APPENDIX E
Geotechnical Study

SOUTHWEST GAS CORPORATION

January 14, 2019

Mr. Steven A. Kupferman, Principal Geologist
Lilburn Corporation
1905 Business Center Dr.
San Bernardino. CA 92408

RE: Permit Application # GTR-2018-00144/P20180097
Response

Dear Mr. Kupferman,

Listed below are each of the Comments and Corrections from Geotechnical Report Review Sheet for the above referenced Permit Application with response and/or comment following each.

1) The report referenced above indicates that there is a potential for liquefaction relative to the proposed project. A quantitative liquefaction evaluation shall be provided. The analysis shall be based on historic groundwater high levels. Potential liquefaction impacts shall be identified relative to site construction and post construction conditions. Liquefaction mitigation measures shall be recommended, if considered appropriate.
   a. Southwest Gas respectfully submits the following in response to the condition: The Northshore High Pressure Steel replacement project is designed to replace existing 6-inch steel pipeline having a wall thickness of .156 and a grade of X-42. This pipeline was installed in 1964 very near to the location of the proposed 8-inch steel having a wall thickness of .322 and grade of X-52. The existing pipeline has endured numerous seismic events with no adverse effects and could realistically remain in service indefinitely. The design of the proposed pipeline adheres to all federal and state regulations Southwest Gas is bound by related to strength and safety and encompasses measures that would most likely be considered for liquefaction mitigation if recommendations were consider appropriate. These measures include pipe material specifications that exceed the operating needs of the pipeline and control valves located within the project boundary that would allow for isolation of the pipeline in the event of failure. With these measures already in place, we would ask what value a quantitative liquefaction evaluation would provide and request that the condition be removed.
2) The boring logs indicated iron staining at shallow depths. The geotechnical consultant shall indicate if this iron staining is indicative of previous groundwater levels. If so,

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specific measures shall be provided relative to mitigation of groundwater impacts during site construction. ***Please see memo enclosed from Trinity***

3) The potential for seiches associated with Big Bear Lake shall be evaluated relative to potential impacts during site construction. Mitigation measures shall be provided, if considered appropriate. ***Please see memo enclosed from Trinity***
4) It was noted during a search of the Board for Professional Engineers, Land Surveyors, and Geologists that the Geotechnical Engineering License for Van Olin is delinquent. This license shall either be brought current or the report shall be revised and signed without the GE license. ***Please see memo enclosed from Trinity***

If you have any questions or require additional information, please do not hesitate to contact me.

Respectfully,

Pam Chavez
Engineering Technician
Southwest Gas Corporation
Southern California Division / Engineering
Office – 760.951.4084

Enclosure

CC: Jim Morrissey

TRINITY
GEOTECHNICAL ENGINEERING, INC.

EN Engineering, LLC
626 Wilshire Blvd., Suite 1020
Los Angeles, CA 90017

December 20, 2018
Project No.: T230

Attention: **Mr. Alejandro Martinez, PE**

Project: Southwest Gas Corporation
Gasline Installation
Northshore Drive and Stanfield Cutoff
Big Bear Lake, California

Subject: REVIEW RESPONSE No. 1:

References:

1. Geotechnical Study, Southwest Gas Corporation, Gasline Installation, Northshore drive and Stanfield Cutoff, Big Bear Lake, California, prepared by Trinity Geotechnical Engineering, Project No.: T230, dated September 14, 2018;
2. San Bernardino County Land Use Services Geotechnical Report Review Sheet, prepared by Lilburn Corporation, dated December 4, 2018.

Dear Mr. Martinez:

Trinity Geotechnical Engineering, Inc. (TGE) previously prepared a Geotechnical Study for the referenced project. TGE has prepared this letter to respond to the review comments provided by the Lilburn Corporation for the County of San Bernardino. The review comments are provided in italics below along with our responses:

1) *The report referenced above indicates that there is a potential for liquefaction relative to the proposed project. A quantitative liquefaction evaluation shall be provided. The analysis shall be based on historic groundwater high levels. Potential liquefaction impacts shall be identified relative to site construction and post construction conditions. Liquefaction mitigation measures shall be recommended, if considered appropriate.*

   As stated in our report a quantitative liquefaction study was not part of the scope of our services. The potential for liquefaction has been brought to the attention of Southwest Gas Corporation representatives. It is our understanding that the client is currently performing a risk evaluation and will address this issue with the county.

2) *The boring logs indicated iron staining at shallow depths. The geotechnical consultant shall indicate if this iron staining is indicative of previous groundwater levels. If so, specific measures shall be provided relative to mitigation of groundwater impacts during site construction.*

According to the Big Bear Lake Municipal Water Department information the high water mark for BBL is ~ 6744 MSL. (spillway crest elevation). Current information states the water level is down ~ 18-ft (~ 6726 MSL) from the crest . Our borings ranged from ~ 6770 MSL (B3) to 6830 MSL (B1) along Northshore Dr. within the proposed trench alignment. Groundwater was not encountered in any borings during our investigation and is not anticipated to impact the shallow cut and cover trench construction. The observed minor iron oxide staining does not appear to be related to previous groundwater levels but rather indicative of the mineralogy of the soil and typical oxide weathering where intermittent surface precipitation (in the form of rain, snow or other sources) migrate through a well drained medium in a semi-arid climate.

3) *The potential for seiches associated with Big Bear Lake shall be evaluated relative to potential impacts during site construction. Mitigation measures shall be provided, if considered appropriate.*

The road surface elevation of Northshore Dr. along the proposed alignment ranges from about 6830 MSL to 6770 MSL. The closest point of trench construction activity to the lake shoreline is > 100-ft (excluding the HDD Stanfield cut-off segment). Given the BBL high water surface 6744 MSL with an average depth of 35-ft (note, current lake surface level at ~6726 MSL with an average depth of about 17-ft) and the distance from the shoreline potential impacts from a seiche event are considered negligible. No mitigation is required.

4) *It was noted during a search of the Board for Professional Engineers, Land Surveyors, and Geologists that the Geotechnical Engineering License for Van Olin is delinquent. This license shall either be brought current or the report shall be revised and signed without the GE license.*

Mr. Olin's GE license is current.

TGE appreciates the opportunity to be of service. If you have any questions or require additional information, please do not hesitate to contact this office at (858) 486-2888.

Respectfully submitted,
TRINITY Geotechnical Engineering, Inc.

Jeffrey Magalong, PE
President

Dennis Poland, PG, CEG
Principal Engineering Geologist

Reviewed by,
VO Engineering, Inc.

Van Olin, PE, GE
Principal Geotechnical Engineer

JM/DP/VO

Distribution: (1) Addressee, via email

Geotechnical Study

Southwest Gas Corporation
Gasline Installation
Northshore Drive and Stanfield Cutoff
Big Bear Lake, California

Prepared for:

EN Engineering, LLC
626 Wilshire Blvd., Suite 1020
Los Angeles, CA 90017

Attention: Mr. Alejandro Martinez, PE

September 14, 2018

TRINITY Geotechnical Engineering, Inc.
13230 Evening Creek Drive, Suite 206
San Diego, CA 92128

TGE Project No.: T230

EN Engineering, LLC
626 Wilshire Blvd., Suite 1020
Los Angeles, CA 90017

September 14, 2018
Project No.: T230

Attention: **Mr. Alejandro Martinez, PE**

Subject: GEOTECHNICAL STUDY

Project: Southwest Gas Corporation
Gasline Installation
Northshore Drive and Stanfield Cutoff
Big Bear Lake, California

Dear Mr. Martinez:

Trinity Geotechnical Engineering, Inc. (TGE) is pleased to present this Geotechnical Study for the Southwest Gas Corporation's Gasline Installation at Northshore Drive and Stanfield Cutoff. This study included research, field investigation, and laboratory testing for the proposed replacement of approximately 2.4 miles of existing Vintage Steel Pipe with 8-inch steel high pressure (STL HP) gas pipeline in Big Bear Lake, California. Geotechnical design parameters and construction recommendations are provided for the proposed replacement pipeline to be installed using conventional cut-and-cover trench methods. Recommendations for the horizontal direction drilling (HDD) installation section at the Stanfield Cutoff are beyond the scope of this study.

TGE appreciates the opportunity to provide this geotechnical engineering service for this project and we look forward to continuing our role as your geotechnical engineering consultant. Please do not hesitate to contact the undersigned with any questions, comments, or concerns regarding this project.

Respectfully submitted,
TRINITY Geotechnical Engineering, Inc.

Jeffrey Magalong, PE
President

Dennis Poland, PG, CEG
Principal Engineering Geologist

Reviewed by,
VO Engineering, Inc.

Van Olin, PE, GE
Principal Geotechnical Engineer

JM/DP/VO

Distribution: (1) Addressee, via email

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APPENDICES

1. INTRODUCTION

This report provides the results of our geotechnical study conducted for the 8-inch steel high pressure (STL HP) gas pipeline replacement project located in Big Bear Lake, California. The approximate location of the project in relation to surrounding streets and landmarks is presented on *Figure No. 1, Vicinity Map*.

