APPENDIX D

ENGINEERING GEOLOGY INVESTIGATION

ENGINEERING GEOLOGY INVESTIGATION
PROPOSED REDEVELOPMENT OF
WATERMAN GARDENS PROJECT
SAN BERNARDINO, CALIFORNIA
PREPARED FOR
PYATOK ARCHITECTS
JOB NO. 10702-8

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December 17, 2010

Pyatok Architects, Inc.
1611 Telegraph Avenue, Suite 200
Oakland, CA 94612
Attention: Mr. Peter Waller

Job No. 10702-8

Dear Mr. Waller:

Attached herewith is the Engineering Geology Investigation report prepared for the proposed redevelopment of the Waterman Gardens project in San Bernardino, California.

This report was based upon a scope of services generally outlined in our proposal, dated September 9, 2010, and other written and verbal communications.

We appreciate this opportunity to provide geotechnical services for this project. If you have questions or comments concerning this report, please contact this firm at your convenience.

PROFESSIONAL GEOLOGIST
JAY J. MARTIN
No. 1529
CERTIFIED ENGINEERING GEOLOGIST
Exp. 8-31-12
STATE OF CALIFORNIA

Respectfully submitted,
C.H.J., INCORPORATED

Jay J. Martin, E.G. 1529
Vice President

JJM:ndt

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INTRODUCTION

During December of 2010, an engineering geology investigation for the proposed redevelopment of the existing Waterman Gardens project located in the City of San Bernardino, California was performed by this firm. The purpose of this investigation was to evaluate the engineering geologic conditions at the subject site and to address the engineering geologic concerns and hazards to the project. This report includes a summary of pertinent geotechnical conditions encountered at nearby sites during previous investigations. A full geotechnical (soils) report addressing the proposed development will be necessary in the future.

To orient our investigation at the site, a copy of an 80-scale topographic site map prepared by Dan Guerra & Associates was furnished for our use. The site map showed the existing structures and trees. The approximate location of the site is shown on the attached Index Map (Enclosure "A-1").

The results of our investigation, together with our conclusions and recommendations, are presented in this report.

SCOPE OF SERVICES

The scope of services provided during this engineering geology investigation included the following:

- Review of published and unpublished literature and maps
- Review and analysis of stereoscopic aerial photographs flown between 1930 and 2001
- A geologic field reconnaissance of the site and surrounding area

- Review of pertinent geotechnical investigations performed on sites in the close vicinity
- Evaluation of the geologic data to develop site-specific recommendations for the redevelopment of the project

PROJECT CONSIDERATIONS

The subject site has been developed with wood-frame residential structures. The existing structures are duplex-style residential houses constructed of wood frame and stucco, totaling approximately 250 units. Redevelopment of the site with approximately 500 new residential units is now proposed. The project may include senior apartments, a large community center, a gymnasium, and townhouses. All structures will be three stories or less in height and will be of wood-frame construction. Light foundation loads are normally associated with such structures. The scope and extent of grading required for the proposed redevelopment is not known at this time; however, it is desired to save as many existing trees as possible, so future grading may be minimal.

SITE DESCRIPTION

The approximately 38-acre site is located southeast of the intersection of Waterman Avenue and Baseline Street in the City of San Bernardino, California. The site is occupied by numerous duplex-style residential structures and appurtenant structures of wood-frame and stucco construction interspersed with several areas of landscaped grass and trees. Additionally, several commercial structures were located at various locations throughout the site. These structures appeared to be of similar construction to the residential structures. In the center of the site is a large grass field which contained playground equipment and a concrete basketball court.

Multiple concrete-lined drainages were located behind the residential structures. These drainages had a predominately east-west trend and were relatively shallow. Asphaltic concrete paved streets and overhead power lines were observed throughout the site.

Commercial developments were located north, west and southwest of the site. Orange groves were located east of the site. A school was located south of the site.

As part of this investigation, aerial photographs between 1930 and 2001 were reviewed. The site and the surrounding area appeared to be developed for agricultural use at the time of the 1930 aerial photograph. At the time of the 1978 aerial photograph the site had been developed with residential structures. Much of the area surrounding the site was developed at the time of the 1978 aerial photograph.

FIELD INVESTIGATION

A geologic reconnaissance of the site and surrounding area was conducted by an engineering geologist from this firm on December 13, 2010.

PRIOR INVESTIGATIONS

Several geotechnical investigations conducted by this firm are in close proximity to the subject site. As part of this investigation, these projects were reviewed by this firm to assist in evaluating the geotechnical hazards relevant to this project.

In August of 2001 this firm prepared a geotechnical report for the expansion of an existing business located southwest of Baseline Street and Perris Street in San Bernardino, California (C.H.J., 2001). Although groundwater was not encountered during this investigation to depths of 51-1/2 feet below ground surface (bgs), contour groundwater mapping by Matti & Carson (1991) showed a minimum depth to groundwater of 33 feet bgs. Due to the conditions of the soil on this site, it was concluded that soils below 33 feet bgs had a potential for liquefaction. The recommended remedial overexcavation beneath proposed structures was 36 inches below ground surface.

In November and December of 2007 this firm prepared a geotechnical report for the Central Valley Juvenile Detention and Assessment Center located at 900 East Gilbert Avenue in the City of San Bernardino, California (C.H.J., 2007). This site, located east of the subject site, was considered to

not have a potential for liquefaction because the groundwater contour mapping by Matti & Carson (1991) showed minimum depths to groundwater between 50 and 75 feet bgs. Several wells in areas less than 1/2 mile from the site showed historic levels of groundwater to be less than 50 feet bgs, but not at any date after 1950. The recommended remedial overexcavation beneath proposed structures was 15 feet below ground surface, due to a thick sequence of loose, young soils at the site.

Both investigations included exploratory borings which generally consisted of interbedded silty-sand (SM) and sand (SP) lenses. Few thin, isolated lenses of silt (ML) were present in depths ranging from 20 to 40 feet bgs. The soils in these investigations were considered to be non-critically expansive soil.

