Volume III
(1 of 2)
DRAFT ENVIRONMENTAL IMPACT REPORT
TECHNICAL APPENDIX
State Clearinghouse No. 2009061113

LYTLE CREEK RANCH SPECIFIC PLAN

Lead Agency:
City of Rialto
Development Services Department
150 South Palm Avenue
Rialto, California 92376

March 2010

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DRAFT ENVIRONMENTAL IMPACT REPORT
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LYTLE CREEK RANCH SPECIFIC PLAN

Annexation No. 170
General Plan Amendment No. 29
Specific Plan No. 12
Development Agreement
Vesting Tentative Tract Map No. 18767
Environmental Assessment Review No. 90-19

Lead Agency:
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March 2010

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GEOTECHNICAL REVIEW

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Appendix III-A-A

Pacific Soils Engineering, Inc.
Updated Geological and Geotechnical EIR Level Review of Documents Pertaining to the Lytle Creek Ranch Land Use Plan
City of Rialto
County of San Bernardino, California
September 3, 2008

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ENVIRONMENTAL IMPACT SERVICES
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September 3, 2008
Work Order 700204

Attention: Mr. Peter Lewandowski

Subject: **UPDATED GEOLOGICAL AND GEOTECHNICAL**
EIR Level Review of Documents Pertaining
to the Lytle Creek Ranch Land Use Plan
City of Rialto, County of San Bernardino, California

References: See Appendix

Gentlemen:

Pacific Soils Engineering, Inc. (PSE) is pleased to submit this updated EIR-level review pertaining to geological and geotechnical studies carried out at Neighborhoods I through IV of Lytle Creek Ranch (LCR). A wide variety of such reports on LCR and its environs have been issued since the 1980's (see Appendix). However, three particular documents form the basis of this review: 1) on April 29, 2008 KTGY Lytle Creek Ranch Land Plan; 2) an EIR-level geotechnical review of the project prepared by GeoSoils, Inc. (GSI, 2008a); and 3) an addendum clarification letter (GSI, 2008c). Item 2, above, is based upon the KTGY plan, is a compendium of earlier work by GSI and other consultants, and sets forth geotechnical and geological issues pertinent to EIR processing. Item 3 is a response to a recent PSE (2008) review of the Item 2 report. These are, therefore, the "lead documents". Additionally, PSE has considered the entire "body of work" on the project, with the understanding that GSI is the geological/geotechnical consultant. Further, GSI investigations are the most current and draw on and supersede earlier work. Other relevant documents, in particular earlier GSI (2006, 2007a, 2007b, 2008b) reports that dealt in detail with fault issues, were reviewed during PSE involvement and are cited herein where deemed appropriate.

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1.0 BACKGROUND AND SCOPE OF THIS REVIEW

Environmental Impact Services (EIS) commissioned PSE on behalf of the City of Rialto to review, from an EIR-level viewpoint, past and current geological and geotechnical investigations (see references) pertaining to planning and EIR processing of LCR. The reports listed in the Appendix were reviewed.

For background and completeness, because fault rupture hazard issues dominate the geological constraints associated with project EIR processing, PSE undertook field and report review of recent GSI Alquist-Priolo (A-P)-level supplemental fault investigations in Neighborhoods I, II, and III of the LCR (GSI, 2006, 2007a, 2007c, 2008b). In 2007, PSE (2007a) issued a draft review of the 2006 GSI report pertaining mainly to fault surface rupture potential in Neighborhoods II and III. GSI (2007b) responded to that review and provided the additional information requested. GSI issued (GSI, 2007a, 2007c,) reports on fault rupture issues associated with Neighborhood I. PSE (2007b) and the County of San Bernardino (2007a) then issued formal reviews of the Neighborhood I fault reports. A response to the PSE (2007b) and County (2007a) reviews was recently completed by GSI (2008b). That response included supplemental field investigation to respond to the two reviews; and information and opinions generated during that study are incorporated into the GSI (2008a) EIR geotechnical document. PSE review of the 2008b and 2008c documents is incorporated into this document. In sum, the A-P-level fault investigation reports by GSI, based in part on work of others, are of detail that surpasses typical information submitted at the EIR-level. And GSI has satisfactorily responded to PSE review comments.

PSE has reviewed the "lead" GSI (2008a, 2008c) EIR-level documents using California Division of Mines and Geology Notes 46 and 49, and California Geological Survey Note 52 (where applicable) as guidelines. Additionally, PSE consulted Appendix G, Section VI, of CEQA, and other applicable state and local guidelines as context for the following assessment of GSI (2008a, 2008c). PSE also incorporated its knowledge of local practices.

