engineered Fill

Fill placed in areas to support proposed foundations should meet the requirements for select engineered fill. Engineered fill should have less than 2 percent by dry weight of vegetation and deleterious material and should meet the gradation requirements presented in Table 2.

Table 2. Fill Gradation Criteria

Sieve Designation	Percent Passing by Dry Weight
3-inch (50 mm)[1]	100
1½-inch (37.5 mm)	90 minimum
¾-inch (19 mm)	70 minimum
No. 4 (4.75 mm)	60 minimum
No. 200 (75 µm)[2]	5 minimum; 30 maximum
1. mm: millimeters 2. µm: micrometers	

Fine-grained soil with a liquid limit greater than 40 and a plasticity index greater than 15 should not be used as engineered fill. If clayey soils do not meet the plasticity requirements, mixing of the clayey soils with sandier soils may be required. Crushing and/or removal of rock particles greater than 3 inches in size will be required. In addition, we do not recommend using river-run material as engineered fill; crushed, angular material is preferred. Imported fill material should be approved by the geotechnical engineer prior to transporting to the site.

Engineered fill should be placed in loose lifts not exceeding 8 inches in thickness and compacted to a minimum of 90 percent relative compaction. The geotechnical engineer should approve all fill prior to placement.

A qualified field technician should be present to observe fill placement and perform field density tests in accordance with ASTM D 6938 at random locations throughout each lift to verify that the specified compaction is being achieved.

6.4 Wet Weather Subgrade Protection

The near-surface soils consist of loose non-cohesive fine-grained granular materials and/or soft fine-grained silts. We expect that both light and heavy construction equipment will have difficulty operating on the near-surface soils if grading commences during and/or immediately following the wet season. Contactors should expect high soil moisture conditions in the near-surface soils throughout the wet season and into the late spring months following a typical winter wet season. The wet season in coastal northern California generally begins in the month of November and continues through May. Heavy rains are also not uncommon during

the months of October and June. Beginning construction activities and earthwork immediately prior to the onset of the wet season is not advised and will likely lead to delays if measures are not taken to stabilize and protect the exposed subgrade.

Soils that have been disturbed during site preparation activities, or unsuitable areas identified during proof-rolling or probing, should be removed to firm ground and replaced with stabilization material and compacted structural fill.

Protection of the subgrade is the responsibility of the contractor. Track-mounted excavating equipment may be required during and following wet weather. The contractor will be responsible for constructing an all-weather access road and staging area. The thickness of the haul road to access the currently undeveloped portions of the site for construction and staging areas will depend on the amount and type of construction traffic. The materials used for haul roads or site access drives should be stabilization material consisting of pit or quarry run rock that is well-graded, angular, crushed rock consisting of 4- to 6-inch minus material with less than 5 percent passing the US Standard No. 4 Sieve. The material should be free of organic matter and other deleterious material. A minimum 6- to 12-inch thick mat of stabilization material should be used for light staging areas. The stabilization material for haul roads and areas with repeated heavy construction traffic will likely need to be increased to between 12- to 18-inches. The actual thickness of haul roads and staging areas should be based on the contractor's approach to site work and the amount and type of construction traffic, and is the contractor's responsibility. The stabilization material should be placed in one lift over the prepared, undisturbed subgrade and compacted using a smooth-drum, non-vibratory roller. Additionally, a geotextile fabric should be placed as a barrier between the subgrade and stabilization material. The geotextile should meet specifications for soil separation and stabilization, such as Mirafi 600X or equivalent.

6.5 Surface Drainage Control

Surface drainage should be planned to prevent ponding and enable water to drain away from foundations and towards suitable collection or discharge facilities. A positive surface drainage of at least 4 percent is recommended within 10 feet of all building foundations. Surface runoff should be directed to the nearest project drainage control system and not allowed to pond. Roof drainage systems should be planned to direct rainwater away from building foundations.

6.6 Utility Trench Backfill

New utility trenches excavated parallel to spread footing foundations should be set back from the footings such that the trench bottoms lie outside a projected hypothetical 1.5H:1V line extending downward from the footing bottom.

Unless concrete bedding is required around utilities, bedding should consist of sand having a sand equivalent (SE) of at least 30. The bedding should extend from 6 inches below to 1 foot above the conduit or pipe. Sand bedding should not be jetted or ponded into place and should be mechanically compacted to a minimum of 90 percent relative compaction.