SITE GEOLOGY

The site is located in the San Bernardino Valley in the northern portion of the Peninsular Ranges Geomorphic Province. The San Bernardino Valley is formed by a structurally down-dropped block of crystalline bedrock material overlain by a thick accumulation of alluvium composed of flood plain and alluvial-fan deposits derived from highlands to the south, east, north, and northwest. The valley is bordered to the north and east by the northwest- to southeast-trending San Andreas Fault and San Bernardino Mountains. The valley is bordered by the Perris structural block to the south and by the northwest- to southeast-trending San Jacinto fault zone to the southwest. The eastern margin of the Lytle Creek alluvial fan, occupied by recent deposits of Lytle Creek, marks the southwest boundary of the valley.

The site is located northwest of the confluence of East Twin Creek and Warm Creek. The surficial native materials at the site are mapped as mid Holocene age alluvial fan deposits of sand and cobbly alluvium and Pleistocene age alluvial deposits consisting primarily of clayey sand and cemented gravel at regional map scales (Dutcher and Garrett, 1963; Morton, 1978; Morton and Miller, 2003).

FAULTING

The following section describes and summarizes the regional and local hazards related to faults and fault-related phenomena at the site.

FAULT RUPTURE HAZARD POTENTIAL:

The site is not located within an Alquist-Priolo Earthquake Fault Zone (APEFZ) designated by the State of California. The closest APEFZ is associated with the San Jacinto fault, located southwest of the site.

LOCAL AND REGIONAL FAULTS:

The tectonics of the Southern California area is dominated by the interaction of the North American Plate and the Pacific Plate, which are sliding past each other in a translational manner. Although some of the motion may be accommodated by rotation of crustal blocks such as the western Transverse Ranges (Dickinson, 1996), the San Andreas fault zone is thought to represent the major surface expression of the tectonic boundary and to be accommodating most of the translational motion between the Pacific Plate and the North American Plate. However, some of the plate motion is apparently also partitioned out to the other northwest-trending strike-slip faults that are thought to be related to the San Andreas system, such as the San Jacinto fault and the Elsinore fault. Local compressional or extensional strain resulting from the translational motion along this boundary is accommodated by left-lateral, reverse, and normal faults such as the Cucamonga fault, the Crafton Hills fault zone, and the blind thrust faults of the Los Angeles Basin (Matti and others, 1992; Morton and Matti, 1993).

SAN JACINTO FAULT ZONE:

The San Jacinto fault zone, a system of northwest-trending, right-lateral, strike-slip faults, is present across the southwestern San Bernardino Valley. The San Bernardino segment of this fault zone is located approximately 2-3/4 miles southwest of the site. The San Jacinto fault is the closest known active fault to the site and is considered to be one of the two dominant faults to the site with respect to the hazard of seismic shaking. More large historic earthquakes have occurred on the San Jacinto fault

than any other fault in Southern California (Working Group on California Earthquake Probabilities, 1988).

The San Jacinto Valley segment of the SJFZ is located approximately 11 miles southeast of the site. The Working Group on California Earthquake Probabilities (1995) tentatively assigned a 43 percent (±17 percent) probability of a major earthquake on the San Jacinto Valley segment of the San Jacinto fault for the 30-year interval from 1994 to 2024.

SAN ANDREAS FAULT ZONE:

The San Andreas fault zone is located along the southwest margin of the San Bernardino Mountains, approximately 3-1/4 miles northeast of the site. The San Andreas fault and the San Jacinto fault pose the greatest seismic shaking hazard to the site. The toe of the mountain front in the San Bernardino area roughly demarcates the presently active trace of the San Andreas fault, which is characterized by youthful fault scarps, vegetational lineaments, springs, and offset drainages. The Working Group on California Earthquake Probabilities (1995) tentatively assigned a 28 percent (±13 percent) probability to a major earthquake occurring on the San Bernardino Mountains segment of the San Andreas fault between 1994 and 2024.

CUCAMONGA FAULT:

The southern margin of the San Gabriel Mountains is coincident with a series of east-west trending, predominantly reverse, and thrust faults known as the Transverse Ranges frontal fault system. The San Fernando fault of this system ruptured during the 1971 magnitude (M) 6.7 San Fernando earthquake. The Cucamonga fault of this system is located at the base of the San Gabriel Mountains, approximately 9-1/2 miles northwest of the site. Evidence of recent activity on this fault includes fresh scarps, sag ponds, and disrupted Holocene alluvium (Dutcher and Garrett, 1963; Yerkes, 1985; Morton and Yerkes, 1987).

LOMA LINDA FAULT:

The mapped trace of the Loma Linda fault is located approximately 3-1/2 miles south of the site (Morton and Miller, 2003). The Loma Linda fault displaces the Plio-Pleistocene San Timoteo Formation, south of the City of Loma Linda and has been traced along a northwest trend by magnetic

and seismic evidence (Fife and others, 1976). The elevated topography of Loma Linda Hill in relation to surrounding areas is apparently the result of ancient movement along this fault. North of Loma Linda, this fault forms a partial barrier to groundwater movement, but is apparently overlain by more than 100 feet of unfaulted alluvial sediments (Dutcher and Garrett, 1963; Hart, 1976). The Loma Linda fault was formerly included in an Alquist-Priolo Zone; however, subsequent trenching studies showed no evidence of Holocene rupture of the fault. The Loma Linda fault is not considered to represent a significant seismic hazard to the site.

RIALTO-COLTON GROUNDWATER BARRIER:

The Rialto-Colton groundwater barrier is shown on published geologic maps approximately 3 miles southwest of the site (Carson and Matti, 1985; and Woolfenden and Kadhim, 1997). The Rialto-Colton groundwater barrier is known only in the subsurface, has no discernable surface features, and is considered to be an inactive fault (Carson and Matti, 1985; Dutcher and Garret, 1963; and Woolfenden and Kadhim, 1997).