The purpose of this study was to evaluate the subsurface conditions within the project site and to provide geotechnical recommendations and parameters for consideration in the design and construction of the project. This report summarizes the data collected and presents our findings, conclusions, and geotechnical design recommendations.

2. SCOPE OF SERVICES

Our scope of services for this project included the following tasks:

- Research and review available historical geotechnical documentation related to the project including: previous geotechnical engineering investigations and grading plans; and in-house geologic maps, historic groundwater data and other available published and unpublished geotechnical information in the vicinity of the site.
- Performed a site reconnaissance to observe the general site conditions, check for accessibility, and identify areas for field exploration;
- Developed a field exploration plan and contacted Underground Service Alert;
- Performed a fieldwork exploration program which included advancement of 5 hollow-stem auger borings and gathering bulk and in-situ soil samples at the project site;
- Preparation of a laboratory test program;
- Performed laboratory testing on selected representative small bulk and in-situ soil samples obtained during the field exploration program, to evaluate the geotechnical engineering properties of these materials;
- Evaluating the accumulated information and developing geotechnical conclusions and recommendations for use in the design and construction of the proposed project. The report includes the following:
    - Geotechnical / geologic maps along the project alignment depicting the location of the borings and pertinent geologic information;
    - Discussion of geotechnical / geologic conditions and geoseismic hazards that may impact the project design or construction;
    - Regional geology, subsurface soil, rock, and groundwater conditions;
    - Field investigation findings;
    - Data reduction and summary of laboratory testing program;

- Construction considerations and recommendations for pipeline installation utilizing open-cut methods, temporary shoring and conceptual dewatering recommendations.

3. SITE & PROJECT DESCRIPTION

The Northshore Drive and Stanfield Cutoff Project consists of replacing approximately 2.4 miles of Vintage Steel Pipe with 8-inch STL HP Pipe in Big Bear Lake, California. The project alignment runs generally along the northeastern shore of the lake beginning on North Shore Lane at The Lighthouse Marina and extending west for approximately 0.5 miles to the intersection with North Shore Drive. The alignment continues west along North Shore Drive for approximately 1.5 miles to the Stanfield Cutoff before running south for approximately 0.4 miles and ending at the intersection with Big Bear Boulevard. The elevation change along the alignment is gradual with elevations ranging from approximately 6,760 to 6,830 feet above mean sea level (MSL). The approximate location of the project in relation to surrounding streets and landmarks is presented on *Figure No. 1, Vicinity Map*.

The majority of the pipeline will be installed by traditional open trench methods with a depth of approximately 7 to 9 feet below existing grades. A portion of the pipeline at the Big Bear Boulevard terminus will be installed by means of horizontal directional drilling (HDD), however recommendations for installation by means of HDD is beyond the scope of this report.

4. FIELD EXPLORATION PROGRAM

Our field exploration program consisted of performing 5 hollow-stem auger (HSA) borings which were advanced at various locations of the alignment. Prior to the start of the field exploration program, a field reconnaissance was conducted to observe site conditions and determine the location of our planned explorations. In accordance with local regulations, Underground Service Alert was notified of our excavations 48 hours prior to the subsurface investigation.

The exploratory borings were advanced using a CME-75 drill rig utilizing 8-inch diameter hollow-stem augers. The drill rig utilized an automatic hammer with about 80% hammer efficiency for obtaining soil samples. The borings were extended to a maximum depth of about 16.5 feet below existing grades. Representative small bulk and in-situ “undisturbed” drive samples were obtained at various depths within the boreholes. The subsurface soil conditions were recorded and logged in the field by a TGE geologist. A laboratory test program was developed to facilitate our geotechnical analysis and is described in the following section. The samples were examined and classified according to the Unified Soil Classification System (USCS). Upon completion, each hole was backfilled to match existing adjacent conditions.

The approximate locations of the borings are shown on *Figure Nos. 2 through 5, Plot Plans.* Detailed logs of the subsurface conditions encountered in the borings are presented in *Appendix A, Exploratory Boring Logs.*

5. LABORATORY TESTING

Laboratory testing was performed on selected representative small bulk and in-situ "undisturbed" soil samples obtained from the borings to aid in the soil classification and to evaluate engineering properties of the foundation soils. The following tests were performed:

- In-situ moisture content and dry density (ASTM D2216 and ASTM D2937);
- Particle size analyses and No. 200-wash (ASTM D422 and ASTM D1140);
- Direct Shear (ASTM D3080); and
- Corrosivity series including sulfate content, chloride content, pH-value, and resistivity (CTM 417, 422, and 643).

Testing was performed in general accordance with applicable ASTM standards and California Test Methods. A summary of the laboratory testing program and the laboratory test results are presented in *Appendix B, Laboratory Test Results*.

6. GEOLOGIC SETTING

The project alignment is located within the Transverse Ranges Geomorphic Province of California. The Transverse Ranges are a complex series of mountain ranges and valleys distinguished by an anomalous dominant east-west trend, contrasting to the northwest-southeast direction of the Coast Ranges and Peninsular Ranges. More regionally, the project site is located in the central portion of the northwest-trending San Bernardino Mountains. The San Bernardino Mountain range is composed primarily of uplifted Cretaceous, Jurassic, and Triassic granitic rocks. The alignment traverses the northern border of Big Bear Lake underlain by alluvial deposits from the granitic mountains.

7. SUBSURFACE CONDITIONS

Based on our site reconnaissance, subsurface excavations, and review of geologic maps, the subsurface materials generally consist of Alluvial soils (Qy, Qyf, Qw) with a portion of the alignment underlain by Sedimentary Rocks south of Bertha Ridge (Ts). A map of the project geology is shown in *Figure No. 6, Regional Geology Map*. Brief descriptions of the subsurface conditions encountered and inferred at this site are presented below. A more detailed description of these materials is provided in *Appendix A, Exploratory Boring Logs*.

7.1 Fill (Qf)

Fill materials were encountered within each exploratory boring to a depth of approximately 1 foot below existing grades. These fill soils generally consisted of silty/clayey sands in a medium dense condition that were capped with aggregate base and asphaltic concrete.

7.2 Alluvial Deposits (Qf, Qyf, Qw)

Alluvial materials underlie the fill soils within most of the alignment and were encountered to depth within each boring. The various alluvial units are termed Deposits of Alluvial Fans (Qf), Young Deposits of Alluvial Fans (Qyf), and Active Wash Deposits (Qw). As encountered, these various alluvial units were similar in composition, consisting of loose to very dense silty sand and clayey sand with an abundance of gravel.

7.3 Sedimentary Rocks South of Bertha Ridge (Ts)

Although not encountered within the subsurface investigation, review of the regional geologic map shows that a portion of the alignment is underlain by Sedimentary Rocks South of Bertha Ridge (Ts). These materials are anticipated to consist of brownish-gray, siltstone or fine to coarse-grained sandstone.

7.4 Groundwater

Groundwater was not encountered within the subsurface exploration to a maximum depth of approximately 16.5 feet below ground surface. Groundwater is not anticipated to affect the open cut portion of construction; however the groundwater level may fluctuate depending on stormwater events, irrigation, and other variable site conditions. It should be noted that the HDD section of pipeline installation may be impacted by groundwater, but evaluation of HDD is beyond the scope of this study.

8. GEOSEISMIC AND GEOTECHNICAL HAZARDS

The findings of our geoseismic and geotechnical hazards evaluation for the project site are summarized in the sections below.

8.1 Faults

There are several major active fault zones (i.e., the fault has displaced within about the last 11,000 years, or Holocene time) within close proximity to the project alignment, namely the North Frontal Thrust system approximately 7 miles to the north and the San Andreas Fault Zone approximately 12 miles to the south. These and other known active fault zones are shown on *Figure No. 7, Regional Fault Map*. Each of these zones contains multiple active fault strands which could produce large seismic events.

Large historical earthquakes that have been generated along these faults include the Big Bear M6.3 (6/28/1992) and the Big Bear M5.5 (6/28/1992) whos epicenter was located approximately 5-miles south-southeast of the project.

Although these nearby faults have potential to rupture with earthquakes of magnitude 7.0 or greater, surface traces of active faults are not known to pass directly through, or to

project toward the project site investigated for this study. In addition, the site is not situated within any published California Official Alquist-Priolo Earthquake Fault Zone (APEFZ) maps. Therefore, the potential for surface rupture due to faulting occurring beneath the site during the design life of the proposed project is considered very low.

8.2 Ground Shaking

The site is located in a seismically active area. The most significant seismic hazard at the site is considered to be shaking caused by an earthquake occurring on a nearby or distant active fault (e.g., San Andreas Fault Zone, North Frontal Thrust System). Provided the project is designed with considerations for the hazard of seismic shaking, the potential for failure due to ground shaking is considered low (see *Section 9.8, Seismic Design Parameters*).