In areas to support improvements (such as adjacent-to-structure foundations), backfill placed above the bedding in utility trenches (including culvert and sprinkler lines) should be properly placed and adequately compacted to minimize settlement and provide a stable subgrade. If possible, the trench backfill should be compacted following rough grading, but prior to final grading and compaction. Onsite inorganic soils meeting the requirements for engineered fill may be used as trench backfill. Backfill consisting of onsite

soils should be placed in layers not exceeding 8 inches in loose thickness, moisture-conditioned, and compacted to at least 90 percent relative compaction as described for engineered fill. Trench backfill need only be compacted to 85 percent relative compaction in landscape areas or in areas more than 5 feet beyond the limits of building foundations.

6.7 Foundations

The proposed structures can be supported by spread footings bottomed a minimum of 18 inches below adjacent soil subgrade in the properly compacted engineered fill. Such foundations may be designed for an allowable bearing capacity of 2,500 pounds per square foot (psf) for dead plus long-term live loads. This value may be increased by one-third to account for short-term effects of wind and seismic loading.

A horizontal friction coefficient of 0.30 times the net vertical dead load may be used for the footing/soil contact. Frictional resistance may be calculated in conjunction with an allowable lateral passive pressure represented by an equivalent fluid weighing 300 pounds per cubic foot (pcf) for short-term loading, such as lateral foundation response to wind or earthquake loadings. Passive pressure should be neglected in the upper 12 inches unless confined by concrete slabs or asphalt pavement.

All foundation excavations should be observed and approved by the geotechnical engineer prior to placement of forms and reinforcing steel. The excavations should be trimmed neat, level and square. All loose, sloughed, and moisture-softened materials should be removed prior to setting reinforcing steel and placement of concrete.

6.8 Concrete Slabs-on-Grade

Slabs-on-grade are anticipated for garage floors, concrete walkways, outdoor patios, and may be used for some single-family residential structure slab-on-grade floors. Slabs-on-grade should be designed and reinforced in accordance with their anticipated use and loading as determined by the project Civil or Structural Engineer.

We recommend the slabs-on-grade have a minimum thickness of 4 inches, be reinforced with No. 3 rebar spaced at 24 inches each way, and exterior slabs-on-grade be reinforced with a minimum of 6x6 welded wire sheeting placed at the center of the slabs. If the reinforced concrete mat foundation is used for the multi-family residential structures, the slabs-on-grade should be reinforced based on the recommendations provided above for design of mat foundations.

Single-family residential floor slabs (if used) should be supported on a minimum of 4 inches of ¾- to 1-inch clean crushed rock to serve as a capillary break. If more than 12 inches of crushed rock will be used beneath these slabs, this capillary break layer should be placed in lifts and be nominally compacted during placement using a vibratory plate compactor.

Exterior slabs-on-grade should be supported on at least 4 inches of Caltrans Class II aggregate base. The subgrade and aggregate base for concrete slabs-on-grade should be prepared and compacted in accordance with the recommendations for engineered fill presented in Section 5.4 of this report.

Where surface moisture is undesirable, a vapor barrier should be used to minimize transmission of soil moisture. We recommend vapor barriers be a minimum of 10 mils thick. The vapor barrier shall be in accordance with ASTM E-1745, "Standard Specifications for Vapor Barrier Retarders used in Contact with Soil or Granular Fill under Concrete Slabs." The membrane should be placed in accordance with the

manufacturer's recommendations. The membrane should be overlapped at least 12 inches and taped at joints. Concrete may be placed directly on the vapor barrier, or as is common practice, the membrane may be covered with a few inches of sand to protect the membrane during construction, especially if the membrane is thin. If used, the sand should be wetted immediately prior to concrete placement to aid in concrete curing. Whether or not a sand layer is used, the membrane should be protected from tearing or puncture during construction.

6.9 Foundation Subdrains

Soil mottling observed in some of our test pits suggests that groundwater levels at the site have historically ranged to within 3 feet of the current ground surface. Because the topsoil at the site is not free-draining, high groundwater conditions during periods of prolonged rain could occur; therefore, waterproofing of the exterior of the foundation stem walls (within the height of the crawlspaces) and/or placement of subdrains at the perimeter foundation in the crawlspace should be considered in the design. The following general recommendations are provided for crawlspace subdrains.