I-215 - SR 210 FAULTS:

Several short fault splays defined by trenching studies for the I-215/SR210 interchange and analysis of regional photographic lineaments and seismicity were reported by Schell (2008) at a location approximately 3 miles northwest of the site. These features are postulated to represent a portion of an active fault zone that extends 15 to 20 kilometers southeastward from the San Gabriel Mountains into the San Bernardino Valley along a trend located between and subparallel to the San Andreas and San Jacinto faults. Based on length/magnitude relations, the magnitude range of earthquakes on this structure is estimated to be from M 6 to M 6.75 (Schell, 2008).

OTHER REGIONAL FAULTS:

The Cleghorn, North Frontal fault, and Mojave segment of the San Andreas fault zone are located approximately 10 1/2 miles north, 14 1/2 miles north, and 17 1/2 miles northwest of the site, respectively. These and more distant regional faults are capable of producing strong ground shaking in the southern California region.

HISTORICAL EARTHQUAKES

A map of recorded earthquake epicenters is included as Enclosure "A-4" (Epi Software, 2000). This map includes the California Institute of Technology database for earthquakes with magnitudes of 4.0 or greater from 1932 through 2009.

The Working Group on California Earthquake Probabilities (1988) lists seven M 6.0 or greater earthquakes that have occurred on the San Jacinto fault since 1899, although they acknowledge that several of these earlier episodes may have occurred on other nearby faults. Two of these earthquakes took place in the San Bernardino Valley. An M 6.5 event in 1899 near Lytle Creek and an M 6.2 event in 1923 near Loma Linda may have occurred on the San Jacinto fault. However, Fife and others (1976) and Matti and Carson (1991) suggest that the 1923 event took place on an unnamed fault parallel to and east of the San Jacinto fault.

No large earthquakes have occurred on the San Bernardino Mountains segment of the San Andreas fault within the regional historical time frame. Using dendrochronological evidence, Jacoby and others (1987) inferred that a great earthquake on December 8, 1812 ruptured the northern reaches of this segment. Recent trenching studies have revealed evidence of rupture on the San Andreas fault at Wrightwood within this time frame (Fumal and others, 1993). Comparison of rupture events at the Wrightwood site and Pallett Creek, and analysis of reported intensities at the coastal missions led Fumal and others (1993) to conclude that the December 8, 1812 event ruptured the San Bernardino Mountains segment of the San Andreas fault largely to the southeast of Wrightwood, possibly extending into the San Bernardino Valley. The average recurrence interval for large earthquakes along the southern San Andreas fault at six paleoseismic sites is 182 years (Stone and others, 2005).

Surface rupture occurred on the Mojave segment of the San Andreas fault in the great 1857 Fort Tejon earthquake. The Coachella Valley segment of the San Andreas fault was responsible for the 1948 M 6.5 earthquake in the Desert Hot Springs area and for the 1986 M 5.6 earthquake in the North Palm Springs area.

No significant historical earthquakes have been specifically attributed to the Cleghorn or Cucamonga faults.

SEISMIC PARAMETERS

Based on the geologic setting and anticipated earthwork, the soils underlying the site are classified as Site Class "D, stiff soil profile", according to the 2010 California Building Code (CBC). The seismic parameters according to the 2010 CBC are summarized in the following table.

2010 CBC - Seismic Parameters	
Mapped Spectral Acceleration Parameters	S_s = 1.71 and S_1 = 0.76
Site Coefficients	F_a = 1.0 and F_v = 1.5
Adjusted Maximum Considered Earthquake (MCE) Spectral Response Parameters	S_{MS} = 1.71 and S_{M1} = 1.15
Design Spectral Acceleration Parameters	S_{DS} = 1.14 and S_{D1} = 0.76

The corresponding value of peak ground acceleration (PGA) from the design acceleration spectrum according to the 2010 CBC is 0.46g.

GROUNDWATER AND LIQUEFACTION

The San Bernardino County Land Use General Plan places the subject site in a zone of high susceptibility for liquefaction. Liquefaction is a process in which strong ground shaking causes saturated soils to lose their strength and behave as a fluid (Matti and Carson, 1991). Ground failure associated with liquefaction can result in severe damage to structures. For sandy soils, the geologic conditions for increased susceptibility to liquefaction are: 1) shallow groundwater (generally less than 50 feet in depth); 2) the presence of unconsolidated sandy alluvium, typically Holocene in age; and 3) strong ground shaking. All three of these conditions must be present for liquefaction to occur.

The site is located in an historic artesian area documented by Mendenhall (1905). The site is not located within an historic irrigated land area.

Based on published groundwater contour mapping by Carson and Matti (1991), the minimum depth to groundwater in the area of the site was approximately 40 feet bgs for the time period from 1973 to 1983. The current depth to groundwater is estimated to be approximately 200 feet based on data from State Well No. 01S/04W-02D006S, located on or near the site (Western Municipal Water District, 2009). This measurement is from a deep well that may or may not reflect static water levels in the upper, unconfined aquifer at the site.

The actual susceptibility of the site to liquefaction should be evaluated during the recommended geotechnical investigation.

SLOPE STABILITY

The term "landslide", as used in this report, refers to deep-seated slope failures with a rupture surface at least 15 feet deep. Landslides are typically related to the underlying structure of the parent material. Surficial failures refer to shallow failures that affect the upper weathered horizon of the parent material. Evidence for deep-seated landsliding was not observed at the site or on the aerial photographs reviewed.

The susceptibility of a geologic unit to landsliding is dependent upon various factors that primarily include: 1) the presence and orientation of weak structures, such as fractures, faults, and/or clay seams; 2) the height and steepness of the natural and/or cut slope; 3) the presence and quantity of groundwater; and 4) the potential/occurrence of strong seismic shaking.