8.3 Liquefaction, Dynamic Settlement, and Lateral Spread

Liquefaction of soils can be caused by ground shaking during earthquakes. Research and historical data indicate that loose, relatively clean granular soils are most susceptible to liquefaction and dynamic settlement, whereas the stability of the majority of clayey silts, silty clays and clays are not adversely affected by ground shaking. Liquefaction is generally known to occur in saturated cohesionless soils at depths shallower than approximately 50 feet in depth. Dynamic settlement due to earthquake shaking can occur in both dry and saturated sands. Lateral spreading can occur during liquefaction of soils on sloping terrain.

The project site is underlain by alluvial soils that contain some zones of loose sands. While groundwater was not encountered during the subsurface investigation to a maximum depth explored of 16.5 feet, groundwater is anticipated at a depth shallower than 50 feet given the proximity to Big Bear Lake, primarily along the Stanfield Cutoff. Based on this information, there is a potential for liquefaction, however the evaluation of liquefaction along with associated dynamic settlement and lateral spread is beyond the scope of this study.

8.4 Landslides, Slope Instability & Rock Fall

Review of landslide hazard maps indicate that the alignment runs through areas classified as “Area 1 - Least Susceptible Areas” and “Area 2 - Marginally Susceptible Areas” as shown on *Figure No. 8, Landslide Potential Areas Map*. During the site reconnaissance and field exploration, we found no obvious visible physiographic features suggesting the existence of a landslide, slope instability, or rockfall along the alignment. Therefore, the potential for landslide, slope instability, or rock fall impacting the site is low.

It should be noted that all slopes (natural, cut, fill or otherwise) are subject to downhill “creep” to some degree, as well as possible surficial deterioration and erosion due to

normal weathering. This general observation is made in order to emphasize the importance of slope maintenance and is not intended to suggest a particularly unusual or compelling adverse condition.

8.4 Tsunamis and Seiches

The project alignment is located a minimum of approximately 70 miles from the coastline at a minimum elevation of approximately 6,760 feet MSL; it is not considered susceptible to impact from tsunamis.

The alignment is not located downslope of any large body of water that could affect the project in the event of an earthquake-induced failure or seiche (oscillation in a body of water due to earthquake shaking).

8.5 Flood

Based on review of the FEMA Flood Rate Insurance Map, the Stanfield Cutoff portion of the alignment is located within an area classified as “Zone A” which is subject to inundation by the 1% annual flood chance flood. The 1% annual chance flood (100-year flood), also known as the base flood is the flood that has a 1% chance of being equaled or exceeded in any given year. The other areas of the alignment are classified as “Zone X” which are areas determined to be outside the 0.2% annual chance floodplain.

8.6 Expansive Soils

Based on the results of the geotechnical borings and soil classification testing, the near surface soils within the project alignment consist primarily of silty sand and clayey sand with gravel. These materials are anticipated to have an Expansion Index in the ***“Very Low”*** to ***“Low”*** range and are suitable for use as backfill provided any vegetation, debris, and rocks greater than 3 inches maximum dimension are removed.

9. DESIGN RECOMMENDATIONS

9.1 General

Based on the results of the field exploration and engineering analyses, it is TGE’s opinion that the proposed project is feasible from a geotechnical standpoint, provided that the recommendations in this report are incorporated into the design plans and implemented during construction. Deviations from these recommendations should be brought to our attention for consideration of technical feasibility and engineering merit.

9.2 Site Earthwork

Clearing and Grubbing

Prior to grading, the project area should be cleared of all rubble, trash, debris, etc. Any buried organic debris or other unsuitable contaminated material encountered during subsequent excavation and grading work should also be removed.

Excavations for removal of any existing footings, utility lines, tanks, and any other subterranean structures should be processed and backfilled in the following manner:

1. Clear the excavation bottom and sidecuts of all loose and/or disturbed material.

2. Prior to placing backfill, the excavation bottom should be moisture conditioned to within 2 percent of the optimum moisture content and compacted to at least 90 percent of the ASTM D1557 laboratory test standard.

3. Backfill should be placed, moisture conditioned (i.e., watered and/or aerated as required and thoroughly mixed to a uniform, near optimum moisture content), and compacted by mechanical means in approximate 6-inch lifts. The degree of compaction obtained should be at least 90 or 95 percent of the ASTM D1557 laboratory test standard, as applicable.

It is also critical that any surficial subgrade materials disturbed during initial demolition and clearing work be removed and/or recompacted in the course of subsequent site preparation earthwork operations.

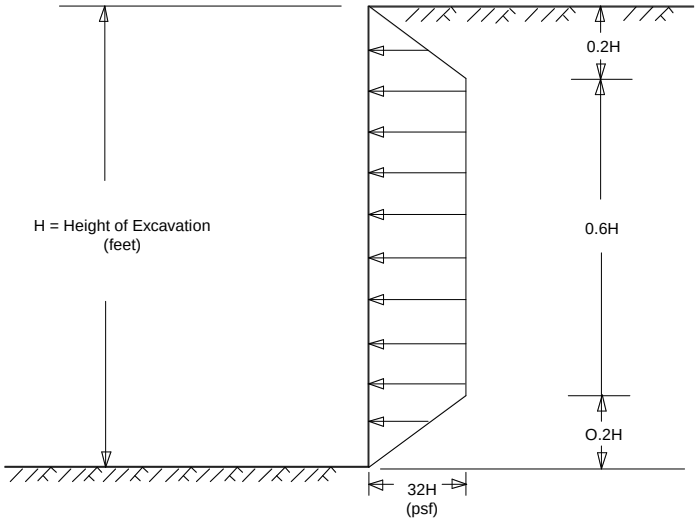
9.3 Temporary Excavations

Excavation of the on-site soils may be achieved with conventional heavy-duty grading equipment within the on-site materials encountered. Temporary, shallow excavations with vertical side slopes less than 4 feet high will generally be stable, although there is a potential for localized sloughing. Vertical excavations greater than 4 feet high should not be attempted without proper shoring to prevent local instabilities. Shoring may be accomplished with hydraulic shores and trench plates, and/or trench boxes, soldier piles and lagging. The actual method of a shoring system should be provided and designed by a contractor experienced in installing temporary shoring under similar soil conditions. If soldier piles and lagging are to be used, we should be contacted for additional recommendations.

All trench excavations should be shored in accordance with CalOSHA regulations. For your planning purposes, the on-site materials may be considered a Type C soil, as defined the current CalOSHA soil classification.

Braced excavations should be designed to resist a trapezoidal distribution of lateral earth pressure. The recommended pressure distribution, for the case where the grade is level

behind the shoring, is illustrated in the following diagram with the maximum pressure equal to 32H in psf, where H is the height of the excavation in feet.



Any surcharge (live, including traffic, or dead load) located within a 1(H): 1 (V) plane drawn upward from the base of the shored excavation should be added to the lateral earth pressures. The lateral load contribution of a uniform surcharge load located across the 1(H): 1(V) zone behind the excavation walls may be calculated by using *Figure No. 9, Lateral Surcharge Loads*. Lateral load contributions of surcharges can be provided once the load configurations and layouts are known. As a minimum, a 2-foot equivalent soil surcharge is recommended to account for nominal construction loads.

Stockpiled (excavated) materials should be placed no closer to the edge of a trench excavation than a distance defined by a line drawn upward from the bottom of the trench at an inclination of 1(H): 1(V), but no closer than 10 feet. All trench excavations should be made in accordance with CalOSHA requirements.

9.4 Temporary Construction Dewatering

Groundwater was NOT encountered during our subsurface investigation to a maximum depth of 16.5 feet below ground surface and is not anticipated to affect construction. However, if groundwater is encountered during construction, temporary dewatering may be required. The means and method of dewatering should be established by a contractor with local experience. It is important to note that temporary dewatering, if necessary, will require a permit and plan that complies with RWQCB regulations.

9.5 Thrust Forces

If thrust blocks are used, the blocks may be designed using a passive resistance equal to an equivalent fluid pressure of 300 pounds per cubic foot (pcf).

9.6 Vertical Pressures

Loads exerted on the pipes should not exceed the manufacturer's recommendations. TGE has provided the following tables as estimates of the vertical pressures for the open-cut pipe installation method. If more specific pressures are needed at spot locations, TGE may be contacted for more in-depth analysis.

Table 1: Design Vertical Pressures (soil) (1)

Depth of Cover (feet)	D (psf)
0-5	650
6-10	1,300

(1) Dead load vertical pressure from soil prism considering load coefficients for cohesionless backfill.

Table 2: Design Vertical Pressures (Dynamic Loads) (1)

Depth of Cover (feet)	D (psf)
2	3,200
4	1,150
6	600
8	360
10	240

(1) Dead load vertical pressure equivalent based on a dynamic load from a truck with a contact pressure of 100 psi.

9.7 Backfill Operations

Following completion of the underground pipeline installation within "cut and cover" zones, backfilling will be required (see *Figure No. 10, Utility Trench Backfill*). Utility soil backfill should be placed in loose horizontal lifts not more than 8-inches in loose thickness and compacted to at least 90 percent of the maximum dry density per ASTM D1557. The upper 12 inches of subgrade soils should be mechanically compacted to at least 95 percent relative compaction based on the latest version of the ASTM D1557 procedure. Within existing pavement areas, the pavement section should match the existing section. All aggregate base and asphaltic concrete shall be compacted to 95 percent relative compaction per ASTM D1557 and the Hveem method, respectively.