Crawlspace subdrains should consist of either 3-inch or 4-inch diameter perforated polyvinyl chloride (PVC) pipe. The PVC pipe should be placed with its perforations face down, embedded in ¾- to 1-inch clean crushed rock completely enclosed in a non-woven drainage filter fabric (such as, Mirafi 140N or equivalent). Crawlspace subdrains should extend to the ground surface to allow the subdrains to provide drainage for any surface water in the crawlspace. Provisions should also be included to prevent moisture intrusion and/or prevent backflow of collected water along the subdrain pipes where they pass through foundations.

Subdrain pipes should be sloped to drain by gravity and be connected to PVC tightline pipes discharging collected water by gravity flow to the project drainage system. Cleanouts should be provided at the upgradient ends of the subdrains, and at every third 90-degree bend in the pipes. Surface runoff conveyance systems, downspouts, and roof-water leaders should not be connected to subdrain systems.

7.0 Construction Considerations

The following construction considerations are presented to aid in project planning. They are not intended to be comprehensive.

Groundwater is not anticipated to be encountered during foundation excavation provided the excavation is performed during the dry months. However, groundwater levels can fluctuate during the wet season due to prolonged periods of precipitation and other factors resulting in groundwater levels higher than observed during our investigation. It is important to note that even small quantities of persistent seepage can substantially complicate construction operations (such as due to infiltration of surface runoff, or when foundation excavations are extended near the groundwater surface).

Due to the weak nature of the unengineered fill and topsoil at the site, trenches may be subject to sidewall instability (sloughing, running, or sudden collapse), particularly in areas where the topsoil has not been previously removed and replaced as engineered fill. The contractor is responsible for planning, scheduling, and implementing construction activities and associated construction site safety issues. OSHA Excavation and Trench Safety Standards and applicable local, state, and federal regulations should be acknowledged and followed.

8.0 Additional Services

We suggest communications be maintained during the design phase between the design team and SHN to optimize compatibility between the design and soil conditions. We also recommend that SHN be retained during the construction phase to verify the implementation of our recommendations related to earthwork.

8.1 Plan and Specification Review

We have assumed, in preparing our recommendations, that SHN will be retained to review those portions of the plans and specifications that pertain to earthwork and foundations, if prepared by others. The purpose of this review is to confirm that our earthwork and foundation recommendations have been properly interpreted and implemented during design. If we are not provided this opportunity for review of the plans and specifications, our recommendations could be misinterpreted.

8.2 Construction-Phase Monitoring

In order to assess construction conformance with the intent of our recommendations, it is important that a representative of SHN perform the following tasks:

1. Monitor site stripping, including overexcavation of the low-density topsoil and unengineered fill material and debris, and any other unsuitable material if it is determined this is required.
2. Monitor subgrade preparation.
3. Observe and test placement of structural fill and backfill.
4. Observe foundation excavations.
5. Observe placement and compaction of subgrade and aggregate base in asphalt-paved areas.

This construction-phase monitoring is important, because it provides the stakeholders and SHN the opportunity to verify anticipated site conditions and recommend appropriate changes in design or construction procedures if site conditions encountered during construction vary from those described in this report. It also allows SHN to recommend appropriate changes in design or construction procedures if construction methods adversely affect the competence of onsite soils to support the structural improvements.

9.0 Limitations

The geotechnical conclusions and recommendations presented in this report are intended for planning and design of the new building and related improvements at the project site as described in this report. These conclusions and recommendations may not apply if:

- changes are made to the proposed construction,
- the report is used for a different site,
- the recommendations given in this report are not followed, or
- any other change is made that materially alters the proposed project.

The analyses and recommendations presented in this report are based upon interpretation of data obtained from the exploration locations located approximately, as shown on Figures 2 and 3 and on general field observations made during the site investigation. Subsurface exploration of any site is necessarily confined to selected locations and subsurface conditions may, and usually do, vary between and around these

locations. Any person associated with this project who observes conditions or features of the site or its surrounding areas that are different from those described in the report should report them immediately to SHN for evaluation. If varied conditions come to light during project development, SHN should be given the opportunity to evaluate the need for additional exploration, testing, or analysis.

The geotechnical recommendations and design criteria given in this report are sensitive to the location, design details, and any special requirements of the new construction. For this reason, we recommend SHN be given the opportunity to review the geotechnical elements of project grading, foundation plans, and specifications to check that the intent of our recommendations have been incorporated into these project documents. If SHN does not review the geotechnical elements of the plans and specifications, the reviewing geotechnical engineer should thoroughly review this report and should agree with its conclusions and recommendations or otherwise provide alternative recommendations. Furthermore, if another geotechnical consultant is retained for follow-up service to this report, SHN will at that time cease to be the geotechnical engineer-of-record. SHN cannot assume responsibility or liability for the adequacy of our geotechnical recommendations unless SHN is retained to observe the soil-related portions of the construction.

