Sladden Engineering

45090 Golf Center Parkway, Suite F, Indio, CA. 92201 (760) 863-0713 Fax (760) 863-0847
6782 Stanton Avenue, Suite C, Buena Park, CA. 90621 (714) 523-0952 Fax (714) 523-1369
450 Egan Avenue, Beaumont, CA. 92223 (951) 845-7743 Fax (951) 845-8863
800 E. Florida Avenue, Hemet, CA. 92543 (951) 766-8777 Fax (951) 766-8778

November 9, 2015

Project No. 544-15196
15-08-350

Hawk Ridge, LLC
c/o Nolte Vertical Five
73-185 Highway 111, Suite A
Palm Desert, California 92260

Subject: Geotechnical Feasibility Evaluation

Project: Proposed 4-Lot Residential Subdivision
North of Benecia Trail and Fairway Drive
Yucca Valley Area
San Bernardino County, California

Sladden Engineering is pleased to present the results of our geotechnical feasibility evaluation for the site of the proposed 4-lot residential subdivision located north of Benecia Trail and west of Fairway Drive in the Yucca Valley area of San Bernardino County, California. Our services were performed in accordance with our proposal for geotechnical consulting services dated August 6, 2015 and your authorization to proceed with the work. The purpose of our investigation was to address potential planning level concerns regarding geologic/geotechnical design constraints as well as the feasibility of the planned grading, residential construction and on-site sewage disposal. Evaluation of subsurface soil and bedrock conditions/rippibility were not included within the scope of services provided. This report has been revised from our original report dated September 29, 2015 to address preliminary review concerns.

The opinions presented herein were based upon our review of applicable geologic literature, aerial photo analysis and interpretation and geologic reconnaissance and mapping of the site and surrounding area. Based on the results of our investigation, it is our professional opinion that the proposed project should be feasible from a geologic and geotechnical perspective.

We appreciate the opportunity to provide service to you on this project. If you have any questions regarding this report, please contact the undersigned.

Respectfully submitted,
SLADDEN ENGINEERING

Matthew J. Cohrt
Principal Geologist

PROFESSIONAL GEOLOGIST
Matthew J. Cohrt
No. 8567
STATE OF CALIFORNIA

Brett L. Anderson
Principal Engineer

REGISTERED PROFESSIONAL ENGINEER
BRETT L. ANDERSON
No. C45389
Exp. 9/30/15
CIVIL ENGINEERING
STATE OF CALIFORNIA

James W. Minor III
Staff Geologist

Geo/jm
Copies: 4 /Addressee

INTRODUCTION

This report presents the results of the geotechnical feasibility study performed by Sladden Engineering (Sladden) for the proposed 4-lot residential subdivision to be constructed on the site located north of Benecia Trail and west of Fairway Drive in the town of Yucca Valley area of San Bernardino County, California. The project site is located at approximately 34.1200 degrees North latitude and 116.4770 degrees West longitude. The approximate location of the site is indicated on the Site Location Map and Earthquake Fault Zone Map (Figures 1 and 2, respectively).

The purpose of our work was to assess potential project planning concerns. Specifically, our work consisted of the following tasks.

- Review of published and unpublished geologic literature regarding the geologic conditions at and near the project site.
- Aerial photographic review and lineament analysis of the site and site vicinity in order to evaluate the location and extent of on-site faulting potential.
- Geologic reconnaissance and mapping in order to assess the existing surface soil and bedrock conditions on and immediately adjacent to the site.
- Preparation of this report summarizing our findings.

PROJECT DESCRIPTION

Based on the provided project plans (NV5, 2015), it is our understanding that the proposed project will consist of constructing a new 4-lot residential subdivision on the subject site. Portions of the lots may encroach into the adjacent granitic bedrock hillsides (Figure 3). In addition to the proposed lots, on-site sewage disposal systems consisting of septic tanks and leach lines have been proposed for the residential lots.

SITE CONDITIONS

The site is located generally north of the Benecia Trail and west of Fairway Drive in the Town of Yucca Valley, California. The subject site is currently vacant with a dirt road located within an ephemeral drainage course that trends through the center of the proposed development. The central and southern portions of the site consist of alluvial soils with scattered native vegetation. The adjacent hillsides are composed of granitoid bedrock. According to the USGS (2012), the site is at an elevation of approximately 3,660 feet above mean sea level (amsl).