For context, PSE recently prepared (PSE, 2008) the aforementioned preliminary review of the GSI (2008a) EIR report. However, owing to the submittal of the GSI (2008b, 2008c) documents, EIS, the applicant, and PSE judged that the PSE review should be updated and expanded for incorporation into the project EIR. Accordingly, in the following text, PSE enumerates and summarizes the key geological and geotechnical engineering aspects of development listed by GSI based on the sum of its work, up to and including GSI (2008c); and supersedes the PSE (2008) review. Included are brief summaries of appropriate mitigation measures (where deemed necessary) for those aspects as set forth by GSI and PSE. And finally, PSE presents its conclusions and recommendations based mainly on GSI (2008a, 2008c). Recommendations include a specific list of geological and geotechnical conditions that should be enumerated in the EIR and that must be, in PSE's judgment, completed prior to plan approval by the controlling agencies.

2.0 GEOLOGICAL AND GEOTECHNICAL ISSUES

2.1 Fault Rupture Hazard

Per Figure 3 of GSI (2008a) as revised in GSI (2008c), LCR Neighborhoods I, II, and III are partly in California Alquist-Priolo (A-P) Earthquake Hazard Zones that require investigation to prevent habitable structures (2000 man-hours per year occupancy) being placed astride California-defined active faults (Bryant and Hart, 2007). For completeness, the original Figure 3 of GSI (2008a) portrayed a north-trending A-P Zone along the westerly margin of Neighborhood IV where, according to the 2008 KTGY Land Plan (Exhibit 1 of GSI, 2008a), single-family residences are planned. GSI (2008c) submitted at the request of PSE (2008) a revised Figure 3 showing that Neighborhood IV is not within an A-P Zone. Figure 3 is thus consistent with Plate 4 of GSI (2008a, 2008c) that depicts Neighborhood IV outside of the A-P Zone at a scale of 1-inch equals 800-feet rather than 1-inch equals 2000-feet.

Owing to the presence of several mapped active faults and appurtenant A-P Zones, LCR has a rich history of fault exploration dating from 1980's explorations by Gary S. Rasmussen and Associates (GRA, 1988) to the recent (GSI, 2008b) exploration of Neighborhood I - PA 8. GSI (2008a) sets forth a history of exploration by five previous consultants (GRA, LOR, Petra, E&S, Soil Testing and Engineers, Inc.) that culminated in multiple widespread and targeted explorations of Neighborhoods I, II, and III by GSI (see references; GSI, 2006, 2007a, 2007c, 2008b, in particular). For brevity, that history is not repeated here. The reader is referred to GSI (2008a).

In sum, using standard-of-practice methodology (Bryant and Hart, 2007; County of San Bernardino, 2007b), GSI (2008a, Plates 1 through 4; revised in GSI, 2008c) identifies active faults and habitable structures setback zones in Neighborhoods I, II, and III based upon its A-P-level field investigations. GSI (2008a) notes that active faults identified in a GSI (2006) investigation of Neighborhoods II and III project toward residential PA 98 and open space/recreational PA's 95 and 97 (Neighborhood II). GSI recommends future investigation in PA 98 to evaluate residential development constraints owing to the possible presence of active faults. Also, GSI recommends additional investigation in open space/recreational PA's 95 and 97 (Neighborhood II) to evaluate development constraints owing to active faults where structures for human occupancy (i.e., golf course club house, community centers, etc.) are proposed. The recommended future investigations, where required, must be reviewed and accepted by the controlling agency (ies).

In it's earlier reviews, PSE noted that some GSI habitable structures setback zone boundaries are drawn coincident with trench walls nearest "zoned" faults which terminate before reaching those trench walls; thus "true 50-ft setbacks may not be represented". However, those trenches that do define those particular setbacks are clearly free of the "zoned" faults outside of the setback boundaries. Additionally, the faults within the setback boundaries show recurrent movements that have not propagated outside of those boundaries. Those setbacks thus are judged to be in accord with Section 3603(a) of Division 2, Title 14 of the California Code of Regulations pertaining to the A-P Act, in that subsurface excavations positively show the presence of unfaulted sediments away from fault splay endpoints. Comments at a recent Technical Advisory Committee to the State Mining and Geology Board (Irvine, California, July 23, 2008) also suggest that the GSI zones are in accord with state criteria.

The foregoing applies to enclosure within setback zones of the end points of the GSI fault splays. The setbacks along the lengths of the faults imposed by GSI (2008b) are applicable owing to the generally complex nature of such faults and, in part, to uncertainty between data points (trenches).