This report was prepared in accordance with the generally accepted standards of geotechnical engineering practice in Humboldt County at the time this report was written. No other warranty, express or implied, is made. It is the owner's responsibility to see that all parties to the project, including the designers, contractors, and subcontractors, are made aware of this report in its entirety.

It should be noted that changes in the standards of practice in the field of geotechnical engineering, changes in site conditions (such as new excavations or fills, new agency regulations, or modifications to the proposed project) are grounds for this report to be professionally reviewed. In light of this, there is a practical limit to the usefulness of this report without critical professional review. It is suggested that 2 years be considered a reasonable time for the usefulness of this report.

10.0 References

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Subsurface Exploration Logs

1

PROJECT: Washington Terrace Subdivision
LOCATION: Washington Terrace Lot 25/26
GROUND SURFACE ELEVATION: 149 Feet
EXCAVATION METHOD: Backhoe
LOGGED BY: P. Sundberg

JOB NUMBER: 020060
DATE EXCAVATED: 4/17/2020
TOTAL DEPTH OF TEST PIT: 10 Feet
SAMPLER TYPE: Hand-driven tube
Bulk

TEST PIT NUMBER
TP-1

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLES	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (tsf) by P.P.	% Passing 200	REMARKS
0.0			SM		SILTY SAND; Dark brown, medium dense, moist, non-plastic, roots up to 1/2" (FILL).	28.4	80.7		>4.5	40.6	FILL
-1.0		■									
-2.0											
-3.0			SM		SILTY SAND; Very dark brown, medium dense, moist, non-plastic, fine sand.	33.7	68.2		2.0		NATIVE TOPSOIL
-4.0		■									
-5.0											
-6.0			SM		SILTY SAND; Yellowish-brown, medium dense, moist, non-cemented, fine sand, mottled.						MARINE TERRACE DEPOSITS
-7.0	☒										
-8.0											
-9.0											
-10.0					Excavation terminated at a depth of 10 feet. Groundwater not encountered. Test pit backfilled with excavated spoils.						
-11.0											
-12.0											
-13.0											
-14.0											
-15.0											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF TEST PIT

PROJECT: Washington Terrace Subdivision
LOCATION: Washington Terrace Lot 22/23
GROUND SURFACE ELEVATION: 149 Feet
EXCAVATION METHOD: Backhoe
LOGGED BY: P. Sundberg

JOB NUMBER: 020060
DATE EXCAVATED: 4/17/2020
TOTAL DEPTH OF TEST PIT: 10 Feet
SAMPLER TYPE: Hand-driven tube

TEST PIT NUMBER
TP-2

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLES	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (tsf) by P.P.	% Passing 200	REMARKS
0.0			SM		SILTY SAND; Dark brown, medium dense, moist, non-cemented (FILL).						FILL
-1.0											
-2.0		■				22.7	83.6		>4.5		
-3.0											
-4.0			SM		SILTY SAND; Very dark brown, medium dense, moist, fine sand, few coarse sand, non-plastic.						NATIVE TOPSOIL
-5.0		■				29.4	74.3		2.75	45.1	
-6.0											
-7.0											
-8.0			SM		SILTY SAND; Yellowish-brown, medium dense, moist, non-cemented, mottled, fine sand.						MARINE TERRACE DEPOSITS
-9.0											
-10.0					Excavation terminated at a depth of 10 feet. Groundwater not encountered. Test pit backfilled with excavated spoils.						
-11.0											
-12.0											
-13.0											
-14.0											
-15.0											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF TEST PIT

PROJECT: Washington Terrace Subdivision
LOCATION: Washington Terrace Lot 27/28
GROUND SURFACE ELEVATION: 150 Feet
EXCAVATION METHOD: Backhoe
LOGGED BY: P. Sundberg

JOB NUMBER: 020060
DATE EXCAVATED: 4/17/2020
TOTAL DEPTH OF TEST PIT: 4.25 Feet
SAMPLER TYPE: Hand-driven tube