LITERATURE REVIEW

Sladden has conducted a review of available published and unpublished geologic literature applicable to the site and its vicinity. Locations of faults in the vicinity of the site were reviewed on the California Fault Map (Jennings, 1994) and Special Studies Zones Maps (CDMG, 1993a and 1993b). The regional geologic conditions for the site and surrounding area were reviewed on the Geologic Map of the Joshua Tree Quadrangle (Dibblee, 1967) and the Geologic Map of the San Bernardino Quadrangle (Bortugno and Spittler, 1986). Additionally, geotechnical reports prepared by Sladden Engineering in the site vicinity were reviewed. A complete list of the geologic references reviewed for this report are presented under the references section. The regional geologic map is presented as Figure 4.

AERIAL PHOTOGRAPHIC REVIEW

Sladden has conducted a lineament analysis for the site by reviewing aerial photographs on file with the County of San Bernardino Flood Control District. This lineament study was used to potentially correlate identified regional fault trends with any fault activity that may occur at the site. Photographs utilized in our lineament analysis are presented in Table 1 below.

Table 1, Aerial Photographs Reviewed

Date	Flight	Photo Numbers	Scale	Source
11/3/77	C-316	10,11,12	1"=2,300'	SBCFC
6/14/93	C-506	11,12,13	1"=1,300'	SBCFC

Note:
SBCFC - San Bernardino County Flood Control

Tonal, geomorphic and vegetative lineaments were evaluated and classed on the basis of: strength of expression, length, continuity, persistence between photos and flights, orientation, and plausible origin. Strong geomorphic lineaments coincident with the 1992 mapped splays of the Pinto Mountain Fault were identified offsite trending near the project site. The lineaments consists of northeast trending, gentle breaks in slope. No other lineaments interpreted as seismogenic in origin were observed in the immediate vicinity of the subject property or trending towards the property.

GEOLOGIC RECONNAISSANCE AND MAPPING

In order to correlate the findings from Sladden's literature review and photo lineament analysis, Sladden conducted a field reconnaissance of the subject site on August 17, 2015. At the time of our study, the site was bisected by a dirt road and undeveloped desert terrain. The site is underlain by alluvium that is anticipated to directly mantle crystalline bedrock at depth. The steeper terrain consists of intrusive bedrock with isolated areas of regolith. No evidence of faulting or secondary seismic effects (e.g. lurching, lateral spreading, subsidence, etc.) were observed during our field reconnaissance. The granitoid bedrock located in the northern section of the proposed site displayed joint sets potentially conducive to rock topple (Figure 3). However, limited scaling would likely mitigate future rock fall hazards.

GEOLOGIC SETTING

The Pinto Mountain Fault is mapped trending to the immediate south of the site and marks the boundary between the Transverse Ranges and Mojave Desert Geomorphic provinces of California. The Transverse Ranges province is characterized by roughly east-west trending, convergent (north-south compressional) deformational structural features. The convergent deformational features of the Transverse Ranges are a result of north-south crustal shorting due to plate tectonics, locally folding and uplifting of the mountains and lowering of the intervening valleys, along with propagation of thrust faults (including blind thrusts) and in filling of the valley basins with sediments. The Transverse Ranges are considered to be one of the most rapidly rising orogenic regions on earth (CGS, 2002a).

According to the CGS (2002a), the Mojave Desert Geomorphic Province is a broad interior region of isolated mountain ranges separated by expanses of desert plains that include an interior enclosed drainage and many playas. There are two important fault trends that control topography. A prominent northwest-southeast trend and a secondary east-west trend (apparent alignment with the Transverse Ranges is significant).

Yucca Valley is roughly a southwest-northeast trending alluviated basin situated between the San Bernardino Mountains to the west, the Little San Bernardino Mountains to the south, the Sawtooths and Bartlett Mountains to the north and Coyote Valley to the east. Yucca Valley is a structurally and tectonically complex geologic region transected by the Pinto Mountain Fault. In contrast to the dominantly dextral sense of relative motion found throughout Southern California, the Pinto Mountain Fault displays sinistral strike-slip motion in response to movement along the San Andreas Fault system (Hopson, 2003).

SEISMICITY AND FAULTING

The southwestern United States is a tectonically active and structurally complex region, dominated by northwest trending dextral faults. The faults of the region are often part of complex fault systems, composed of numerous subparallel faults that splay or step from main fault traces. Strong seismic shaking could be produced by any of these faults during the design life of any proposed development at the Site.