Based on field and laboratory classification, the on-site soils are considered suitable for use as backfill within the trench backfill zone (see *Figure No. 10, Utility Trench Backfill)* provided any vegetation, debris, and rocks greater than 3 inches minimum diameter are removed. All imported fill should consist of granular, non-expansive soil with an Expansion Index of 20 or less. Import material should be evaluated by our firm prior to

transport to the site and not contain any contaminated soil, expansive soil, debris, organic matter, or other deleterious materials.

9.8 Seismic Design Parameters

Preliminary seismic design parameters for the project site were also developed for possible use in the design of ancillary structures, as per the guidelines outlined in the 2016 CBC, Volume 2, Chapter 16 (Note: 2015 International Building Code). **TGE should be contacted with latitude/longitude coordinates for site specific improvements requiring seismic parameters.** The seismic design parameters for Site Class "D" were developed using a JAVA ™ application, Java Ground Motion Parameter Calculator–Version 5.0.9 available on the USGS website (http://earthquake.usgs.gov). The preliminary seismic design parameters for the project alignment are presented in *Table 3* below.

Table 3: 2016 CBC Seismic Design Parameters

2016 CBC Seismic Design Parameter	Value
Site Class Definition (Table 1613.5.5.)	D
Mapped Spectral Accelerations for short periods, S_S (Section 1613.5.1.)	1.922g
Mapped Spectral Accelerations for 1-sec period, S_1 (Section 1613.5.1.)	0.698g
Site Coefficient, F_a (Table 1613.5.3(1).)	1.0
Site Coefficient, F_v (Table 1613.5.3(2).)	1.5
Maximum considered earthquake spectral response acceleration for short periods, S_{MS} adjusted for Site Class (Equation 16-37)	1.922g
Maximum considered earthquake spectral response acceleration at 1-sec period, S_{M1} adjusted for Site Class (Equation 16-38)	1.047g
Five-percent damped design spectral response acceleration at short periods, S_{DS} (Section 1613.5.4.)	1.281g
Five-percent damped design spectral response acceleration at 1-sec period, S_{D1} (Section 1613.5.4.)	0.698g

Note: Above parameters are based on latitude/longitude coordinates (36.2629° N, 116.8932° W)

9.9 Pavements

The project installation is anticipated to excavate within existing paved surfaces. Replacement of surface improvements should match the existing adjacent flexible asphalt concrete pavement section and concrete curb/gutter and sidewalk and conform

with the San Bernardino County Standard Drawings. The upper 12 inches of the subgrade soils and aggregate base should be compacted to a minimum 95 percent relative compaction in accordance with ASTM D1557. The asphaltic concrete should be compacted to a minimum 95 percent of the unit weight determined in accordance with the Hveem procedure.

9.10 Soil Corrosion

The corrosion potential of the on-site materials to steel and buried concrete was evaluated. Laboratory testing was performed on representative samples of the existing surficial materials to evaluate pH, minimum resistivity, and chloride and soluble sulfate content. Laboratory test procedures and results are provided in *Appendix B*. General recommendations to address the corrosion potential of the on-site materials are also provided in the subsections below. If additional recommendations are desired, it is recommended that a corrosion specialist be consulted.

9.10.1 Reinforced Concrete

Laboratory tests indicate that the potential of sulfate attack on concrete in contact with the on-site soils is “Not Applicable” based on ACI 318-11, Table 4.2.1 and 4.3.1. It is recommended that Type II cement be used for all proposed structure foundations.

The results of chloride content testing at the near-surface soil indicate the potential of chloride attack on concrete structures is low. Reinforcing steel in concrete structures and pipes in contact with soil have a low risk of chloride attack; TGE recommends that the level of protection should anticipate a chloride content of 100 parts per million (ppm). The pH-values are near-neutral and do not warrant corrosion consideration. If considered necessary, possible methods of protection that could be used include increased concrete cover, low water-cement ratio, corrosion inhibitor admixture, silica fume admixture, and waterproof coating on the concrete exterior.

9.10.2 Metallic

Laboratory tests indicate that some of on-site surficial materials have a high electrical resistivity. High electrical resistivity presents a low potential for corrosion to buried ferrous metals. Based on the Caltrans Corrosion Guidelines (2018, Ver. 3.0), the on-site materials are considered “not corrosive”. A corrosion consultant should provide specific corrosion recommendations. In any case, consideration should be given to plastic piping where possible.

10. CONSTRUCTION CONSIDERATIONS

Construction considerations for the proposed improvements are presented below.

1. Based on our investigation, groundwater was not encountered within the subsurface exploration to a depth of approximately 16.5 feet below existing grades. Therefore, groundwater is not anticipated to affect construction, however periodic water seepage zones and ground water mounding may occur during the wet weather season. Groundwater should be anticipated within the HDD portion of the alignment given the proximity to the lake.

2. The contractor should anticipate variable subsurface conditions ranging from loose to very dense silty/clayey sand with gravels within the alignment. Caving within the trench excavations should also be anticipated due to the lenses of clean sand and gravels.

3. Temporary excavations may be required for removal and/or installation of underground elements. The Occupational Safety and Health Administration (OSHA) regulations provide trench sloping and shoring design parameters for excavations up to 20-feet in depth, based on a description of the soil types encountered. TGE recommends that a Type C OSHA Classifications be used for temporary excavations within the on-site alluvial materials. Excavations should be inspected by the geotechnical engineer and the performance evaluated.

4. All backfill material should be compacted to at least 90 or 95 percent relative compaction, as applicable, based on the ASTM D1557 laboratory test method.

5. If materials at the bottom of any excavations are disturbed during construction activities, they should be removed and recompacted to a minimum 90 percent relative compaction, based on ASTM D1557.

11. LIMITATIONS

The recommendations and opinions expressed in this report are based on TGE's review of background documents and on information developed during this study. More detailed limitations of the geotechnical engineering report are presented in the ASFE's information bulletin in *Appendix C*.

Due to the limited nature of our field explorations, conditions not observed and described in this report may be present at the site. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation and laboratory testing can be performed upon request. It should be understood that conditions different from those anticipated in this report may be encountered during construction operations.

Site conditions, including ground-water level, can change with time as a result of natural processes or the activities of man at the subject site or at nearby sites. Changes to the applicable laws, regulations, codes, and standards of practice may occur as a result of government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which TGE has no control.

TGE's recommendations for this site are, to a high degree, dependent upon appropriate quality control of subgrade preparation, fill placement, and other construction activities. Accordingly, the recommendations are made contingent upon the opportunity for TGE to observe grading operations and foundation excavations for the proposed construction. If parties other than TGE are engaged to provide such services, such parties must be notified that they will be required to assume complete responsibility as the geotechnical engineer of record for the geotechnical phase of the project by concurring with the recommendations in this report and/or by providing alternative recommendations.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. TGE should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

TGE has endeavored to perform this study using the degree of care and skill ordinarily exercised under similar circumstances by reputable geotechnical professionals with experience in this area in similar alluvial conditions. No other warranty, either expressed or implied, is made as to the conclusions and recommendations contained in this study.

This report has been prepared for the exclusive use of the client and their consultants in the design of the proposed replacement gas line. In particular, it should be noted that this report has not been prepared from the perspective of a construction bid preparation instrument and should be considered by prospective construction bidders only as a source of general information, subject to interpretation and refinement by their own expertise and experience; particularly with regard to construction feasibility. Contract requirements set forth by the project plans and specifications will supersede any general observations and specific recommendations presented in this report.

12. REFERENCES

1. American Society of Civil Engineers, ASCE Manuals And Reports on Engineering Practice No. 108, 2014, Pipeline Design for Installation by Horizontal Directional Drilling, Second Edition;

2. ASTM, 2001, Soil and Rock: American Society for Testing and Materials: vol. 4.08 for ASTM test methods D-420 to D-4914; and vol. 4.09 for ASTM test methods D-4943 to highest number;

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4. ASTM, 2011, Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings, Test Method F1962;

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7. California Department of Conservation, Division of Mines and Geology, 1998, Maps of Known Active Fault Near-Source Zones in California and Adjacent Portions of Nevada: International Conference of Building Officials, dated February, Scale 1" = 4 km;

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9. California Building Code 2013, California Code of Regulations Title 24, Part 2, January 1, 2014;

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13. International Building Code, 2012;