TEST PIT NUMBER
TP-3

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLES	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (tsf) by P.P.	% Passing 200	REMARKS
0.0			SM		SILTY SAND; Brown, medium dense, moist, many fine roots, weak cementation.						
-1.0			SM								
-2.0		■			SILTY SAND; Yellowish-brown, dense to very dense, fine to medium sand with zones of sandy clay and sandstone bedrock, apparent fractures and thin laminations a low and high angles, few fine to coarse angular to subrounded gravel and cobbles.	20.9	83.7			37.7	
-3.0											
-4.0											
-5.0					Excavation terminated at a depth of 4.25 feet. Groundwater not encountered. Test pit backfilled with excavated spoils.						
-6.0											
-7.0											
-8.0											
-9.0											
-10.0											
-11.0											
-12.0											
-13.0											
-14.0											
-15.0											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF TEST PIT

PROJECT: Washington Terrace Subdivision
LOCATION: Washington Terrace Lot 26/27/28
GROUND SURFACE ELEVATION: 150 Feet
EXCAVATION METHOD: Backhoe
LOGGED BY: P. Sundberg

JOB NUMBER: 020060
DATE EXCAVATED: 4/17/2020
TOTAL DEPTH OF TEST PIT: 3.75 Feet
SAMPLER TYPE:

TEST PIT NUMBER
TP-4

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLES	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (tsf) by P.P.	% Passing 200	REMARKS
0.0			SM		SILTY SAND; Dark brown, medium dense, moist, fine to medium sand.						TOPSOIL
-1.0											
-2.0											
-3.0											
			SM		SILTY SAND; Yellowish-brown, medium dense, moist.						MARINE TERRACE DEPOSITS
-4.0											
-5.0					Excavation terminated at a depth of 3.75 feet. Groundwater not encountered. Test pit backfilled with excavated spoils.						
-6.0											
-7.0											
-8.0											
-9.0											
-10.0											
-11.0											
-12.0											
-13.0											
-14.0											
-15.0											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF TEST PIT

PROJECT: Washington Terrace Subdivision
LOCATION: Washington Terrace Lot 30/31
GROUND SURFACE ELEVATION: 150 Feet
EXCAVATION METHOD: Backhoe
LOGGED BY: P. Sundberg

JOB NUMBER: 020060
DATE EXCAVATED: 4/17/2020
TOTAL DEPTH OF TEST PIT: 7.5 Feet
SAMPLER TYPE: Bulk

TEST PIT NUMBER
TP-5

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLES	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (tsf) by P.P.	% Passing 200	REMARKS
0.0			SM		SILTY SAND; Dark brown, medium dense, moist, fine sand.						TOPSOIL
-1.0											
-2.0											
-3.0											
-4.0			SM		SILTY SAND; Yellowish-brown, medium dense, moist, fine to medium sand, non cemented.						MARINE TERRACE DEPOSITS
-5.0											
-6.0			SM		WELL-GRADED SAND with SILT AND GRAVEL; Yellowish-brown, medium dense to dense, moist, fine to coarse rounded sand and gravel.						
-7.0	X										
-8.0					Excavation terminated at a depth of 7.5 feet. Groundwater not encountered. Test pit backfilled with excavated spoils.						
-9.0											
-10.0											
-11.0											
-12.0											
-13.0											
-14.0											
-15.0											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF TEST PIT

PROJECT: Washington Terrace Subdivision
LOCATION: Washington Terrace Lot 33/34
GROUND SURFACE ELEVATION: 150 Feet
EXCAVATION METHOD: Backhoe
LOGGED BY: P. Sundberg

JOB NUMBER: 020060
DATE EXCAVATED: 4/17/2020
TOTAL DEPTH OF TEST PIT: 9 Feet
SAMPLER TYPE: Hand-driven tube

TEST PIT NUMBER
TP-6

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLES	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (tsf) by P.P.	% Passing 200	REMARKS
0.0			SM		SILTY SAND; Dark b rown, medium dense, moist, fine sand, non cemented (FILL).						FILL
-1.0											
-2.0			SM		SILTY SAND; Very dark brown, medium dense, moist, fine sand, non cemented.						TOP SOIL
-3.0		■				29.7	74.9		4.0	49.3	
-4.0											
-5.0											
-6.0			SM		SILTY SAND; Yellowish-brown, medium dense, moist, fine to medium sand.						MARINE TERRACE DEPOSITS
-7.0											
-8.0			SM		SILTY SAND with GRAVEL; Olive brown, medium dense to dense, moist, fine to coarse rounded sand and gravel (~25%).						
-9.0					Excavation terminated at a depth of 9 feet. Groundwater not encountered. Test pit backfilled with excavated spoils.						
-10.0											
-11.0											
-12.0											
-13.0											
-14.0											
-15.0											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF TEST PIT