Sladden considers the most significant geologic hazard at the site to be the potential for moderate to strong seismic shaking that is likely to occur during the design life of any future development. The Site is located in the highly seismic Southern California region within the influence of several fault systems that are considered to be active or potentially active. An active fault is defined by the State of California as a "sufficiently active and well defined fault" that has exhibited surface displacement within the Holocene epoch (about the last 11,000 years). A potentially active fault is defined by the State as a fault with a history of movement within Pleistocene time (between 11,000 and 1.6 million years ago).

The Pinto Mountain Fault is a left lateral strike-slip fault with a significant dip-slip component, and may form a "left step" with the Morongo Valley Fault near its western terminus. The fault roughly forms the boundary between the Mojave Desert and Transverse Ranges Geomorphic provinces and is estimated to be at least 73 kilometers long (Bryant, 1986). Portions of the Pinto Mountain Fault experienced "triggered slip" during the 1992 Landers earthquake (Bryant, 1992).

Mapping of the Pinto Mountain Fault has been performed by Bader and Moyle (1960), Dibblee (1967), Grimes (1981), and Bryant (1986 and 1992). Prior to the 1992 Landers earthquake, there was little agreement among earlier mapping of the fault with respect to location. Compilation of the 1988 Special Studies Zones maps consisted of field checking earlier works by those previously cited, in addition to stereoscopic analysis of aerial photographs, and field verification and mapping (Bryant, 1986). Portions of the State designated earthquake fault zones were reevaluated and rezoned following the 1992 Landers earthquake in which extensive surface fault rupture occurred within and outside some of the State Designated earthquake fault zones of the region. Up to 6 centimeters (cm) of vertical displacement was recorded on the Pinto Mountain Fault along with right-stepping fracture patterns following the 1992 event (Bryant, 1992).

The Town of Yucca Valley General Plan denotes a short east to west trending fault and a poorly defined late Pleistocene buried fault (Figure 5). Figure 5 highlights the poorly defined Pleistocene fault and short east to west trending fault mapped by Grimes (1981). The east-west fault was not verified as a fault by Bryant (1986) within the CDMG FER-181 document. FER-181 highlights these faults mapped by Grimes (1981) as poorly defined.

According to Bryant (1988) FER-181 Supplement No. 2, the east-west fault shows no evidence of significant faulting. Grimes (1987) stated that the fault offsets older alluvium against granitic bedrock and is delineated by a vague vegetation lineament in late Pleistocene alluvium within the project vicinity.

For a fault to be considered active per Alquist Priolo act, evidence of faulting shall be apparent within Holocene (past 11,000 years) materials. No evidence of faulting has been noted or observed within Holocene alluvium at the subject site. No geomorphic evidence of faulting in the form of deflected drainages, shutter ridges, offset ridges and side hill benches is apparent (Bryant, 1988).

Prior to and following the 1992 Landers earthquake no significantly active and well defined faults within the project site have led to new earthquake fault zones in the project vicinity.

Table 2 lists the closest known potentially active faults which was generated using the EQFAULT computer program (Blake, 2000), as modified using the fault parameters from the Revised 2002 California Probabilistic Seismic Hazard Maps (Cao et al, 2003). This table does not identify the probability of reactivation or the on-site effects from earthquakes occurring on any of the other faults in the region.

TABLE 2
CLOSEST KNOWN ACTIVE FAULTS

Fault Name	Distance (Km)	Maximum Event
Pinto Mountain	<2.0	7.2
Burnt Mountain	6.6	6.5
Landers	7.3	7.3
Eureka Peak	7.6	6.4
North Frontal Fault Zone (East)	11.1	6.7
San Andreas - Southern	21.2	7.2
San Andreas – San Bernardino	21.2	7.5
San Andreas - Coachella	22.0	7.5
Johnson Valley (Northern)	22.1	6.7
Emerson So. - Copper Mountain	22.8	7.0
Lenwood – Lockhart – Old Woman Springs	29.8	7.5
Calico – Hidalgo	33.0	7.3
North Frontal Fault Zone (West)	36.0	7.2
Pisgah – Bullion Mountain – Mesquite Lake	37.7	7.3
Helendale - S. Lockhart	45.7	7.3
San Jacinto – Anza	58.4	7.2

CONCLUSIONS

Based on the provided site plan (NV5, 2015), it is concluded that the project site is not located within a Earthquake Fault Zone as designated by the State of California for the Pinto Mountain Fault (Figure 2). The Pinto Mountain Fault exhibited surface rupture during the 1992 Landers earthquake in which up to 6 cm of vertical displacement was recorded along with right stepping fracture patterns. Faults mapped by Grimes (1981) within the subject site are poorly defined and are not verified as active faults by Bryant (1986).