Geologic mapping during cleanout operations to specifically verify the absence of active faults that could affect future development should be carried out near these endpoints. Also, specific recommendations regarding mitigation of local ground deformation that reasonably might occur in these areas should be part of the permitting process and should be based on the planned graded configurations and types of structures planned at these margins. Further, these requirements are applicable to much of the project as noted in Sections 2.2 and 4.1.7, below.

2.2 Co-Seismic Ground Deformation

GSI (2006, 2007a, 2007b, 2008a) and PSE (for example, 2007b) indicate the possibility of co-seismic ground deformation such as ground lurch, ground cracks and associated surface deformation or subsidence/uplift away from active faults splays. GSI (2006, 2008a, 2008b) proposes engineering designs such as post-tensioned slabs or mat foundations to mitigate such effects. PSE concurs that this is a viable option for same and, as stated in Note 49, for "deformation manifested on broad warps" across wide fault zones. As the development process continues, specific engineering recommendations for same must be submitted to the governing authority for approval at the appropriate time. Initial designs are given in GSI (2008a). These should be finalized after geotechnical exploration and in accord with structural engineering recommendations after actual graded configurations and structure types are known. PSE notes that owing to the unpredictable locations of possible future ground deformation associated with strong local earthquakes, most of the LCR development will probably require mitigation.

GSI (2008a) also notes that engineering design can effectively mitigate small displacement active fault splays. PSE agrees that small displacements along such faults can be mitigated with geotechnical and structural engineering designs, such as those set forth by Bray and others (1998). The State does not yet allow for same within A-P zones, although a current effort to revise A-P regulations will likely lead to acceptance of such mitigation. The State does, however, allow for mitigation of co-seismic ground deformation as discussed in the preceding paragraph.

If mitigation of small displacement fault splays (other than avoidance) is undertaken, a specific set of performance standards must be set forth prior to plan approval. That is, the amount of tolerable surface displacement must be formulated and specific structural or geotechnical designs should be emplaced prior to development and be continually assessed as ground conditions are exposed. Such mitigations must be submitted to and approved by the governing agency prior to plan approval.

2.3 Liquefaction/Dynamic Settlement

GSI (2008a, Plate 1) preliminarily identified high potential for liquefaction in alluviated areas of Neighborhood I. The high potential classification is based on the presence of shallow ground water in alluvial areas of Neighborhood I and observation of paleoliquefaction features in some fault trenches.

GSI preliminarily classified alluvial areas of Neighborhoods II, III, and IV as having low potential (Plates 2 through 4). On the other hand, the County of San Bernardino Geologic Hazard Overlay Map FH21C places most of Neighborhoods III and IV in zones of "generally" high to medium liquefaction susceptibility. Likewise, Matti and Carson (1986; Sheet 4) posit that much of Neighborhood IV has "high" susceptibility to liquefaction, and that Neighborhood III possesses moderately high to moderate susceptibility, seemingly based largely on historical groundwater records and an assumed Mw 7.0 earthquake on the San Jacinto fault. The State of California has not zoned the LCR region under the Seismic Hazards Zoning Act.

At the request of PSE (2008a), GSI (2008c) has incorporated the County of San Bernardino liquefaction zones into their revised plates. PSE requested that information for disclosure and to serve as guidelines for future explorations. GSI (2008c) notes that their initial EIR-level assessments of liquefaction potential are based upon site-specific information not available to Matti and Carson (1986) and the County of San Bernardino; and that, therefore, its initial assessment is better constrained.

As pointed out by GSI (2008a, for example), site-specific liquefaction potential assessments have been performed under now-defunct standards or in qualitative manners. GSI (2008a, 2008c) concludes that site-specific liquefaction evaluations should be undertaken at LCR based on specific development concepts. PSE concurs with that conclusion.

Currently, the procedures for liquefaction susceptibility standards are incorporated in California Division of Mines Special Publication 117 (CDMG, 1997). In sum, GSI (2008a) proposes as mitigation, site-specific Special

Publication 117 compliant assessments/investigations and special engineered foundation design and/or ground-improvement techniques where warranted. PSE concurs with that conclusion. Prior to plan approval, liquefaction assessments consistent with the then-current standards of practice and controlling agency requirements must be undertaken, be approved by the controlling agency, and be implemented into project design.