The site is underlain by alluvial deposits that are not particularly susceptible to landsliding. Based on the nature of the underlying geologic materials, the gentle site topography, and the lack of visible evidence, landsliding is not anticipated to be a hazard to the project.

Lateral spreading is a liquefaction-related phenomenon in which relatively gentle slopes can fail along a liquefied layer. The hazard of lateral spreading, if any, is related to liquefaction potential and should be evaluated during the recommended geotechnical investigation.

FLOODING AND EROSION

No evidence for previous flooding of the site was observed. Existing drainage improvements on the site mitigate the potential for erosion, and proper drainage of the site should be designed. An evaluation of the hazard posed by flooding to the project falls under the purview of others.

CONCLUSIONS

On the basis of our investigation, it is the opinion of this firm that the project is feasible from an engineering geologic standpoint.

Severe seismic shaking of the site can be expected during the lifetime of the proposed structures.

Expansive soils were not encountered during prior geotechnical investigations on adjacent properties. However, the presence or absence of expansive soils and their potential impact should be evaluated during the recommended geotechnical investigation.

Conditions conducive to landsliding are not present at the site. No evidence for landsliding on the site was observed on the aerial photographs or during our site reconnaissance.

The site is located within an area of high liquefaction potential.

RECOMMENDATIONS

GEOTECHNICAL INVESTIGATION:

A geotechnical investigation should be conducted for the site. Among the geotechnical concerns and hazards at the site are liquefaction potential, consolidation potential, seismic and static settlement,

and expansive soils. These are relatively common geotechnical hazards and can be addressed and mitigated by proper design and construction of the project.

The client has requested an estimate of remedial removal depths in building pad areas. For preliminary planning purposes, a removal depth of 36 inches could be utilized. Remedial removals should include all existing fill and any native materials deemed geotechnically unsuitable for support of structures and fill. Remedial removal depths should be recommended based on the results of the geotechnical investigation.

SEISMIC DESIGN CONSIDERATIONS:

Based on the geologic setting and anticipated earthwork, the soils underlying the site are classified as Site Class "D, stiff soil profile", according to the 2010 CBC. The seismic parameters according to the 2010 CBC are summarized in the following table.

2010 CBC - Seismic Parameters	
Mapped Spectral Acceleration Parameters	$S_s = 1.71$ and $S_1 = 0.76$
Site Coefficients	$F_a = 1.0$ and $F_v = 1.5$
Adjusted Maximum Considered Earthquake (MCE) Spectral Response Parameters	$S_{MS} = 1.71$ and $S_{M1} = 1.15$
Design Spectral Acceleration Parameters	$S_{DS} = 1.14$ and $S_{D1} = 0.76$

The corresponding value of peak ground acceleration (PGA) from the design acceleration spectrum according to the 2010 CBC is 0.46g.

LIMITATIONS

C.H.J., Incorporated has striven to perform our services within the limits prescribed by our client, and in a manner consistent with the usual thoroughness and competence of reputable engineering geologists practicing under similar circumstances. No other representation, express or implied, and

no warranty or guarantee is included or intended by virtue of the services performed or reports, opinion, documents, or otherwise supplied.

This report reflects the testing conducted on the site as the site existed during the investigation, which is the subject of this report. However, changes in the conditions of a property can occur with the passage of time, due to natural processes or the works of man on this or adjacent properties. Changes in applicable or appropriate standards may also occur whether as a result of legislation, application, or the broadening of knowledge. Therefore, this report is indicative of only those conditions tested at the time of the subject investigation, and the findings of this report may be invalidated fully or partially by changes outside of the control of C.H.J., Incorporated. This report is therefore subject to review and should not be relied upon after a period of one year.

The conclusions and recommendations in this report are based upon observations performed and data collected at separate locations, and interpolation between these locations, carried out for the project and the scope of services described. It is assumed and expected that the conditions between locations observed and/or sampled are similar to those encountered at the individual locations where observation and sampling was performed. However, conditions between these locations may vary significantly. Should conditions be encountered in the field, by the client or any firm performing services for the client or the client's assign, that appear different than those described herein, this firm should be contacted immediately in order that we might evaluate their effect.

If this report or portions thereof are provided to contractors or included in specifications, it should be understood by all parties that they are provided for information only and should be used as such.

The report and its contents resulting from this investigation are not intended or represented to be suitable for reuse on extensions or modifications of the project, or for use on any other project.

CLOSURE

We appreciate this opportunity to be of service and trust this report provides the information desired at this time. Should questions arise, please do not hesitate to contact this office.

Respectfully submitted,
C.H.J., INCORPORATED

V. Romano

V. John Romano
Staff Geologist

Jay J. Martin, E.G. 1529
Vice President

VJR/JJM:ndt

REFERENCES

Carson, S.E. and Matti, J.C., 1985, Contour map showing minimum depth to ground water, upper Santa Ana River Valley, California, 1973-1979, U.S. Geologic Survey miscellaneous field studies map MF-1802.

C.H.J., Incorporated, 2001, Geotechnical Investigation, Proposed Addition to Farmdale Creamery Plant, San Bernardino, California, prepared for Farmdale Creamery, C.H.J., Incorporated Job No. 01713-3, dated August 15, 2001.

C.H.J., Incorporated, 2007, Geotechnical Investigation, Central Valley Juvenile Detention and Assessment Center Redevelopment, San Bernardino, California, prepared for County of San Bernardino Architect and Engineering, C.H.J., Incorporated Job No. 07884-3, dated January 1, 2008.

Dickinson, W. R., 1996, Kinematics of transrotational tectonism in the California Transverse Ranges and its contribution to cumulative slip along the San Andreas transform fault system: Geological Society of America Special Paper 305.

Dutcher, L.C., and Garrett, A.A., 1963, Geologic and hydrologic features of the San Bernardino area, California, with reference to underflow across the San Jacinto fault: U.S. Geological Survey Water Supply Paper 1419.