Based on our review of pertinent geologic literature and interpretation of aerial photographs, it is our professional opinion that the project should be feasible from a geologic perspective. The main concern in the construction of the proposed project is the presence of hard bedrock conditions that will likely be encountered during site grading.

Remedial grading within the proposed new building areas will be required and include over-excavation and re-compaction of loose surface soil and/or bedrock encountered during grading. We anticipate that removals will be on the order of 3 to 4 feet below pad grade should be expected.

We anticipate that conventional spread footings should be suitable for the support of proposed residential structures. All footings should be founded upon properly compacted engineered fill soil.

The site should be suitable for septic tanks and leach lines within the mapped alluvial sediments. However, if bedrock is encountered within the proposed septic systems location, alternate system location should be considered.

LIMITATIONS

This report has been prepared for the exclusive use of Hawk Ridge, LLC and Nolte Vertical Five, LLC, and their agents for specific application to the proposed development, located North West of Benecia Trail and Fairway drive in the Yucca Valley area of San Bernardino County, California. The findings, conclusions and recommendations presented in this report were prepared in accordance with generally accepted geological practice at the time and location it was prepared. No other warranty, expressed or implied, is made.

The scope of our geologic evaluation for did not include any other geotechnical investigative services nor any environmental site assessment for the presence or absence of hazardous/toxic materials in the soil, surface water, groundwater, air, or the presence of wetlands.

This report may be used only by the client and only for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both on Site and off Site) or other factors may change over time, and additional work may be required with the passage of time. Based on the intended use of this report and the nature of the new project, Sladden Engineering may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release Sladden Engineering from any liability resulting from the use of this report by any unauthorized party.

REFERENCES

Bader, J.S. and Moyle, W.R., 1960, Data on Water Wells and Springs in the Yucca Valley-Twentynine Palms Area, San Bernardino and Riverside Counties, California: California Department of Water Resources Bulletin No. 91-2, 163 Pages. Map Scale 1:62,500.

Blake, T., 2000, EQFAULT and EQSEARCH, Computer Programs for Deterministic and Probabilistic Prediction of Peak Horizontal Acceleration from Digitized California Faults.

Bortugno, E.J., and Spittler, T.E., 1986, Geologic map of the San Bernardino Quadrangle: California Division of Mines and Geology, Map No.3A (Geology) of the Regional Geologic Map Series. Scale 1:250,000.

Bryant W.A., 1988, East Airfield fault, Mesquite Lake fault, and Western Segment of the Pinto Mountain fault, San Bernardino County, California: California Division of Mines and Geology, Supplement No. 2 to FER-181.

Bryant, W.A., 1992, Fault Evaluation Report FER-234, Surface Rupture Along the Johnson Valley, Homestead Valley, and Related Faults Associated with the Ms 7.5 28 June 1992 Landers Earthquake; California Division of Mines and Geology. Scale 1:24000.

California Division of Mines and Geology, 1993a, State of California Special Studies Zones, Yucca Valley North Quadrangle. Scale 1:24000.

California Division of Mines and Geology, 1993b, State of California Special Studies Zones, Yucca Valley South Quadrangle. Scale 1:24000.

California Geological Survey, 2002a, Note 36, "California Geomorphic Provinces".

California Geological Survey, 2002b, Note 49, "Guidelines For Evaluating The Hazard Of Surface Fault Rupture".

Cao T., Bryant, W.A., Rowshandel B., Branum D., Wills C.J., 2003, "The Revised 2002 California Probablistic Siesimic Hazard Maps".

Dibblee, T.W., 1967, Geologic Map of the Joshua Tree quadrangle, San Bernardino and Riverside Counties, California: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-516, Scale 1:62,500.

Geotechnical Investigation report prepared by Sladden Engineering dated; January 24, 2014 Project No. 544-13331, Report No. 14-01-024.

GoogleEarth.com, 2015, Vertical Aerial Photograph for the Yucca Valley Area, California, Undated, Variable Scale. Reviewed at googlearth.com on May 24, 2010.

Grimes, G.J., 1981, Geologic Map of Part of the Yucca Valley Area: Unpublished Map for the California Division of Mines and Geology Data Base Augmentation Program. Scale 1:24000.