2.4 Strong Ground Shaking

Owing to proximity to major active faults, GSI (2008a) indicates that LCR improvements could be subject to strong ground shaking during their design lives. Accordingly, GSI (2008a) calculated possible on-site peak horizontal ground accelerations (PGA) that could hypothetically be generated by earthquakes on those faults. GSI used two "predictive" methodologies: deterministic and probabilistic. The deterministic approach, which does not incorporate uncertainty in magnitude, location, and recurrence intervals, suggests PGA on the order of 0.62g to 0.98g. The probabilistic method, which incorporates the above uncertainties, derived a PGA of 0.9g with a 10-percent probability of being exceeded in 50-years. The latter method is typically used in geotechnical engineering formulae for assessing liquefaction susceptibility and slope stability, and for some kinds of structural engineering analyses. The current standard for earthquake resistant design of most structures is, however, the 2007 California Building Code. GSI (2008a) gives 2007 California Building Code design parameters based on site subsoil conditions. GSI (2008a) correctly notes, "The primary goal of seismic design is to protect life, not to eliminate all damage."

Because of the large size of the site, the ground motion numbers given by GSI (2008a) could vary slightly because of distance from faults – an important variable in predictive methodologies. GSI (2008a) thus states that seismic design should be re-evaluated during plan reviews, and at the conclusion of grading. PSE concurs. Further, owing to on-going research and the continuing occurrence of worldwide earthquakes, seismic design methodologies and codes tend to evolve. Thus, actual seismic design of engineered structures must be in conformance with the then-current codes.

2.5 Slope Stability/Landslides

GSI (2008) states that indications of deep-seated or seismically induced landsliding, slope creep, or significant slope failures were not observed during various GSI investigations (for example, GSI, 1994, 2006, 2007a). According to LOR (GSI, 2008a, 2008b; LOR, 1994b) slope failures have occurred in the Sycamore Canyon area of Neighborhood I. GSI or other consultants have not performed currently compliant geotechnical investigations to characterize earth materials properties. Based on available mapping (see References), slope stability/landslide issues could be of some economic concern for development, but are not foreseen to be prohibitive to project development. However, site-specific geotechnical investigation(s) must be carried out in accordance with standards set forth in the current codes and standards of practice (GSI, 2008b, 2008, PSE 2008a). That is, 2007 CBC design, Special Publication 117, and local (City/County) ordinances must be complied with. A similar statement should be included in the EIR as part of the mitigation process.

Mitigation of slope stability issues is usually obtained by one or a combination of the following: buttresses, catchment or stabilization fills, retaining walls, gabions, catchments berms, or slope laybacks, and constructing fill slopes with appropriate code-compliant factors of safety. Prior to plan approval, project specific mitigations based on exploration and analyses must be completed and approved.

2.6 Debris Flow/Flooding/Inundation/Seiching

GSI (2008a) Plates 1 through 4 indicate that much of LCR could be subject to debris flow/flooding/inundation. Also, County of San Bernardino map FH21B indicates that much of LCR is within 100-year flood zones. GSI (2008a) offers the following discussion of potential and mitigation:

"Evidence for major active debris flows that may impact the subject development was generally not specifically noted on the property and on aerial photographs. However, the potential for large debris flows within drainages and tributary canyons is moderately high under present soil cover, vegetation, and excessive precipitation conditions and may be further exacerbated in burn areas. Further, low-lying areas of the project are underlain by alluvial deposits that owe their origin, at least in part, to irregular flooding. In consideration of the potential for prolonged rainfall, possible brush fires, and vegetation denudation, we recommend that the project civil engineer consider using debris/desilting/detention basins and/or debris impact walls with sufficient freeboard where swales or their watershed intersect the proposed development. Further, we recommend that the project civil engineer evaluate the site for flooding associated with catastrophic failure of flood control device and up-gradient water-storage tanks and aqueducts during an earthquake.

Seiching refers to the periodic oscillation of an enclosed or semi-enclosed body of water which often occurs during, and following an earthquake. Considering that the site is located within, and in close proximity to, significant seismic zones and proposed development likely includes the construction of lakes for at least one golf course and landscape aesthetics, there is high potential for seiching and associated down-gradient flooding within Neighborhood II. This potential should be evaluated when the location, and side and bottom configuration of any proposed lake(s), become available. Seiche potential for any up-gradient or adjacent existing lakes should also be evaluated."

2.7 Expansive Soils

GSI (2008a) indicates the potential for expansive soils to be present at LCR, particularly in Neighborhood I. That firm recommends testing during future investigations and after grading. Widely used and effective mitigation is through enhanced slab/foundations based on tested engineering properties of underlying soils.

2.8 Unstable Geologic Units

Slope stability is discussed above. Alluvium can be unstable relative to settlement, hydrocollapse, etc. GSI (2008a) discusses qualitative characteristics based on its regional knowledge. Prior to approval of subdivision plans, appropriate results of standards-of-practice investigations, analyses and proposed mitigation (where required) based on actual plans must be submitted to and approved by the controlling agency. A statement similar to the above should be incorporated into the appropriate mitigations section of the project EIR.