PROJECT: Washington Terrace Subdivision
LOCATION: Washington Terrace Lot 36/37
GROUND SURFACE ELEVATION: 150 Feet
EXCAVATION METHOD: Backhoe
LOGGED BY: P. Sundberg

JOB NUMBER: 020060
DATE EXCAVATED: 4/17/2020
TOTAL DEPTH OF TEST PIT: 9 Feet
SAMPLER TYPE: Hand-driven tube

TEST PIT NUMBER
TP-7

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLES	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (tsf) by P.P.	% Passing 200	REMARKS
0.0			SM		SILTY SAND; Dark brown, medium dense, moist, fine sand, non cemented (FILL).						FILL
-1.0											
-2.0											
-3.0											
-4.0	X		SM		SILTY SAND; Very dark brown, medium dense, moist, fine sand, non cemented.						TOPSOIL
-5.0											
-6.0											
-7.0											
-8.0			SM		SILTY SAND; Yellowish-brown, medium dense, moist, non cemented.						MARINE TERRACE DEPOSITS
-9.0					Excavation terminated at a depth of 9 feet. Groundwater not encountered. Test pit backfilled with excavated spoils.						
-10.0											
-11.0											
-12.0											
-13.0											
-14.0											
-15.0											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF TEST PIT

PROJECT: Washington Terrace Subdivision
LOCATION: Washington Terrace Lot 38/39
GROUND SURFACE ELEVATION: 141 Feet
EXCAVATION METHOD: Backhoe
LOGGED BY: P. Sundberg

JOB NUMBER: 020060
DATE EXCAVATED: 4/17/2020
TOTAL DEPTH OF TEST PIT: 7.5 Feet
SAMPLER TYPE: Hand-driven tube

TEST PIT NUMBER
TP-8

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLES	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (tsf) by P.P.	% Passing 200	REMARKS
0.0			ML		SANDY SILT; Very dark brown, soft, moist, non cemented, fine sand.						TOPSOIL
-1.0											
-2.0											
-3.0		■				23.4	69.3		1.0	54.3	
-4.0			SM		SILTY SAND; Yellowish-brown, medium dense, moist, few coarse rounded sand, non cemented.						MARINE TERRACE DEPOSITS
-5.0											
-6.0			SM		SILTY SAND with GRAVEL; Reddish-brown, medium dense to dense, moist, fine to coarse rounded sand and gravel (~25%), moderate to strong cementation.						
-7.0											
-8.0					Excavation terminated at a depth of 7.5 feet. Groundwater not encountered. Test pit backfilled with excavated spoils.						
-9.0											
-10.0											
-11.0											
-12.0											
-13.0											
-14.0											
-15.0											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF TEST PIT

PROJECT: Washington Terrace Subdivision
LOCATION: Washington Terrace Lot 4
GROUND SURFACE ELEVATION: 141 Feet
EXCAVATION METHOD: Backhoe
LOGGED BY: P. Sundberg

JOB NUMBER: 020060
DATE EXCAVATED: 4/17/2020
TOTAL DEPTH OF TEST PIT: 8 Feet
SAMPLER TYPE: Hand-driven tube

TEST PIT NUMBER
TP-9

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLES	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (tsf) by P.P.	% Passing 200	REMARKS
0.0			ML		SANDY SILT; Very dark brown, soft, moist, fine sand, non cemented.						TOPSOIL
-1.0											
-2.0											
-2.5		■							1.0		
-3.0											
-4.0					grades brown						
-4.5		■	SM		SILTY SAND; Yellowish-brown, medium dense, moist, fine to medium sand, non cemented, mottled.	20.0	75.4		1.25		MARINE TERRACE DEPOSITS
-5.0											
-6.0											
-7.0			SP-SM		POORLY GRADED SAND with SILT; Olive brown, medium dense, non cemented, fine to medium sand.						
-8.0					Excavation terminated at a depth of 8 feet. Groundwater not encountered. Test pit backfilled with excavated spoils.						
-9.0											
-10.0											
-11.0											
-12.0											
-13.0											
-14.0											
-15.0											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF TEST PIT

PROJECT: Washington Terrace Subdivision
LOCATION: Washington Terrace Lot 11
GROUND SURFACE ELEVATION: 139 Feet
EXCAVATION METHOD: Backhoe
LOGGED BY: P. Sundberg