14. Macnab, A., 2002, Earth Retention Systems Handbook;

15. U.S. Geological Survey, 2001, USGS, Geologic Map of the Fawnskin 7.5' Quadrangle, San Bernardino County, California.

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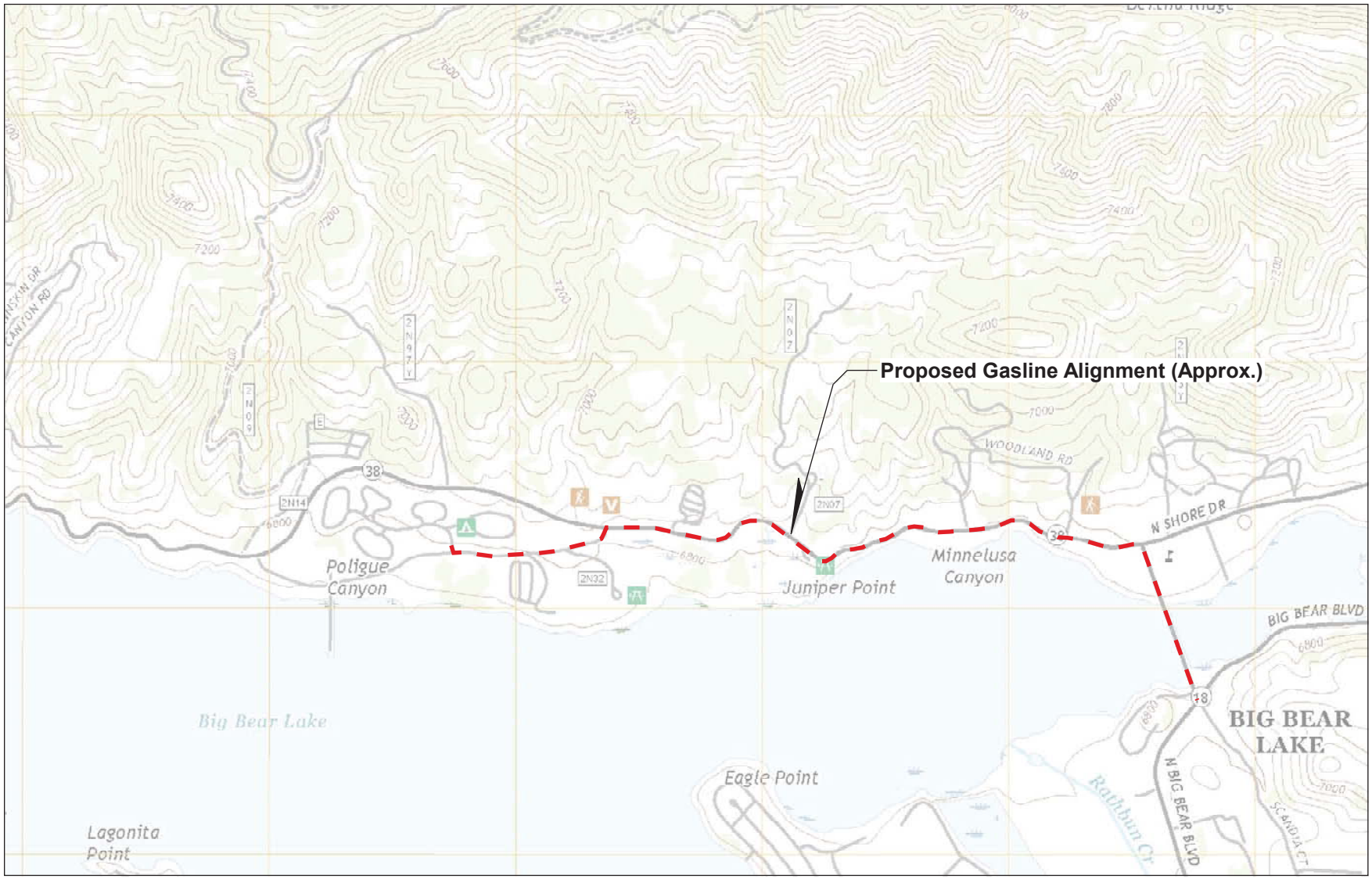
FIGURES



Reference: USGS 2015 Topographic Map (Fawnskin, CA - 7.5 Minute Quadrangle)

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Vicinity Map

Gasline Installation
Northshore Drive and Stanfield Cutoff
Big Bear Lake, CA

TGE Project No.: T230	Figure No.: 1

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Legend

- Proposed Gasline alignment (Approx.)
- Boring location (Approx.)

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Plot Plan 1

Gasline Installation
Northshore Drive and Stanfield Cutoff
Big Bear Lake, CA

TGE Project No.: T230	Figure No.: 2

TRINITY
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Legend

- Proposed Gasline alignment (Approx.)
- Boring location (Approx.)

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Plot Plan 2

Gasline Installation
Northshore Drive and Stanfield Cutoff
Big Bear Lake, CA

TGE Project No.: T230	Figure No.: 3

TRINITY
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Legend

- Proposed Gasline alignment (Approx.)
- Boring location (Approx.)

Prepared for:

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Plot Plan 3

Gasline Installation
Northshore Drive and Stanfield Cutoff
Big Bear Lake, CA

TGE Project No.: T230	Figure No.: 4

TRINITY
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Legend

- Proposed Gasline alignment (Approx.)
- Boring location (Approx.)

Prepared for:

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Plot Plan 4

Gasline Installation
Northshore Drive and Stanfield Cutoff
Big Bear Lake, CA

TGE Project No.: T230	Figure No.: 5

TRINITY
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Legend

- Proposed Gasline alignment (Approx.)
- Boring location (Approx.)

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Plot Plan 5

Gasline Installation
Northshore Drive and Stanfield Cutoff
Big Bear Lake, CA

TGE Project No.: T230	Figure No.: 6

Reference: Geologic map of the Fawnskin 7.5' Quadrangle, San bernardino County, California by Fred K. Miller, Jonathan C. Matti, Howard J. Brown, and Robert E. Powell, 2001

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Map Units

- QyfG - Young deposits of alluvial fans, unit 3
- Qf - Deposits of alluvial fans
- Qw - Active-wash deposits
- TsG - Sedimentary rocks south of Bertha Ridge and John Bull Mountain

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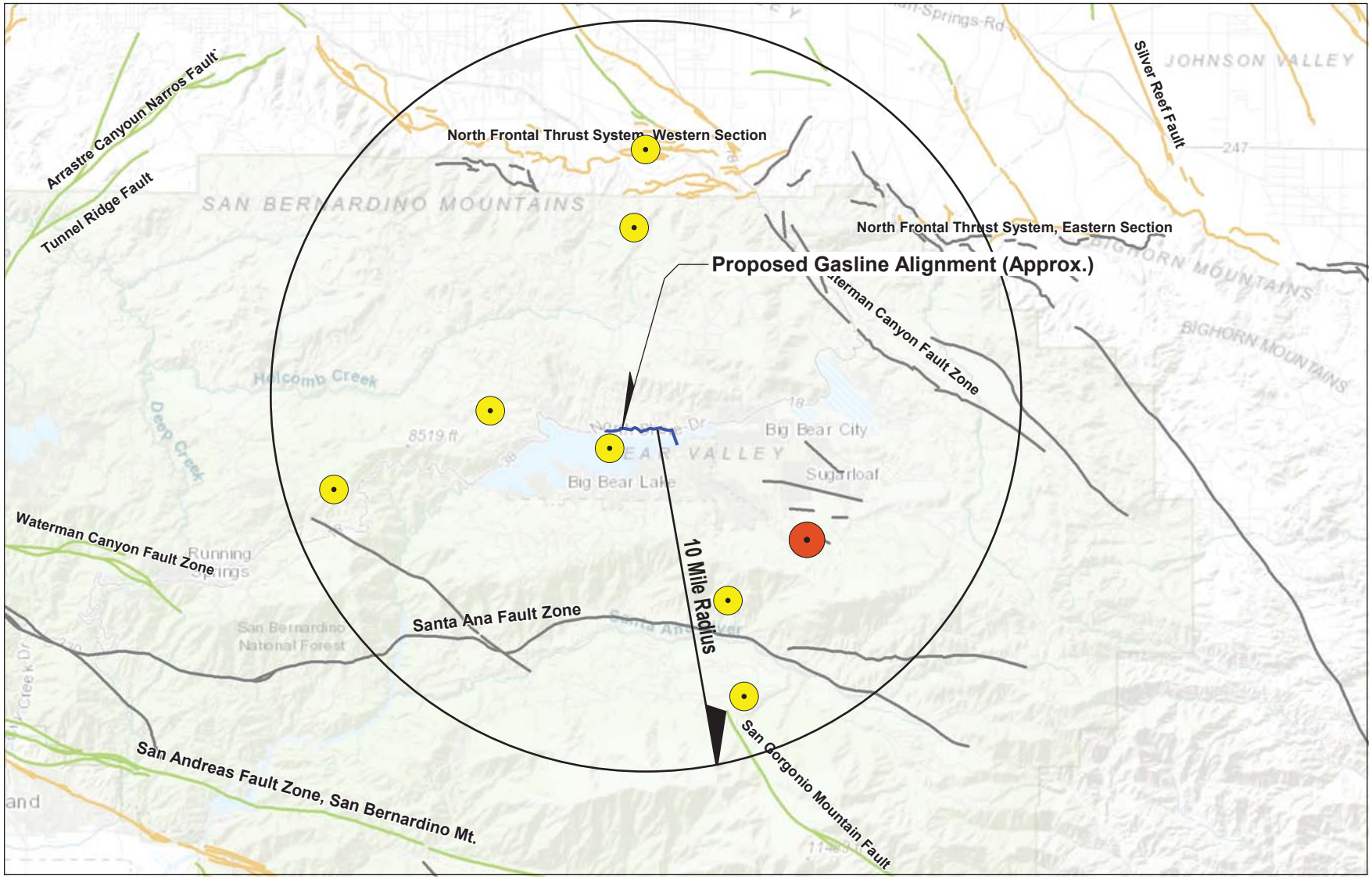
Regional Geology Map

Gasline Installation
Northshore Drive and Stanfield Cutoff
Big Bear Lake, CA

TGE Project No.: T230	Figure No.: 7



Reference: Esri; U.S. Geological Survey and California Geological Survey, 2006, Quaternary fold and fault database for the United States; USGS Earthquake Archives

Quaternary Faults - Faults are classified by age of last known movement.