Hopson, R.F., 2003, The Origin Of Morongo Valley, An Extensional Basin In The Eastern Transverse Ranges, Southern California: Geology of the Mojave Desert and Adjacent Terranes: National Association of Geoscience Teachers, Far Western Section, 2003 Spring Conference, p. 91-101, available at http://web1.greatbasin.net/~fhopson/mv.html.html.

Jennings, Charles W. (Compiler), 1994, Fault Activity Map of California and Adjacent Areas, California Division of Mines and Geology, Geologic Data Map No. 6.

Nolte Vertical Five (NV5), 2015, Tentative Parcel Map No. 19685.

San Bernardino County Flood Control (SBCFC), 1977, 1993, Stereo photographs of the Yucca Valley area and surrounding areas.

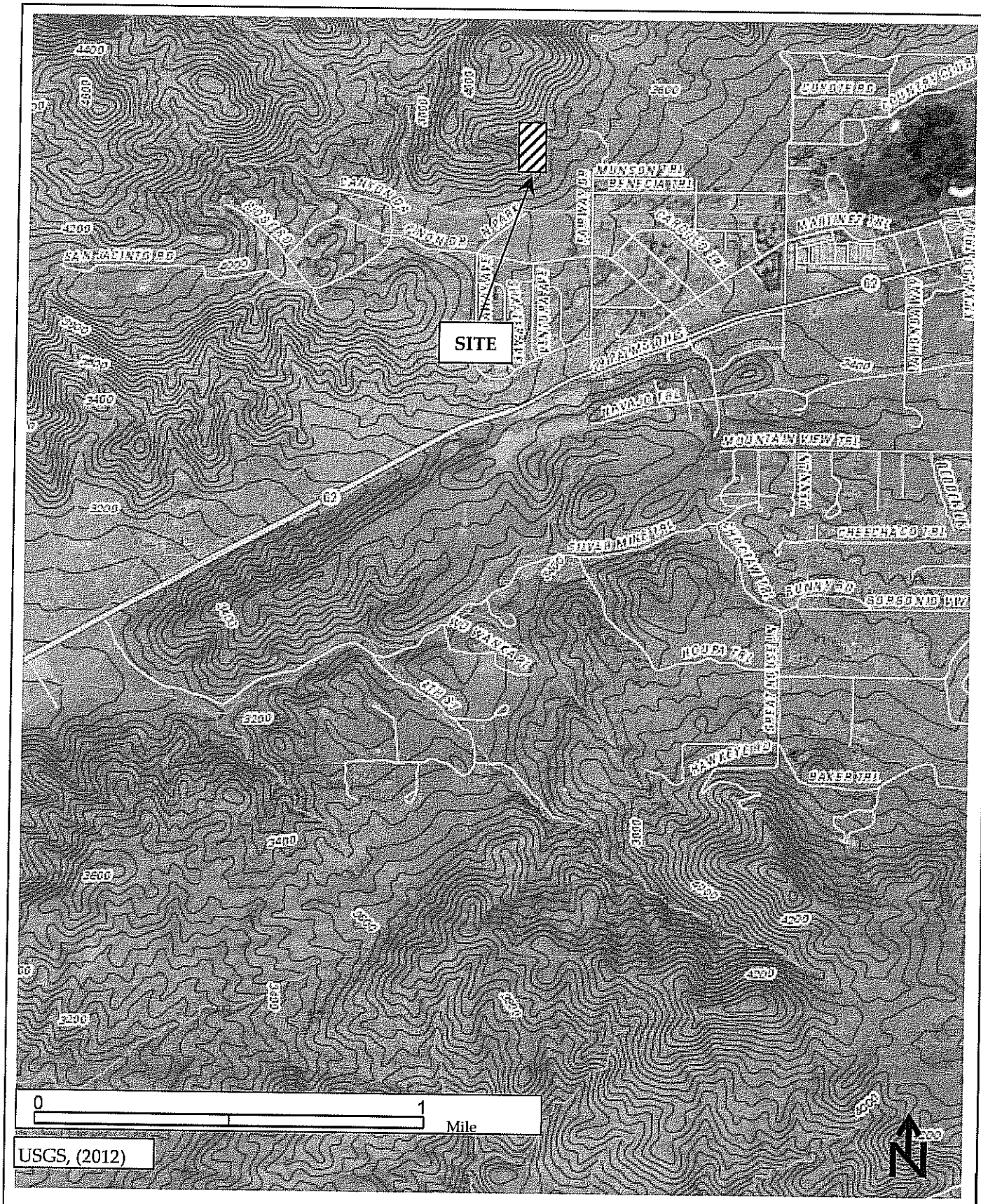
Town of Yucca Valley General Plan, Safety Element document, 2014, avaiable at http://www.yucca-valley.org/departments/gpu.html.