3.0 CONCLUSIONS

3.1 The lead EIR-level geotechnical reports (GSI, 2008a, 2008c) discuss fault rupture hazards in detail owing to investigative efforts up to this writing. In particular, the results of GSI fault investigations (GSI, 2006, 2007a, 2007c, 2008b) are incorporated into the "lead" GSI EIR documents. PSE reviewed the four GSI fault reports and issued reviews of same (PSE, 2007a, 2007b, and in part in this document). GSI satisfactorily responded to those PSE reviews with GSI (2007b, 2008c). PSE concludes that GSI has assessed Neighborhoods I, II, III relative to surface fault rupture hazard based upon reasonable hypotheses supported by reasonably obtainable data. GSI conclusions and recommendations regarding proposed mitigation of fault rupture potential at LCR are judged to be in accord with current A-P criteria and local standards-of-practice.

3.2 GSI (2008a, 2008c) generally characterizes the geological and geotechnical setting, lists, and briefly discusses the likely geological and geotechnical issues and potential mitigations of same associated with development of LCR. The entire body of exploratory work on LCR (see references) also provides background to GSI (2008a). In sum, PSE concludes that the GSI (2008a, 2008c) reports are sufficient for EIR purposes provided the conditions enumerated below are part of the EIR process.

4.0 CONDITIONS

In its initial EIR-level review, PSE (2008) recommended that two kinds of conditions be incorporated into the EIR process. PSE asked that the first kind should be submitted as an addendum or supplement to GSI (2008a); and the second kind should be incorporated into the EIR and must be complied with in the permit process prior to plan approval by the controlling agency. GSI (2008c) addressed and submitted material for inclusion in the project EIR document as requested by PSE (2008), thereby satisfying the first kind of conditions.

4.1 Conditions Recommended To Be Incorporated Into The EIR Document

PSE suggests that the following list of conditions be incorporated into the EIR document. These deal mainly with the need for further exploration to better quantify possible geological/geotechnical constraints so that specific design measures can be implemented. The current GSI (2008a) document sets forth geological and geotechnical issues that it judges bear on future development. GSI also lists typical mitigations where deemed necessary. Geological issues can be mitigated with a variety of accepted practices and designs as GSI (2008a, 2008c) points out. PSE suggests the following conditions:

4.1.1 Parts of the LCR may be subject to liquefaction; earlier investigations of it were either subjective or completed under standards less stringent than current standards. Based upon the possibility of the presence of liquefiable soils and, at least local shallow ground water, GSI (2008a, 2008c) recommends further exploration and analyses as part of the mitigation process, and preliminarily indicates that foundation designs and/or ground improvement would be implemented where required. Such investigations must be completed and incorporated into design using the then-current standards (for example, SP 117); and must be reviewed and approved by the controlling agency prior to plan approval.

4.1.2 Similarly, geological/geotechnical issues including expansive soils, slope stability (seismic and non-seismic) compressible soils, expansive soil, debris flows, ridge top shattering must be mitigated through a program of exploration, analyses, and resultant design based on actual development plans. Agency review and incorporation of same into design prior to plan approval must be undertaken.

4.1.3 Much of LCR is within 100-year flood zones (GSI, 2008a). As recommended by GSI, the project civil engineer should evaluate the site for flooding associated with catastrophic failure of flood control devices, and up-gradient water storage tanks during an earthquake. Further, GSI recommends that the project civil engineer consider using debris/flood/detention basins and/or debris impact walls with sufficient freeboard where swales or their watersheds intersect the proposed development." PSE concurs with that mitigative process.

4.1.4 In Neighborhood I, GSI (2008a) suggests that rock fall or ridge-top shattering might occur during a strong local earthquake. A mitigation process of exploration, analysis, and incorporation of specific remedial measures that could include compacted blanket fill and engineering design for mitigation of ridge-top shattering must be undertaken.

4.1.5 PSE judges that GSI (2008a) has investigated Neighborhoods I, II, III relative to surface fault rupture hazard in accordance with now-current A-P policies and criteria and local standards of practices. Plates 1 through 3 (GSI, 2008a) show setback zones in Neighborhoods I, II, and III based on those investigations. The maps included in the EIR-level report, however, show no specific grading configurations to evaluate. Specific recommendations regarding setback distances, including assessment of fault propagation through overlying fills and setback adjustments should be based on actual proposed graded configurations, and must be shown on the appropriate plans prior to approval.