Historic <150 years ago | Holocene to Latest Pleistocene <15,000 years ago | Late Quaternary <130,000 years ago | Quaternary >1.6 Ma

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Historical Earthquake Epicenter by Magnitude

- 5.0 - 5.9
- 6.0 - 6.9

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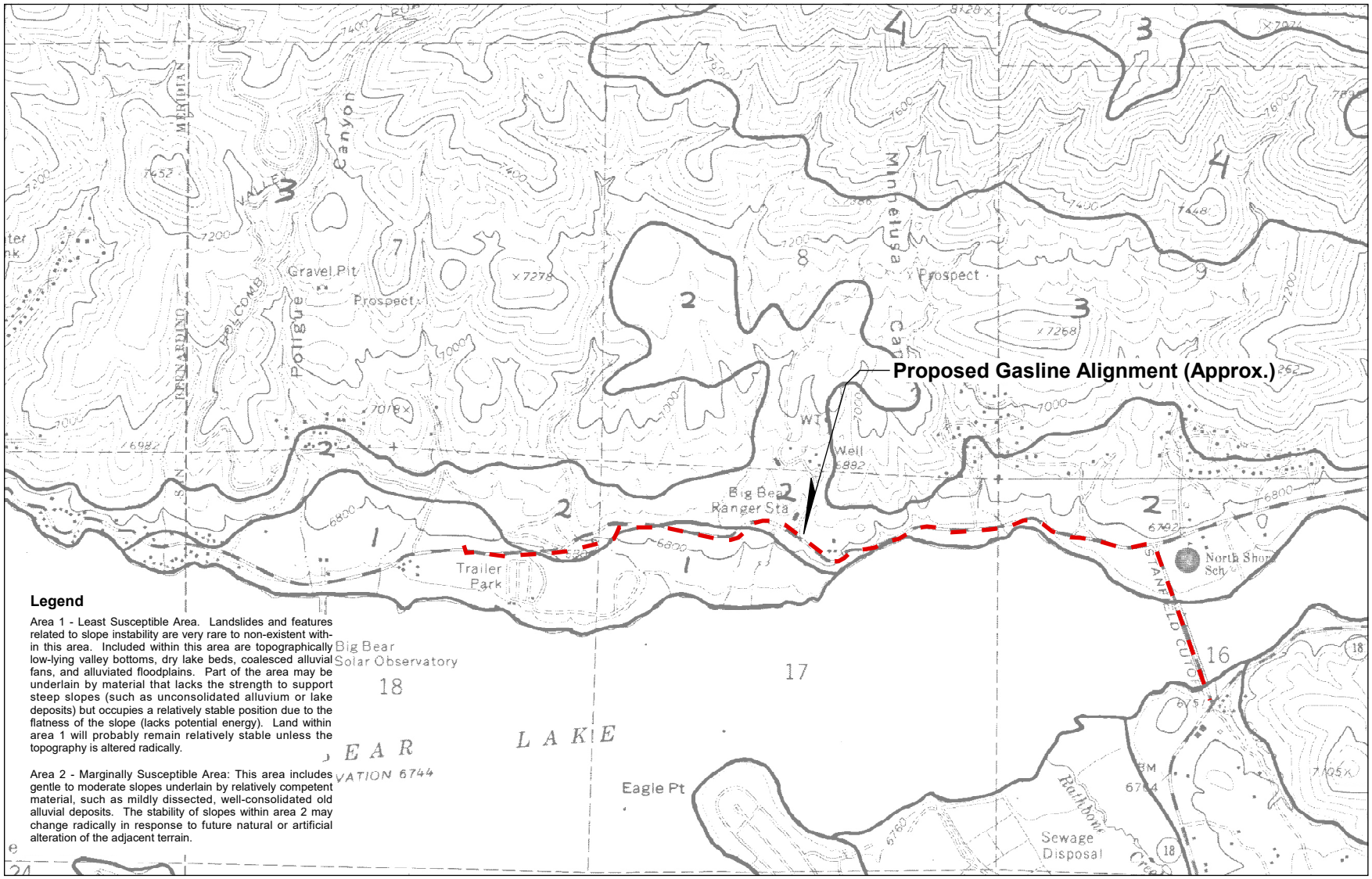
Regional Fault Map

Gasline Installation
Northshore Drive and Stanfield Cutoff
Big Bear Lake, CA

TGE Project No.: T230 | **Figure No.: 8**



Reference: CGS Earthquake Zones of Required Investigation, Landslide Hazards Big Bear Reagion by Siang S. Tan, Fawnskin Quadrangle, dated 1989

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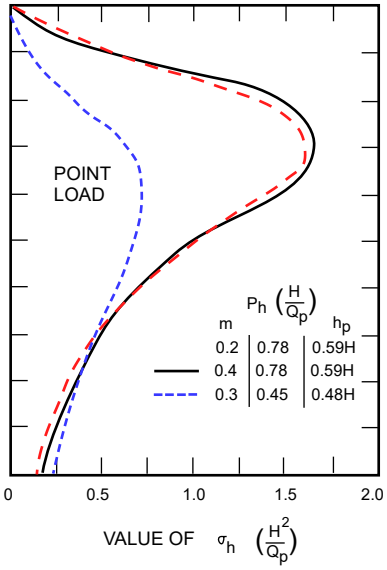
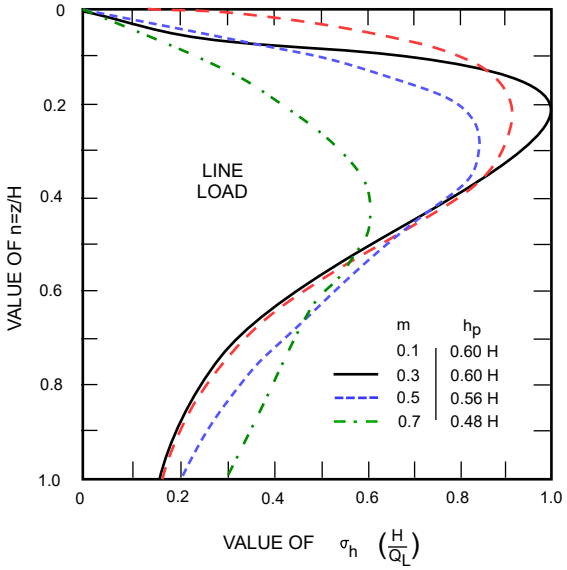
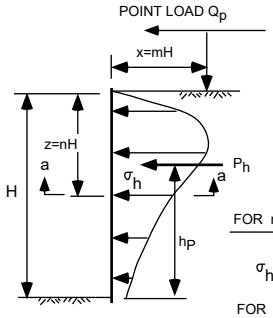
Landslide Potential Areas Map

Gasline Installation
Northshore Drive and Stanfield Cutoff
Big Bear Lake, CA

TGE Project No.: T230	Figure No.: 8







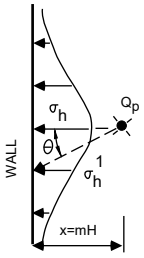
FOR m ≦ 0.4 :

$$\sigma_h\left(\frac{H^2}{Q_p}\right) = \frac{0.28\,n^2}{(0.16+n^2)^3}$$

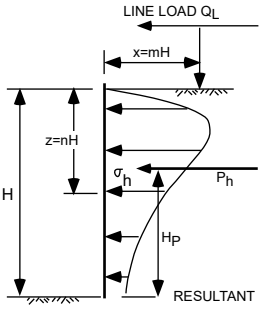
FOR m > 0.4 :

$$\sigma_h\left(\frac{H^2}{Q_p}\right) = \frac{1.77\,m^2\,n^2}{(m^2+n^2)^3}$$

$$\sigma_h^1 = \sigma_h \cos 2(1.1\theta)$$



SECTION a ~a
PRESSURE FROM POINT LOAD Q_p
(BOUSSINESQ EQUATION MODIFIED BY EXPERIMENT)



FOR m ≦ 0.4 :

$$\sigma_h\left(\frac{H}{Q_L}\right) = \frac{0.20\,n}{(0.16+n^2)^2}$$

$P_H = 0.55\,Q_L$

FOR m > 0.4 :

$$\sigma_h\left(\frac{H}{Q_L}\right) = \frac{1.28\,m^2 n}{(m^2+n^2)^2}$$

RESULTANT $P_H = \frac{0.64\,Q_L}{(m^2+1)}$

PRESSURE FROM LINE LOAD Q_L
(BOUSSINESQ EQUATION MODIFIED BY EXPERIMENT)

Reference: Navfac, DM 7.02, Chapter 3, Analysis of Walls and Retaining Structures, Figure 11, Horizontal Pressures on Rigid Wall from Surface Loads, pg. 7.2.74, September, 1986.