United States Geological Survey (USGS), 2012, Topographic Map of the Yucca Valley South Quadrangle, Scale 1:24000.

United States Geological Survey (USGS), 2012, Topographic Map of the Yucca Valley North Quadrangle, Scale 1:24000.

FIGURES

Site Location Map
Earthquake Fault Zone Map
Site Specific Geologic Map
Regional Geologic Map
Yucca Valley Geologic Map



USGS, (2012)

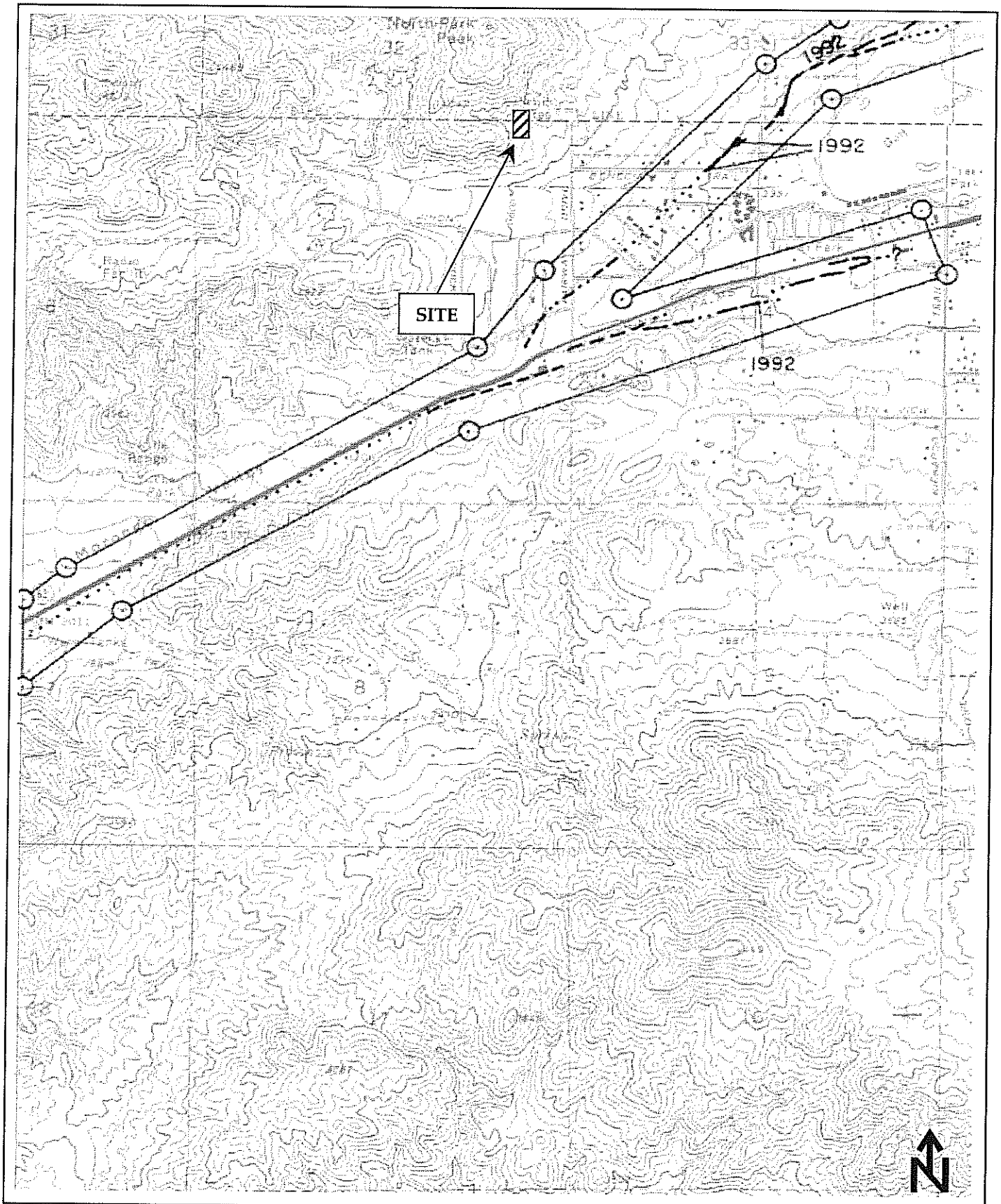
Sladden Engineering

SITE LOCATION MAP

Project Number:	544-15196
Report Number:	15-08-350
Date:	November 9, 2015

FIGURE

1



EARTHQUAKE FAULT ZONE MAP

FIGURE 2

Project Number:	544-15196
Report Number:	15-08-350
Date:	November 9, 2015

Sladden Engineering

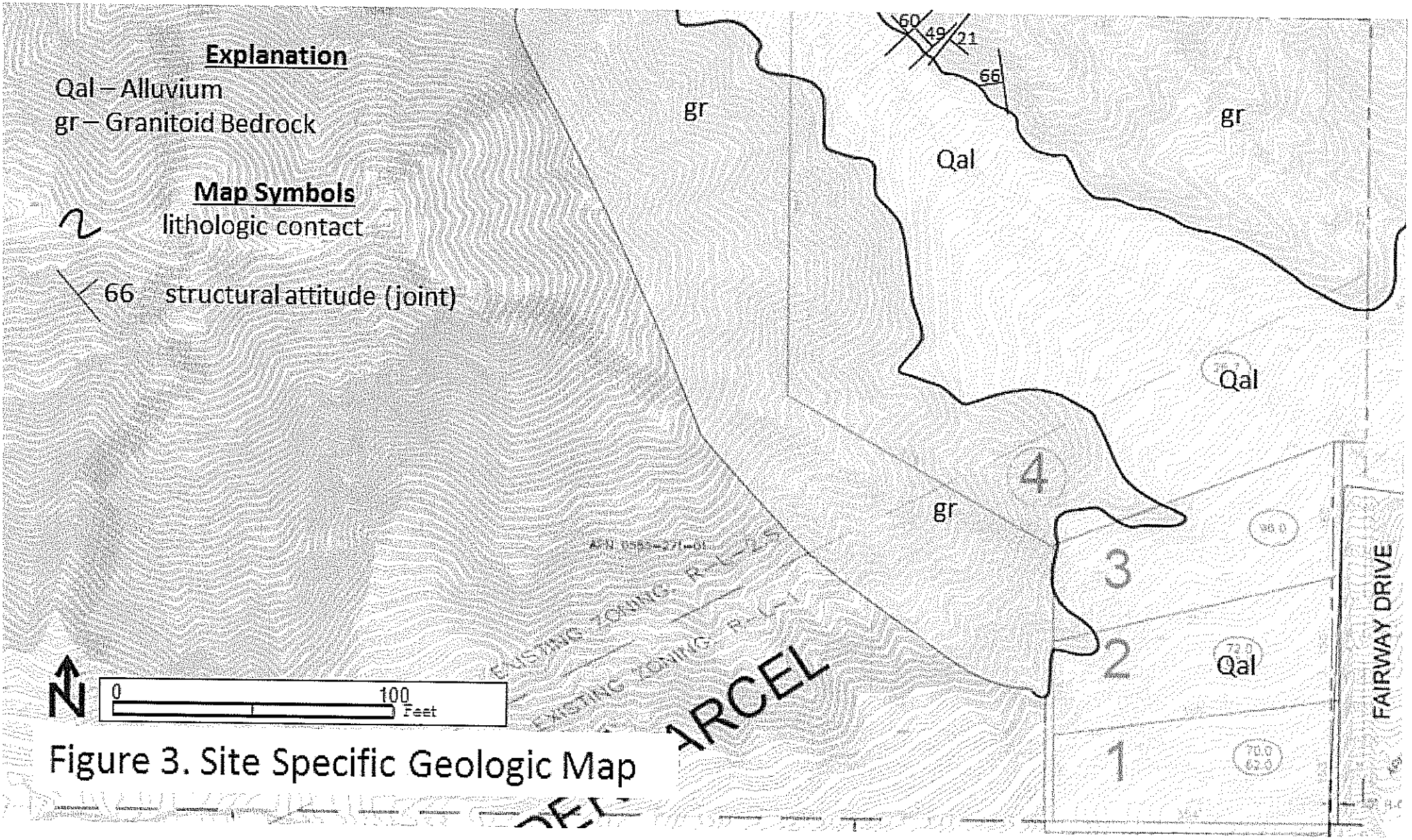


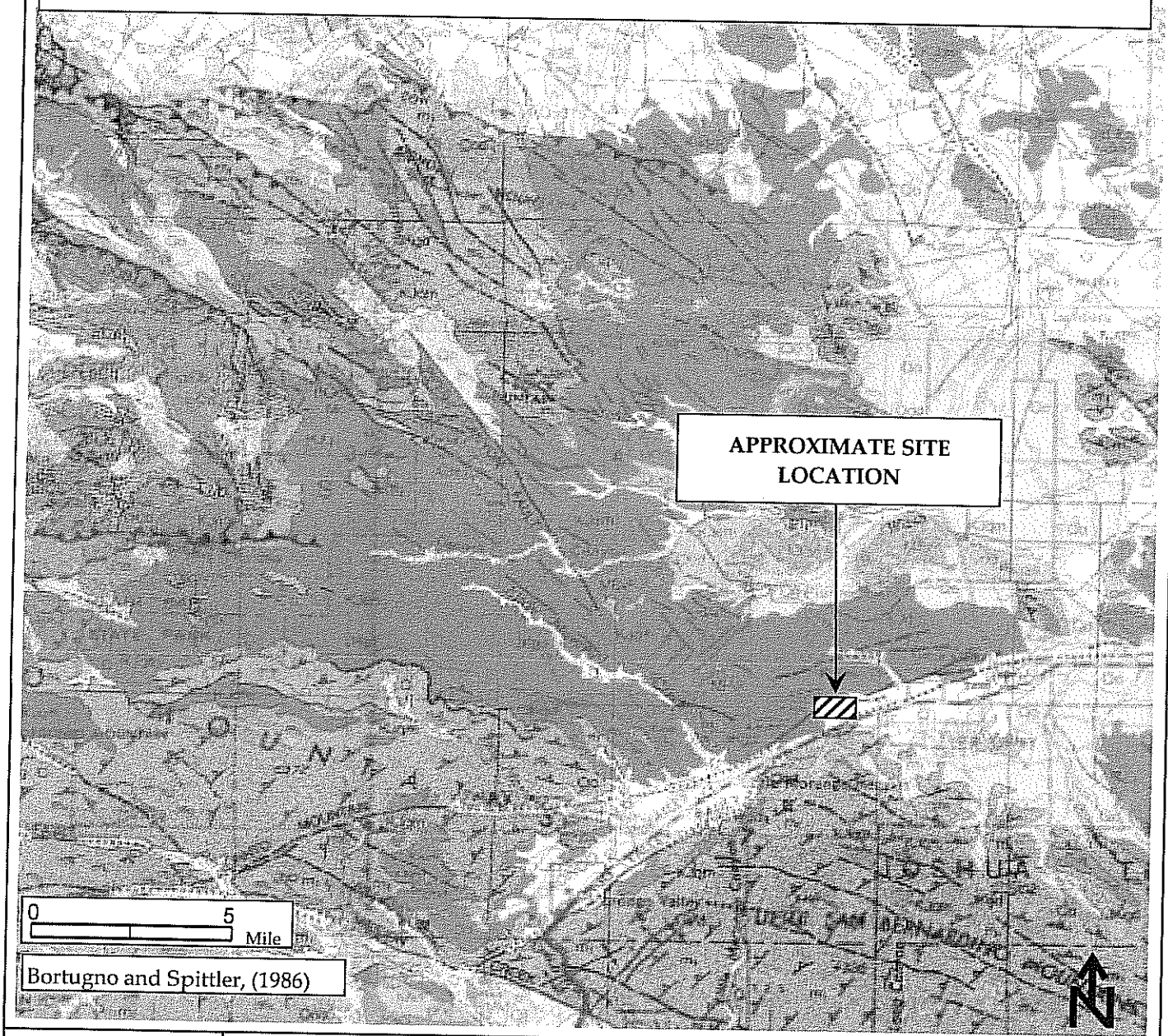
Figure 3. Site Specific Geologic Map

EXPLANATION OF SITE UNITS

Q — Alluvium *(Undifferentiated)*

QT — Continental deposits *(Undifferentiated; fluvial gravel, sand, silt, and clay)*

KJgm — Cretaceous or Jurassic quartz monzonite; Quartz Monzonite of Pleasant View Ridge



Sladden Engineering	REGIONAL GEOLOGIC MAP		FIGURE
	Project Number:	544-15196	4
	Report Number:	15-08-350	
	Date:	November 9, 2015	