Epi Software, 2000, Epicenter Plotting Program.

Fife, D.L., Rodgers, D.A., Chase, G.W., Chapman, R.H., and Sprotte, E.C., 1976, Geologic hazards in southwestern San Bernardino County, California: California Division of Mines and Geology Special Report 113.

Fumal, T.E., Pezzopane, S.K., Weldon, R.J., and Schwartz, D.P., 1993, A 100-year average recurrence interval for the San Andreas fault at Wrightwood, California: Science, v. 259, p. 199-203.

Hart, E.W., 1976, Loma Linda fault: California Division of Mines and Geology Fault Evaluation Report 4.

International Conference of Building Officials, 2010, California Building Code, Whittier, California.

Matti, J.C., and Carson, S.E., 1991, Liquefaction susceptibility in the San Bernardino Valley and vicinity, southern California - A regional evaluation: U.S. Geological Survey Bulletin 1898.

Matti, J.C., Morton, D.M., and Cox, B.F., 1992, The San Andreas fault system in the vicinity of the central Transverse Ranges province, Southern California: U.S. Geological Survey Open File Report 92-354.

REFERENCES

Mendenhall, W.C., 1905, The hydrology of the San Bernardino Valley, California: U.S. Geological Survey Water Supply Paper 142.

Morton, D.M. 1978, Geologic Map of the San Bernardino South Quadrangle, San Bernardino and Riverside Counties, California, U.S. Geological Survey OFR 78-20.

Morton, D.M. and Matti, J.C., 1993, Extension and contraction within an evolving divergent strike-slip fault complex: The San Andreas and San Jacinto fault zones at their convergence in Southern California: in Powell, R.E. and others, The San Andreas Fault System: Palinspastic Reconstruction, and Geologic Evolution: Geological Society of America Memoir 178.

Morton, D.M., and Miller, F.K., 2003, Preliminary Geologic Map of the San Bernardino 30 minute by 60 minute Quadrangle, California, U.S. Geological Survey Open-File Report 03-293. Scale: 1:100,000.

Morton, D.M., and Yerkes, R.F., 1987, Introduction to surface faulting in the Transverse Ranges, California, in Morton, D.M., and Yerkes, R.F., eds.: Recent reverse faulting in the Transverse Ranges, California: U.S. Geological Survey Professional Paper 1339, p. 1-5.

San Bernardino, County of, 2007, General Plan.

Schell, B. A., 2008, Holocene Faulting, San Bernardino Valley Area, San Bernardino County, California, Environmental and Engineering Geoscience, vol. XIV, no. 2.

Stone, E.L., Grant, L.B., and Arrowsmith, J.R., 2005, Recent rupture history of the San Andreas fault southeast of Cholame in the northern Carrizo Plain, California: Seismological Society of America Bulletin, v. 92, No. 3, pp. 983-997.

Western Municipal Water District, 2009, Cooperative Well Measuring Program, Covering the Upper Santa Ana River Watershed, the San Jacinto Watershed and the Upper Santa Margarita Watershed.

Woolfenden, L.R., and Kadhim, D., 1997, Geohydrology and Water Chemistry in the Rialto-Colton Basin, San Bernardino County, California: U.S. Geological Survey Water-Resources Investigations, Report 97-4012.

Working Group on California Earthquake Probabilities, 1988, Probabilities of large earthquakes occurring in California on the San Andreas fault: U.S. Geological Survey Open-File Report 88-398.

REFERENCES

Working Group on California Earthquake Probabilities, 1995, Seismic hazards in southern California: Probable earthquakes, 1994 to 2024: Bulletin of the Seismological Society of America, v. 85, no. 2, p. 379-439.

Yerkes, R.F., 1985, Earthquake and surface faulting sources - Geologic and seismologic setting, in Ziony, J.I., ed., Evaluating earthquake hazards in the Los Angeles region: U.S. Geological Survey Professional Paper 1360, p. 25-41.

AERIAL PHOTOGRAPHS REVIEWED

Fairchild Aerial Photograph Collection, 1930, Black and White Aerial Photograph flight C-910 no. 83