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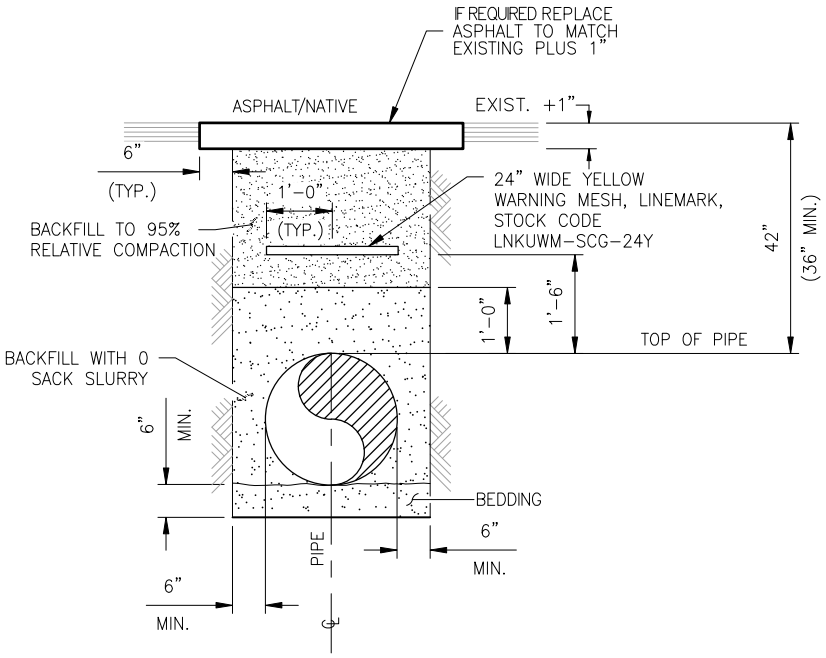
Lateral Surcharge Loads

Gasline Installation
Northshore Drive and Stanfield Cutoff
Big Bear Lake, CA

TGE Project No.: T230 | **Figure No.: 9**



TYPICAL TRENCH DETAIL FOR REPLACEMENT SEGMENTS

Notes: (1) 0 Sack slurry within the bedding and shading material should consist of free-draining sand with a minimum sand equivalent (SE) of 20

TRINITY GEOTECHNICAL ENGINEERING, INC.	Prepared for: SOUTHWEST GAS CORPORATION	**Utility Trench Backfill** **Gasline Installation** **Northshore Drive and Stanfield Cutoff** **Big Bear Lake, CA** **TGE Project No.: T230** | **Figure No.: 10**

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APPENDIX A

Exploratory Boring Logs

FIELD TESTING AND SAMPLING

The California Sampler (Ring)

The Ring sampler was driven into the ground in accordance with test method ASTM D 3550-84. The sampler, with an external diameter of 3.0-inches, was lined with 1-inch long, thin brass rings with inside diameters of approximately 2.4 inches. The sampler was driven into the ground 12 to 18-inches with a 140-pound hammer free falling from a height of 30-inches. Blow counts were recorded for every 6-inches of penetration. The N-values were estimated for the California Sampler by multiplying the sum of the blow counts for the last two 6-inch intervals of the 18-inch sampler penetration by a factor of 0.6 (Reference: Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction in California, G.R. Martin and M. Lew, 1999). The samples were removed from the sample barrel in the brass rings, sealed and transported to the laboratory for testing.

Large Bulk Samples

Samples of representative earth materials over 20 pounds in weight were collected from the auger cuttings, placed in bags, sealed and transported to the laboratory for testing.

Small Bulk Samples

Samples less than 5-pounds in weight of representative earth materials were collected from the split spoon sampler, hand digging or exploratory cuttings. These samples were used for determining natural moisture content and classification indices.

LOG SYMBOLS:


Bulk/Bag sample


Modified California sampler
(3 inch outside diameter)


Standard penetration
Split spoon sampler
(2 inch outside diameter)


Shelby tube


Rock Core Drilling
(2-inch diameter)


Water level
(level after completion)


Water level
(level where first encountered)

Abbreviations:

SA - (38% SAND analysis (percent passing #200 sieve)
WA - (38%) - One point grain size analysis (Percent passing #200 sieve)
PI - Plasticity index
LL - Liquid limit
DS - Direct shear test
'R' - R-value test
CORR - Corrosivity test
EI - UBC expansion index
LC - Laboratory compaction test

General Notes:

1. Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual.
2. No warranty is provided as to the continuity of soil conditions between individual sample locations.
3. Logs represent general soil conditions observed at the point of exploration on the date indicated.
4. In general, unified soil classification designations presented on the logs were evaluated by visual methods only. Therefore, actual designations (based on laboratory tests) may vary.

Consistency criteria based on field tests

Granular Soils

Relative density	SPT* (# blows/ft)	Relative density (%)
Very Loose	<4	0 - 15
Loose	4 - 10	15 - 35
Medium Dense	10 - 30	35 - 65
Dense	30 - 50	65 - 85
Very dense	>50	85 - 100

Cohesive Soils

Consistency	SPT (# blows/ft)	Torvane Undrained shear strength (tsf)	Pocket** penetrometer Unconfined compressive strength
Very soft	<2	<0.13	<0.25
Soft	2 - 4	0.13 - 0.25	0.25 - 0.5
Firm	4 - 8	0.25 - 0.5	0.5 - 1.0
Stiff	8 - 15	0.5 - 1.0	1.0 - 2.0
Very stiff	15 - 30	1.0 - 2.0	2.0 - 4.0
Hard	>30	>2.0	>4.0

* Number of blows of 140 pounds hammer falling 30 inches to drive a 2 inch O.D. (1 3/8" I.D.) split barrel samler (ASTM - D 1586-99 standard penetration test)

** Unconfined compressive strength in Tons/ft^2. Read from pocket penetrometer

Moisture content

Description	Field test
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

Cementation

Description	Field test
Weakly	Crumbles or breaks with handling or slight finger pressure
Moderately	Crumbles or breaks with considerable finger pressure
Strongly	Will not crumble or break with finger pressure

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Log Legend

Gasline Installation
Northshore Drive and Stanfield Cutoff
Big Bear Lake, CA

TGE Project No.: T230 | **Figure No.: A-2**

Boring Log B-1

Date Drilled: 8-21-2018	**Logged By:** Stephen Quimpo
Exploratory Equipment: CME-75	**Surface Elevation:** 6830 feet above MSL (Approx.)
Driving Weight: 140 lbs Auto Hammer - 30" drop	**Total Depth of Boring:** 11.5 feet bgs
Drilling Method: 8-inch OD Hollow Stem Auger	**Groundwater Elevation During Drilling:** Not encountered

Depth in Feet	Sample	Blow Counts	N value	Material Description	USCS	Color	Consistency	Moisture	Time (Min:Sec)	Dry Density (pcf)
				Fill - 4-inch of Crushed Aggregate						
				Qyf - Young deposits of alluvial fans - Silty SAND with Gravel, medium to coarse grained, angular gravels are up to 0.5" in particle size dimension, trace amount of $CaCO_3$	SM/SC	Brown	Medium Dense	Damp to Moist		
5		5 6 4	6		SM		Loose	Moist		107.9
10		11 15 18	20	Trace of greenish weathered nodules, Fe_2O_3 staining		Yellow Brown	Medium Dense			126.6

Moisture Content (% Dry Weight): 5 10 15 20 25

End of boring at 11.5 feet

Note: 1. Groundwater not encountered

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Boring Log B-1

Gasline Installation
Northshore Drive and Stanfield Cutoff
Big Bear Lake, CA

TGE Project No.: T230 | **Figure No.: A-3**

Boring Log B-2

Date Drilled: 8-21-2018	**Logged By:** Stephen Quimpo
Exploratory Equipment: CME-75	**Surface Elevation:** 6795 feet above MSL (Approx.)
Driving Weight: 140 lbs Auto Hammer - 30" drop	**Total Depth of Boring:** 11.5 feet bgs
Drilling Method: 8-inch OD Hollow Stem Auger	**Groundwater Elevation During Drilling:** Not encountered

Depth in Feet	Sample	Blow Counts	N value	Material Description	USCS	Color	Consistency	Moisture	Time (Min:Sec)	Dry Density (pcf)
				10-inch of AC Pavement						
				Qyf - Young deposits of alluvial fans - Clayey SAND with Gravel, fine to coarse grained, angular gravels are up to 1.0" in particle size dimension, trace amount of Fe_2O_3	SM/SC	Dark Brown	Medium Dense	Damp to Moist		
5		4 3 6	5	Gravels become sub rounded up to 2.5" in particle size dimension, trace of cobbles, Fe_2O_3 staining	SM	Brown	Loose			121.6
10		13 15 15	18	No recovery			Medium Dense			