4.1.6 As part of the mitigation process, the consulting engineering geologist should map cleanouts and cut areas during grading to confirm the absence of active faults or, if same are encountered, to make mitigation recommendations.

4.1.7 GSI (2008a) indicates co-seismic ground deformation away from the actual surface faults could occur. PSE concurs. The possibility of transitory ground lurching and associated ground cracks or small-scale deformation cannot be discounted, nor can locations of same be foreseen. Thus, mitigation will likely be widespread on the project. The GSI (2008a) initial recommendations regarding strengthened foundations for the project site(s) are considered valid. As the processing continues, specific mitigation recommendations should be based on proposed development, site conditions, and then-current engineering practices. GSI (2008a) sets forth initial enhanced foundation designs. The project structural engineer in consultation with the geotechnical consultants should review actual designs.

5.0 CLOSURE

In sum, the GSI (2008a, 2008c) EIR-level reports satisfactorily present the geotechnical issues and general mitigation procedures involved with planning and processing of the LCR Land Plan. The enumerated conditions should be incorporated into the EIR document.

We thank you for the opportunity to be of service, If you have any questions regarding this and other geological/geotechnical aspects of the LCR Project, please contact our office (951) 582-0170.

Respectfully submitted,
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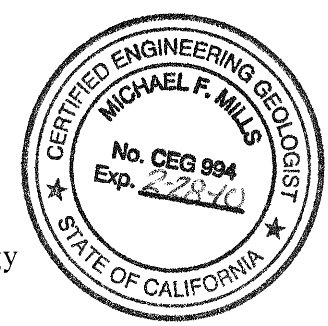

Distribution (1) Addressee

MFM:bjb-700204, September 3, 2008 (Updated EIR-Level Review)

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Appendix III-A-B

GeoSoils, Inc.
Addendum: Clarification Letter
EIR Level Geotechnical Review
Lytle Creek Ranch Land Use Plan
City of Rialto
San Bernardino County, California
July 31, 2008

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ADDENDUM: CLARIFICATION LETTER
EIR LEVEL GEOTECHNICAL REVIEW
LYTLE CREEK RANCH LAND USE PLAN
CITY OF RIALTO, SAN BERNARDINO COUNTY, CALIFORNIA

FOR

LYTLE DEVELOPMENT COMPANY
3281 E. GUASTI ROAD, SUITE 330
ONTARIO, CALIFORNIA 91761

W.O. 5049-A3.1-SC JULY 31, 2008

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GeoSoils, Inc.

Geotechnical • Geologic • Coastal • Environmental

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July 31, 2008

W.O. 5049-A3.1-SC

Lytle Development Company
3281 E. Guasti Road, Suite 330
Ontario, California 91761

Attention: Mr. Ron Pharris and Mr. Jan Dabney

Subject: Addendum: Clarification Letter, EIR Level Geotechnical Review, Lytle Creek Ranch Land Use Plan, City of Rialto, San Bernardino County, California

Dear Mr. Pharris and Mr. Dabney:

In accordance with your request and authorization, GeoSoils, Inc. (GSI) is providing this letter to clarify our preliminary conclusions and recommendations regarding geologic hazards as they pertain to the proposed Lytle Creek Ranch Land Use Plan (KTGY, 2008 [see the Appendix]). Based upon discussions with Mr. Peter Lewandowski of Environmental Impact Services (EIS [project planning consultants]), Mr. Michael Mills of Pacific Soils and Engineering, Inc. (PSE [geologic reviewer for the City of Rialto]) has reviewed the project EIR-level geotechnical review prepared by GSI (2008b). PSE indicated that the GSI (2008b) conclusions, primarily pertaining to liquefaction susceptibility, differ from those shown on the San Bernardino County Geologic Hazard Overlay Map FH21 C and FH22 C (County of San Bernardino, 2007), and liquefaction susceptibility maps prepared by Matti and Carson (1986). In order to expedite EIR approval, GSI clarifies herein the reasoning behind our preliminary conclusions regarding site liquefaction susceptibility, as well as other minor issues discussed with the client.

GSI's scope of work has included: 1) a review of geologic, geotechnical, and published data by GSI and others for the site and vicinity (see the Appendix); 2) a review of the San Bernardino County Land Use Plan - Geologic Hazard Overlay Maps (County of San Bernardino, 2007); 3) regional liquefaction susceptibility maps prepared by Matti and Carson (1986); 4) geologic and geotechnical engineering analyses; and 5) the preparation of this clarification letter and accompaniments. Unless specifically superceded herein, the conclusions and recommendations in GSI (2008b), remain pertinent and applicable and should be appropriately implemented during project planning, design, and construction.