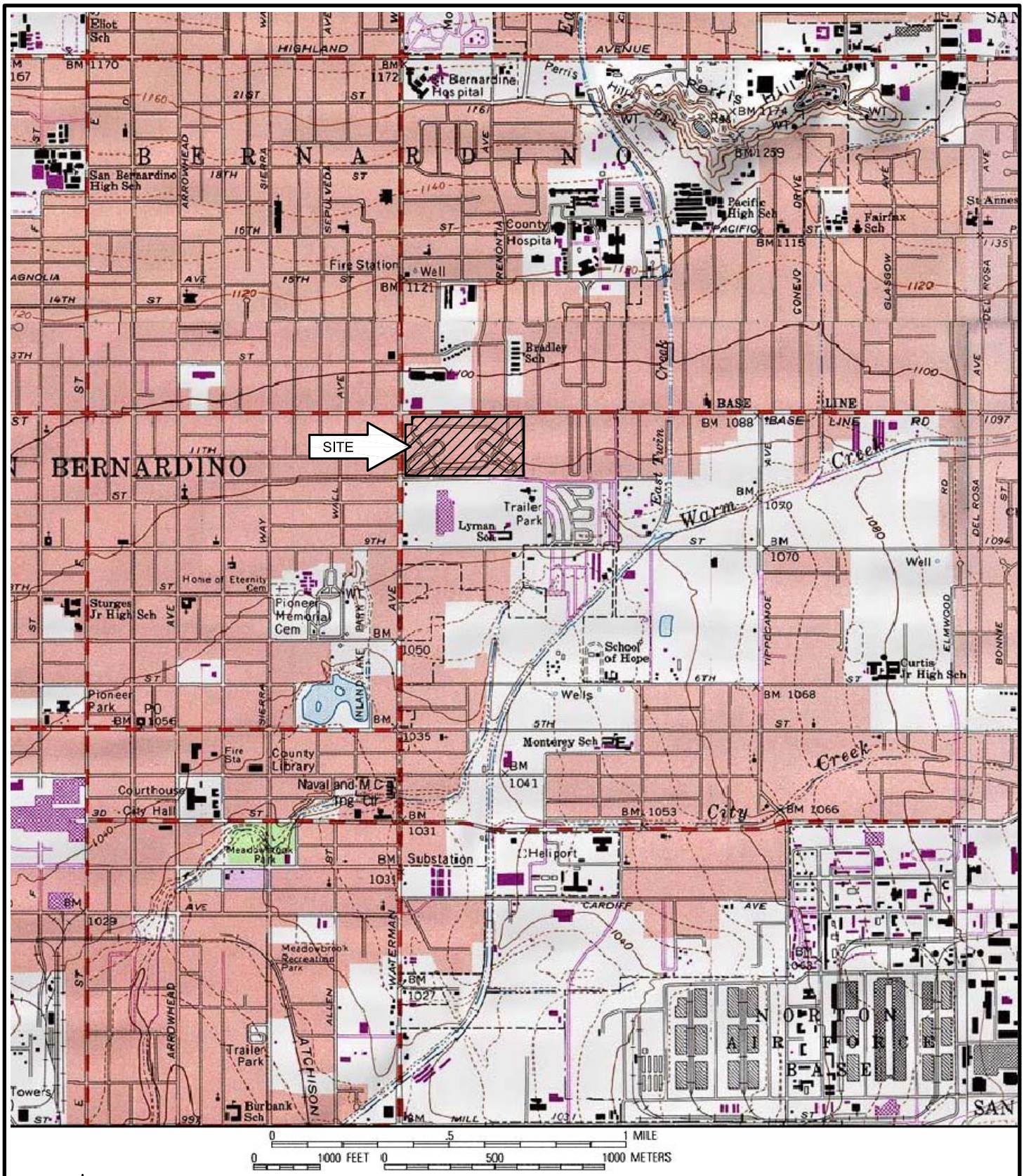
San Bernardino County Flood Control District, January 21, 1978, Black and White Aerial Photograph Nos 120 and 121

San Bernardino County Flood Control District, July 1, 1991, Black and White Aerial Photograph Nos 138 and 139

San Bernardino County Flood Control District, June 15, 2001, Black and White Aerial Photograph No. 169

APPENDIX "A"

GEOTECHNICAL MAPS



0 .5 1 MILE

0 1000 FEET 0 500 1000 METERS

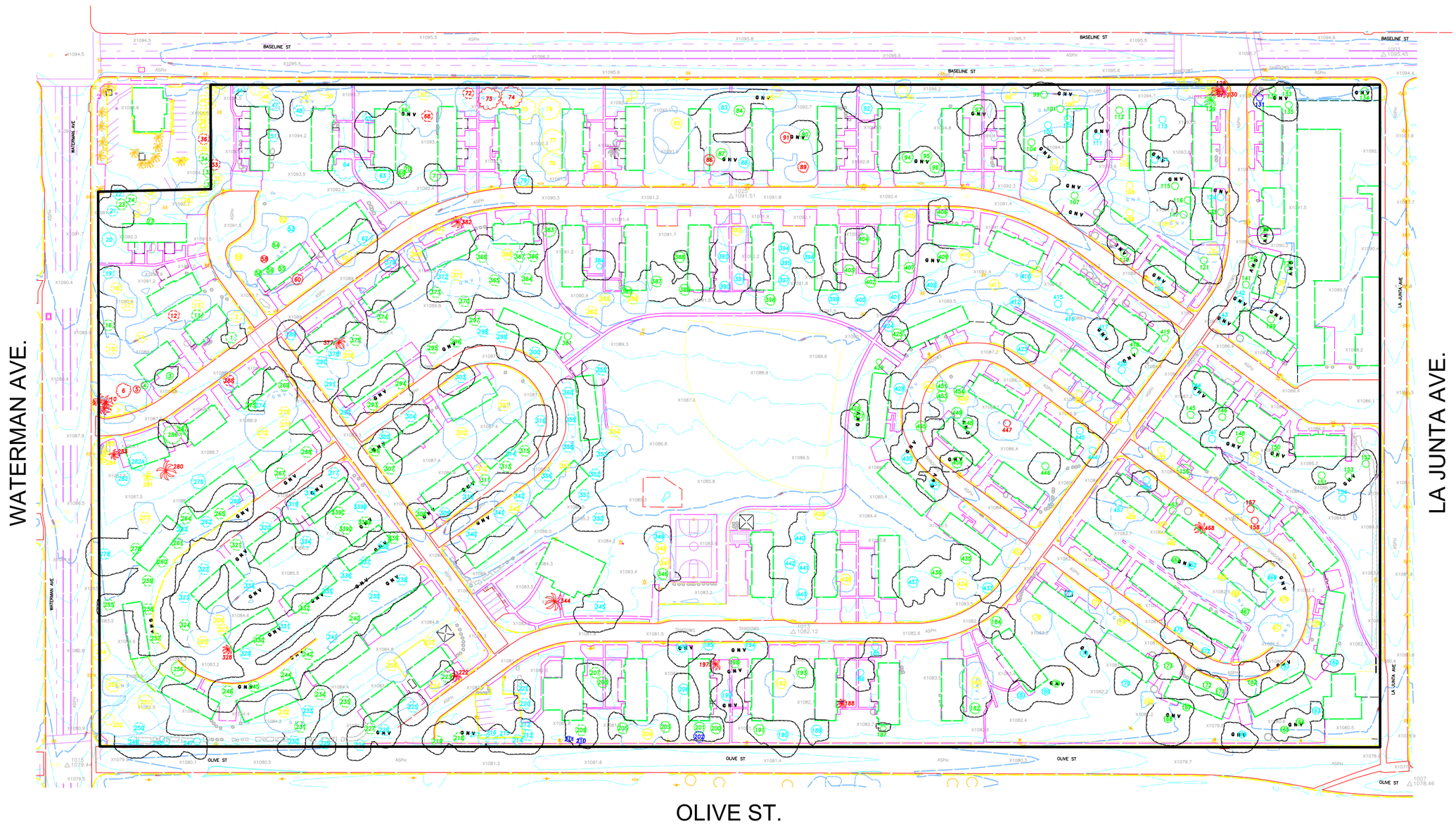
-N-

SCALE: 1" = 2,000'