Moisture Content (% Dry Weight)

5 10 15 20 25

End of boring at 11.5 feet

Note: 1. Groundwater not encountered

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Boring Log B-2

Gasline Installation
Northshore Drive and Stanfield Cutoff
Big Bear Lake, CA

TGE Project No.: T230 | **Figure No.: A-4**

Boring Log B-3

Date Drilled: 8-21-2018	**Logged By:** Stephen Quimpo
Exploratory Equipment: CME-75	**Surface Elevation:** 6770 feet above MSL (Approx.)
Driving Weight: 140 lbs Auto Hammer - 30" drop	**Total Depth of Boring:** 11.5 feet bgs
Drilling Method: 8-inch OD Hollow Stem Auger	**Groundwater Elevation During Drilling:** Not encountered

Depth in Feet	Sample	Blow Counts	N value	Material Description	USCS	Color	Consistency	Moisture	Time (Min:Sec)	Dry Density (pcf)
				Qyf - Young deposits of alluvial fans - Silty SAND with Gravel (angular) and Cobbles (sub rounded) up to 4.5" in particle size dimensions, fine to coarse grained, trace amount of Fe_2O_3	SM	Brown	Medium Dense	Damp		
5		6 9 10	11	Poorly graded SAND with Gravel, angular gravels up to 2" in particle size dimensions, trace amount of Fe_2O_3						116.0
10		13 15 15	18	Increase in gravel and cobble content, cobbles up to 4.5" in particle size dimensions						126.3

Moisture Content (% Dry Weight)

5 10 15 20 25

End of boring at 11.5 feet

Note: 1. Groundwater not encountered

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Prepared for: SOUTHWEST GAS CORPORATION

Boring Log B-3

Gasline Installation
Northshore Drive and Stanfield Cutoff
Big Bear Lake, CA

TGE Project No.: T230 | **Figure No.: A-5**

Boring Log B-4

Date Drilled: 8-21-2018	**Logged By:** Stephen Quimpo
Exploratory Equipment: CME-75	**Surface Elevation:** 6790 feet above MSL (Approx.)
Driving Weight: 140 lbs Auto Hammer - 30" drop	**Total Depth of Boring:** 16.5 feet bgs
Drilling Method: 8-inch OD Hollow Stem Auger	**Groundwater Elevation During Drilling:** Not encountered

Depth in Feet	Sample	Blow Counts	N value	Material Description	USCS	Color	Consistency	Moisture	Time (Min:Sec)	Dry Density (pcf)
				Qyf - Young deposits of alluvial fans - Silty SAND with Gravel, fine to coarse grained, angular gravels are up to 1.5" in particle size dimension, trace of roots	SM	Brown	Medium Dense	Damp		
				Trace of cobbles up to about 5" in particle size dimension						
5		9 10 21	19	Slight Fe_2O_3 staining, increase in gravel content			Medium Dense			120.2
10		50/3"	50+	Trace of cobbles			Very Dense			
15		40 22 15	22	Increase in cobble content, $CaCO_3$ stringers			Medium Dense			117.8

Moisture Content (% Dry Weight): 5 10 15 20 25

End of boring at 16.5 feet

Note: 1. Groundwater not encountered

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Boring Log B-4

Gasline Installation
Northshore Drive and Stanfield Cutoff
Big Bear Lake, CA

TGE Project No.: T230 | **Figure No.: A-6**

Boring Log B-5

Date Drilled: 8-21-2018	**Logged By:** Stephen Quimpo
Exploratory Equipment: CME-75	**Surface Elevation:** 6765 feet above MSL (Approx.)
Driving Weight: 140 lbs Auto Hammer - 30" drop	**Total Depth of Boring:** 11.5 feet bgs
Drilling Method: 8-inch OD Hollow Stem Auger	**Groundwater Elevation During Drilling:** Not encountered

Depth in Feet	Sample	Blow Counts	N value	Material Description	USCS	Color	Consistency	Moisture	Time (Min:Sec)	Dry Density (pcf)
				Fill - Silty SAND with Gravel	SM	Brown	Medium Dense	Moist		
				Qyf - Young deposits of alluvial fans - Silty SAND with Gravel, fine to coarse grained, trace of roots						
5		5 6 4	6	Gravelly SAND		Light Brown	Loose			107.0
10		11 15 18	20	Poorly graded SAND to sandy GRAVEL with silt, trace of Fe_2O_3		Yellow Brown	Medium Dense			107.1

Moisture Content (% Dry Weight)

5 10 15 20 25

End of boring at 11.5 feet

Note: 1. Groundwater not encountered

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Boring Log B-5

Gasline Installation
Northshore Drive and Stanfield Cutoff
Big Bear Lake, CA

TGE Project No.: T230 | **Figure No.: A-7**

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APPENDIX B

Laboratory Test Results

Laboratory Test Results

In-Situ Moisture Content and Dry Density

The in-situ moisture content and dry density of the soils were determined in accordance with ASTM D-2216 and ASTM D-2937 laboratory test methods, respectively. The in-situ moisture content method involves obtaining the moist weight of the sample and then drying the sample to obtain its dry weight, the moisture content is calculated by taking the difference between the wet and dry weights, dividing it by the dry weight of the sample and expressing the result as a percentage. Dry density is calculated by dividing the dry weight by the total volume expressed in pounds per cubic foot (Note: test performed on relatively undisturbed samples only). The results of the in-situ moisture content and dry density tests are presented in the table below and in *Appendix A, Exploratory Boring Logs*:

Table 1: Moisture Content and Dry Density Test Results (ASTM D-2216 & D-2937)

Location	Depth (ft, bgs)	Moisture Content (%)	Dry Density (pcf)
B-1	5	13.6	107.9
	10	8.3	126.6
B-2	5	8.3	121.6
B-3	5	4.9	116.0
	10	3.5	126.3
B-4	5	1.7	120.2
	15	4.9	117.8
B-5	5	13.8	107.0
	10	10.5	107.1

Particle Size Analyses

In accordance with ASTM D-422, quantitative determinations of the distribution of coarse-grained particle sizes in selected samples were made. Mechanically actuated sieves were utilized for separating the various classes of coarse-grained (gravel and sand) particles. For soil samples containing fine-grained particle sizes, additional testing was conducted in accordance with ASTM D-1140 to determine the fines content (i.e., soil passing a No. 200 Sieve). The sieve analysis test results are provided in the tables below:

Table 2: Sieve Analysis Test Results (ASTM D-422 & D-1140)

Sieve Size	B-1 @ 1-5' Percent Passing	B-2 @ 1-5' Percent Passing	B-3 @ 1-5' Percent Passing	B-4 @ 1-5' Percent Passing	B-5 @ 1-5' Percent Passing
1 in	100	100	97	97	93
¾ in	100	100	97	92	90
½ in	98	97	91	85	87
3/8 in	95	95	88	82	84
¼ in	92	91	85	78	81
#4	89	90	84	75	77
#8	82	86	76	68	69
#10	79	84	73	66	67
#16	72	81	61	58	59
#30	64	77	48	47	50
#40	59	74	42	41	46
#50	55	71	36	35	41
#100	42	59	24	23	31
#200	30	45	16	16	23
Classification	SM/SC	SM/SC	SM	SM	SM

Direct Shear

Direct shear tests were performed on relatively undisturbed samples in accordance with ASTM D-3080 to evaluate the shear strength characteristics of the in-situ materials. The test method consists of placing the soil sample in the direct shear device, applying a series of normal stresses, and then shearing the sample at a constant rate of shearing deformation. The shearing force and horizontal displacements are measured and recorded as the soil specimen is sheared. The shearing is continued well beyond the point of maximum stress until the stress reaches a constant or residual value. The direct shear test results are provided in the table below:

Table 3: Direct Shear Test Results (ASTM D-3080)

Location	Depth (ft, bgs)	Apparent Cohesion, c (psf)	Friction Angle, ϕ (degrees)
B-1	5	425	37.5
B-2	5	450	37.0
B-3	5	150	39.0
B-4	5	200	38.0
B-5	5	350	36.5

Corrosion Tests

Chemical analytical tests were performed on soil samples collected during the field exploration program to evaluate the corrosion potential of the on-site materials. These tests were performed in accordance with California Test Method Nos. 417 (sulfate), 422 (chloride), and 643 (pH and resistivity). The results of these tests are summarized below:

Table 4: Corrosion Test Results (CTM Nos. 417, 422, & 643)

Location	Depth (ft, bgs)	pH	Resistivity (ohm-cm)	Chloride Content (ppm)	Sulfate Content (ppm)
B-1	1-5	7.83	2242	80	5
B-2	1-5	7.85	2577	65	25
B-3	1-5	7.72	1857	5	110
B-4	1-5	7.42	6183	5	50
B-5	1-5	7.46	3512	5	45

APPENDIX C

ASFE Important Information About Your Geotechnical Engineering Report

Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

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