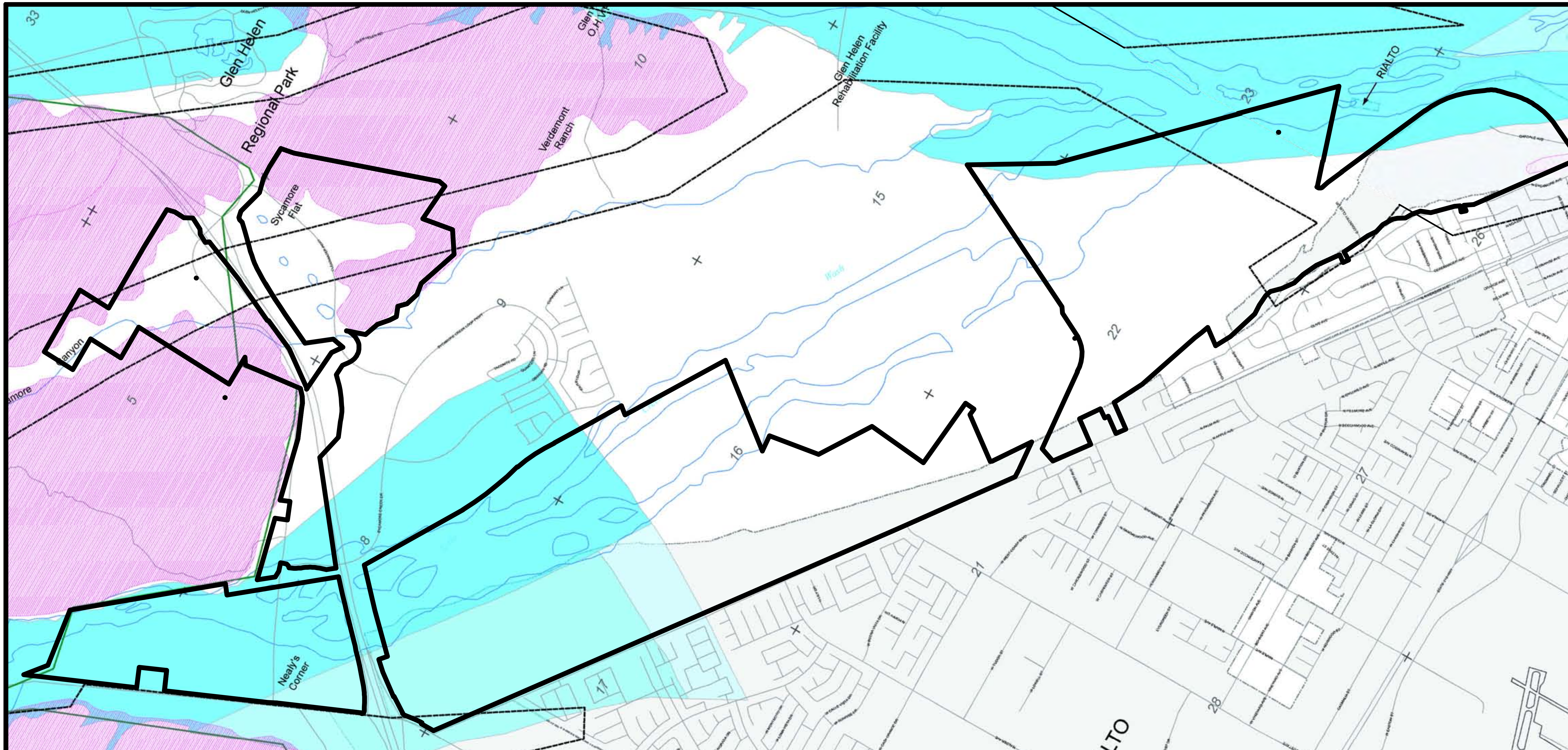
LIQUEFACTION SUSCEPTIBILITY DISCUSSION

Liquefaction susceptibility is related to many factors, and the following conditions should be concurrently present for liquefaction to occur: 1) sediments must be relatively young in age and not be strongly cemented; 2) sediments generally consist of medium- to fine-grained, relatively cohesionless sands; 3) the sediments must have low relative density; 4) free groundwater must be present in the sediment; and 5) the site must experience a seismic event of a sufficient duration and magnitude to induce straining of soil particles.