JOB NUMBER: 020060
DATE EXCAVATED: 4/17/2020
TOTAL DEPTH OF TEST PIT: 8 Feet
SAMPLER TYPE:

TEST PIT NUMBER
TP-10

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLES	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (tsf) by P.P.	% Passing 200	REMARKS
0.0			ML		SANDY SILT; Very dark brown, soft, moist, fine sand, non cemented, 1/4" roots at top.						TOPSOIL
-1.0											
-2.0											
-3.0											
-4.0											
-5.0			SM		SILTY SAND; Yellowish-brown, medium dense, moist, fine to medium sand, non cemented, few strongly cemented nodules, mottled.						MARINE TERRACE DEPOSITS
-6.0											
-7.0											
-8.0					Excavation terminated at a depth of 8 feet. Groundwater not encountered. Test pit backfilled with excavated spoils.						
-9.0											
-10.0											
-11.0											
-12.0											
-13.0											
-14.0											
-15.0											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF TEST PIT

PROJECT: Washington Terrace Subdivision
LOCATION: Washington Terrace Lot 1/7
GROUND SURFACE ELEVATION: 143 Feet
EXCAVATION METHOD: Backhoe
LOGGED BY: P. Sundberg

JOB NUMBER: 020060
DATE EXCAVATED: 4/17/2020
TOTAL DEPTH OF TEST PIT: 9 Feet
SAMPLER TYPE:

TEST PIT NUMBER
TP-11

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLES	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (tsf) by P.P.	% Passing 200	REMARKS
0.0			SM		SILTY SAND; Very dark brown, medium dense, moist, fine sand, fine to 1/4" roots at the top (FILL).						FILL
-1.0											
-2.0											
-3.0			SM		SILTY SAND; Very dark brown, medium dense, moist, fine sand, non cemented.						TOPSOIL
-4.0											
-5.0					grades brown						
-6.0			SM		SILTY SAND; Yellowish-brown, medium dense, moist, fine to medium sand, weak cementeation, mottled.						MARINE TERRACE DEPOSITS
-7.0											
-8.0											
-9.0					Excavation terminated at a depth of 9 feet. Groundwater not encountered. Test pit backfilled with excavated spoils.						
-10.0											
-11.0											
-12.0											
-13.0											
-14.0											
-15.0											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF TEST PIT

PROJECT: Washington Terrace Subdivision
LOCATION: Washington Terrace Lot 16/18
GROUND SURFACE ELEVATION: 142 Feet
EXCAVATION METHOD: Backhoe
LOGGED BY: P. Sundberg

JOB NUMBER: 020060
DATE EXCAVATED: 4/17/2020
TOTAL DEPTH OF TEST PIT: 8 Feet
SAMPLER TYPE:

TEST PIT NUMBER
TP-12

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLES	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (tsf) by P.P.	% Passing 200	REMARKS
0.0			SM		SILTY SAND; Dark brown/yellowish-brown, thinly bedded (FILL).						FILL
			ML		SANDY SILT; Very dark brown, medium stiff, moist, fine sand, non cemented.						TOPSOIL
-1.0											
-2.0											
-3.0											
-4.0			SM		SILTY SAND; Yellowish-brown, medium dense, moist, weak cementation, mottled, fine sand.						MARINE TERRACE DEPOSITS
-5.0											
-6.0			SP-SM		POORLY GRADED SAND with SILT; Olive brown, medium dense, non cemented, fine sand, mottled.						
-7.0											
-8.0					Excavation terminated at a depth of 8 feet. Groundwater not encountered. Test pit backfilled with excavated spoils.						
-9.0											
-10.0											
-11.0											
-12.0											
-13.0											
-14.0											
-15.0											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF TEST PIT

Laboratory Test Results

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Phone: (707) 441-8855 Email: info@shn-engr.com Web: shn-engr.com
812 W. Wabash Avenue, Eureka, CA 95501-2138

DENSITY BY DRIVE- CYLINDER METHOD (ASTM D2937)

Project Name:	JLF Washington Terrace	Project Number:	020060
Performed By:	JMA	Date:	6/10/2020
Checked By:	NAN	Date:	6/11/2020
Project Manager:	GDS		