INDEX MAP

FOR: PYATOK ARCHITECTS, INC.	GEOTECHNICAL INVESTIGATION WATERMAN GARDENS SAN BERNARDINO, CALIFORNIA	ENCLOSURE "A-1"
DATE: DECEMBER 2010		JOB NUMBER 10702-8

C.H.J. Incorporated



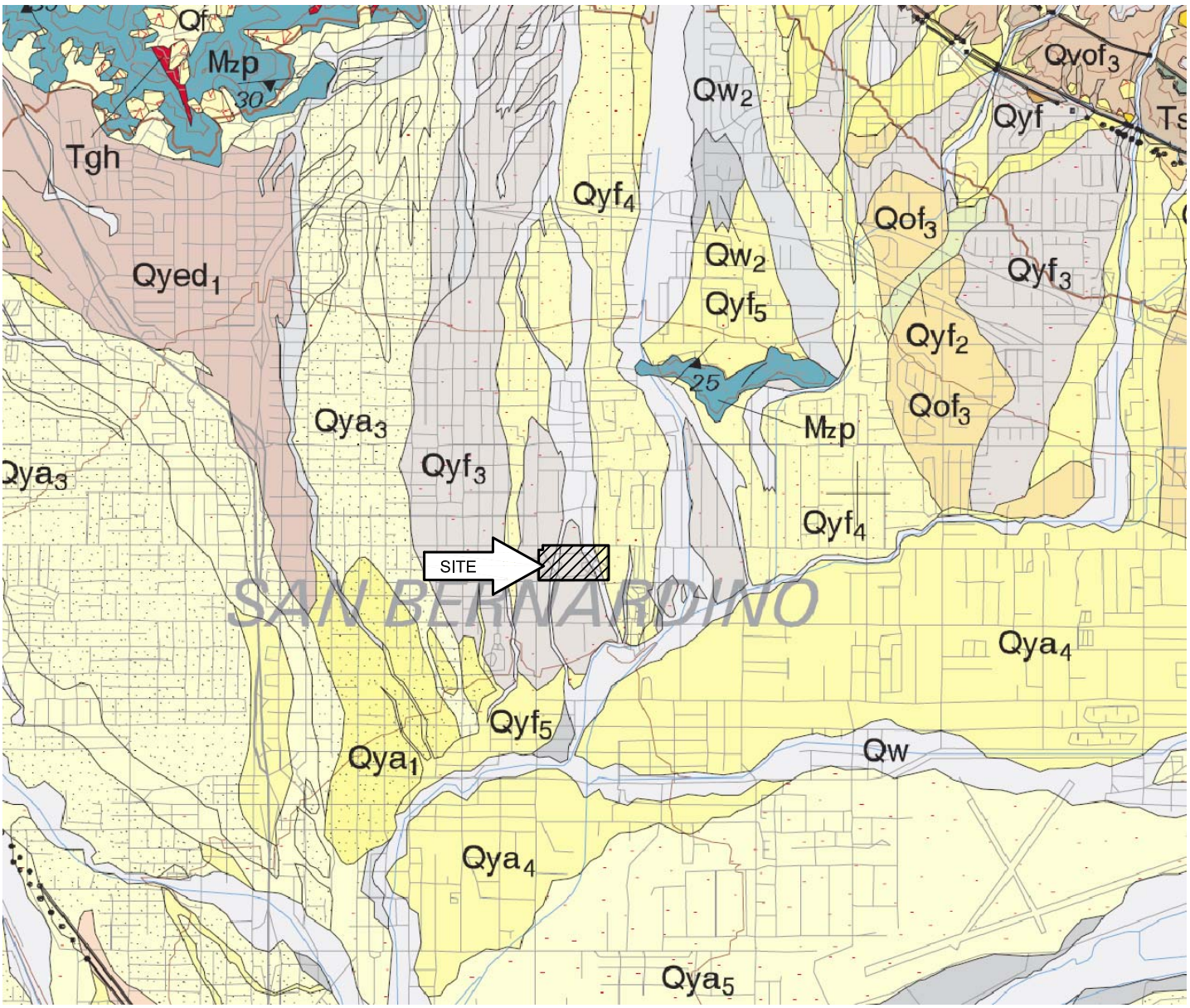
-N-

SCALE: 1" = 150'

EXISTING SITE CONDITIONS

FOR: PYATOK ARCHITECTS, INC.	GEOTECHNICAL INVESTIGATION WATERMAN GARDENS SAN BERNARDINO, CALIFORNIA	ENCLOSURE "A-2"
DATE: DECEMBER 2010		JOB NUMBER 10702-8

C.H.J. Incorporated



GEOLOGIC UNITS:

Qw - Very young wash deposits (late Holocene)
Qyf - Young alluvial fan deposits (Holocene and late Pleistocene)
Qya - Young alluvial valley deposits (Holocene and late Pleistocene)
Qyed - Young eolian deposits (dune sand), (Holocene and late Pleistocene)
Qof - Old alluvial fan deposits (late to middle Pleistocene)
Tgh - Hypabyssal granitic rocks (Oligocene)
Mzp - Pelona Schist, undifferentiated (Mesozoic)

geologic contact

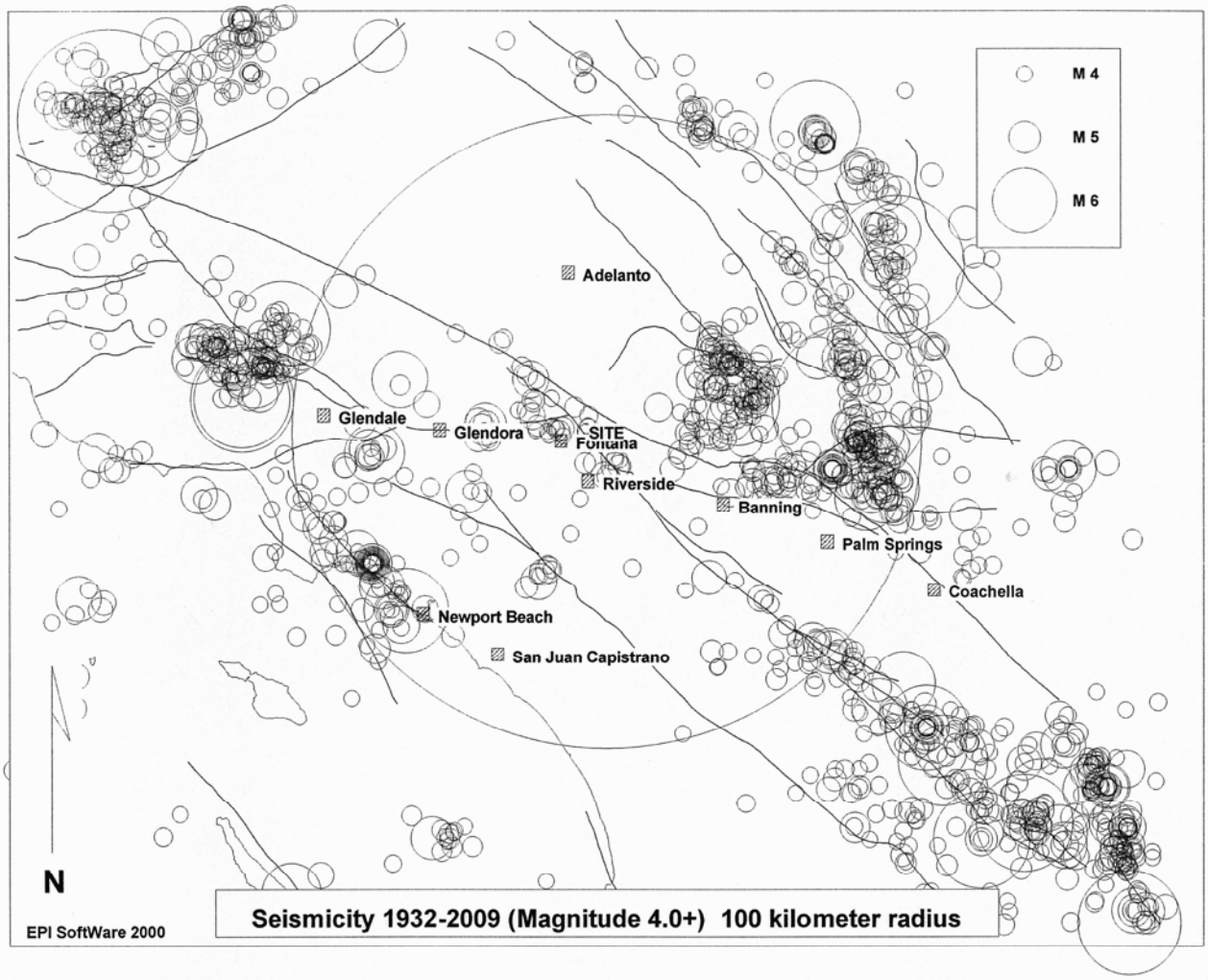
-N-

SCALE: 1" = 4,000'

GEOLOGIC INDEX MAP

FOR: PYATOK ARCHITECTS, INC.	GEOTECHNICAL INVESTIGATION WATERMAN GARDENS SAN BERNARDINO, CALIFORNIA	ENCLOSURE "A-3"
DATE: DECEMBER 2010		JOB NUMBER 10702-8

C.H.J. Incorporated



SITE LOCATION: 34.1199 LAT. -117.2757 LONG.

MINIMUM LOCATION QUALITY: C

TOTAL # OF EVENTS ON PLOT: 1545

TOTAL # OF EVENTS WITHIN SEARCH RADIUS: 654

MAGNITUDE DISTRIBUTION OF SEARCH RADIUS EVENTS:

4.0- 4.9 : 590
5.0- 5.9 : 59
6.0- 6.9 : 4
7.0- 7.9 : 1
8.0- 8.9 : 0

CLOSEST EVENT: 4.5 ON FRIDAY, JANUARY 09, 2009 LOCATED APPROX. 3 KILOMETERS SOUTHWEST OF THE SITE

LARGEST 5 EVENTS:

7.3 ON SUNDAY, JUNE 28, 1992 LOCATED APPROX. 77 KILOMETERS EAST OF THE SITE
6.4 ON SUNDAY, JUNE 28, 1992 LOCATED APPROX. 42 KILOMETERS EAST OF THE SITE
6.4 ON SATURDAY, MARCH 11, 1933 LOCATED APPROX. 85 KILOMETERS SOUTHWEST OF THE SITE
6.1 ON THURSDAY, APRIL 23, 1992 LOCATED APPROX. 90 KILOMETERS EAST OF THE SITE
6.0 ON SATURDAY, DECEMBER 04, 1948 LOCATED APPROX. 84 KILOMETERS EAST OF THE SITE

0 50 100
KILOMETERS

EARTHQUAKE EPICENTER MAP

FOR: PYATOK ARCHITECTS, INC.	GEOTECHNICAL INVESTIGATION WATERMAN GARDENS SAN BERNARDINO, CALIFORNIA	ENCLOSURE "A-4"
DATE: DECEMBER 2010		JOB NUMBER 10702-8

C.H.J. Incorporated