Lab Sample Number	20-627	20-628	20-630	20-631	20-632
Boring Label	TP1	TP1	TP2	TP2	TP3
Sample Depth (ft)	1-1.5	3.5-4	1.5-2	4.25-4.75	1.5-2
Diameter of Cylinder, in	2.42	2.42	2.42	2.42	2.42
Total Length of Cylinder, in.	6.00	6.00	6.00	6.00	6.00
Length of Empty Cylinder A, in.	0.00	0.00	0.00	0.00	0.00
Length of Empty Cylinder B, in.	0.50	0.82	0.52	0.48	1.71
Length of Cylinder Filled, in	5.50	5.18	5.48	5.52	4.29
Volume of Sample, in^3	25.30	23.83	25.21	25.39	19.73
Volume of Sample, cc.	414.56	390.44	413.05	416.06	323.35

Pan #	ss9	ss10	ss1	ss15	ss14
Weight of Wet Soil and Pan	884.7	766.1	873.6	834.7	716.5
Weight of Dry Soil and Pan	732.4	622.2	748.2	689.3	626.1
Weight of Water	152.3	143.9	125.4	145.4	90.4
Weight of Pan	196.6	195.5	194.9	194.4	192.8
Weight of Dry Soil	535.8	426.7	553.3	494.9	433.3
Percent Moisture	28.4	33.7	22.7	29.4	20.9
Dry Density, g/cc	1.29	1.09	1.34	1.19	1.34
Dry Density, lb/ft^3	80.7	68.2	83.6	74.3	83.7

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DENSITY BY DRIVE- CYLINDER METHOD (ASTM D2937)

Project Name:	JLF Washington Tarrace	Project Number:	020060
Performed By:	JMA	Date:	6/10/2020
Checked By:	NAN	Date:	6/11/2020
Project Manager:	GDS		

Lab Sample Number	20-634	20-636	20-639	20-640	
Boring Label	TP6	TP8	TP9	TP9	
Sample Depth (ft)	2.25-2.75	2.25-2.75	2.25-2.75	4.25-4.75	
Diameter of Cylinder, in	2.42	2.42	2.42	2.42	
Total Length of Cylinder, in.	6.00	6.00	6.00	6.00	
Length of Empty Cylinder A, in.	0.00	0.41	1.07	0.00	
Length of Empty Cylinder B, in.	0.00	0.00	0.00	0.00	
Length of Cylinder Filled, in	6.00	5.59	4.93	6.00	
Volume of Sample, in^3	27.60	25.71	22.68	27.60	
Volume of Sample, cc.	452.24	421.34	371.59	452.24	

Pan #	ss11	ss2	a12	a1	
Weight of Wet Soil and Pan	896.5	771.2	585.5	740.9	
Weight of Dry Soil and Pan	735.2	661.5	490.1	631.8	
Weight of Water	161.3	109.7	95.4	109.1	
Weight of Pan	192.7	193.5	87.3	85.9	
Weight of Dry Soil	542.5	468.0	402.8	545.9	
Percent Moisture	29.7	23.4	23.7	20.0	
Dry Density, g/cc	1.20	1.11	1.08	1.21	
Dry Density, lb/ft^3	74.9	69.3	67.7	75.4	

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PERCENT PASSING # 200 SIEVE (ASTM - D1140)

Project Name:	JLF	Project Number:	020060
Performed By:	Washington Terrace	Date:	6/10/2020
Checked By:	NAN	Date:	6/11/2020
Project Manager:	GDS		

Lab Sample Number	20-627	20-631	20-632	20-634	20-636
Boring Label	TP1	TP2	TP3	TP6	TP8
Sample Depth	1-1.5	4.25-4.75	1.5-2	2.25-2.75	2.25-2.75
Pan Number	ss9	ss15	ss14	ss11	ss2
Dry Weight of Soil & Pan	307.2	408.4	374.9	377.3	334.6
Pan Weight	196.6	194.4	192.8	192.7	193.5
Weight of Dry Soil	110.6	214.0	182.1	184.6	141.1
Soil Weight Retained on #200&Pan	262.3	311.8	306.3	286.2	258.0
Soil Weight Passing #200	44.9	96.6	68.6	91.1	76.6
Percent Passing #200	**40.6**	**45.1**	**37.7**	**49.3**	**54.3**

Lab Sample Number					
Boring Label					
Sample Depth					
Pan Number					
Dry Weight of Soil & Pan					
Pan Weight					
Weight of Dry Soil					
Soil Weight Retained on #200&Pan					
Soil Weight Passing #200					
Percent Passing #200					

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