Based on our review of County of San Bernardino (2007), liquefaction susceptibility within the proposed Lytle Creek Ranch development area is classified as non-susceptible and highly susceptible in Neighborhood I, non-susceptible and highly susceptible within Neighborhood II, non-susceptible to highly susceptible within Neighborhood III, and non-susceptible and medium to highly susceptible within Neighborhood IV. Exhibit A shows the relationship of the site with respect to the County of San Bernardino (2007) geologic hazard overlays. These classifications are shown in the table below. It should be noted that the County approximated their liquefaction susceptibility zones, based on data published by Matti and Carson (1986), as discussed herein.

LIQUEFACTION SUSCEPTIBILITY - COUNTY OF SAN BERNARDINO (2007)	
NEIGHBORHOOD	RATING
I	Non-Susceptible and Highly Susceptible
II	Non-Susceptible and Highly Susceptible
III	Non-Susceptible to Highly Susceptible
IV	Non-Susceptible and Medium to Highly Susceptible

Matti and Carson (1986) assigned regional susceptibility ratings based on: 1) the depth to groundwater; 2) the distance to the causative fault; and 3) the density characteristics of regional geologic units determined from standard penetration tests (SPT's) in boreholes within very limited areas of the County, and applied them regionally. Their mapping was based on three different earthquake scenarios. These are an $M_s = 6.75$ earthquake on the Cucamonga fault, an $M_s = 7.0$ earthquake on the San Jacinto fault, and an $M_s = 8.0$ earthquake on the San Andreas fault. The following tables present the Matti and Carson (1986) conclusions pertaining to liquefaction susceptibility for each Lytle Creek Ranch neighborhood for an $M_s = 6.75$, 7.0, and 8.0 on the Cucamonga, San Jacinto, and San Andreas faults, respectively:



LEGEND

Generalized Landslide Susceptibility
- Low to moderate
- Moderate to high
- Mapped, Existing Landslide
- Rockfall/Debris-Flow Hazard Area (Forest Falls Only)

Generalized Liquefaction Susceptibility
- Low
- Medium
- High

Earthquake Fault Zones
- Earthquake Fault Zone Boundary
- County Designated Fault Zones

Cities

Approximate limits of site area

2000 0 2000
Scale Feet

N

From County of San Bernardino, 2007.

GeoSoils, Inc. RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.

SAN BERNARDINO COUNTY GEOLOGIC HAZARDS MAP

Exhibit A

W.O. 5049-A3-SC	DATE 07/08	SCALE 1"=2000'

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LIQUEFACTION SUSCEPTIBILITY - M_s = 6.75 CUCAMONGA FAULT	
NEIGHBORHOOD	**RATING**
I	Moderately High Susceptibility
II	Low to Moderate and Low Susceptibility
III	Low to Moderately High Susceptibility
IV	Low to Moderately High Susceptibility

LIQUEFACTION SUSCEPTIBILITY - M_s = 7.0 SAN JACINTO FAULT	
NEIGHBORHOOD	**RATING**
I	High Susceptibility
II	Moderate to Low and Low Susceptibility
III	Moderate to High Susceptibility
IV	High Susceptibility

LIQUEFACTION SUSCEPTIBILITY - M_s = 8.0 SAN ANDREAS FAULT	
NEIGHBORHOOD	**RATING**
I	Moderate Susceptibility
II	Moderate and Moderately High to Moderate Susceptibility
III	Low, Moderate, and High Susceptibility
IV	Moderate Susceptibility

In summary, there is a high correlation between Matti and Carson (1986), and the County of San Bernardino (2007), but the ratings are not identical. Further, the susceptibility ratings are in large part devoid of any site-specific geologic or geotechnical information.

LIQUEFACTION SUSCEPTIBILITY CONCLUSIONS

The GSI (2008b)conclusions regarding liquefaction susceptibility are based on direct geologic mapping, observations made during the GSI (1994, 1999, 2006, 2007, and 2008a) subsurface studies, and our experience with similar sites in the vicinity. Subsurface studies and analyses to evaluate liquefaction vulnerability for the Lytle Creek Ranch project are to be performed on a project-specific level, based on proposed use.

Owing to relative induration, cementation, or crystalline nature, it is GSI's opinion that areas of the site underlain in the near surface by Quaternary-age, older alluvial fan deposits, Tertiary-age "Granodiorite of Telegraph Peak," Cretaceous-age leucocratic muscovite monzogranite and mylonitic leucogranite, and Paleozoic Pelona schist (see Plates 1 through 4) were non-susceptible to liquefaction. During subsurface explorations for fault locating and age-dating within Planning Area 3 (PA 3) of Neighborhood I (GSI, 2007), GSI observed paleoliquefaction features in mid- to late Holocene alluvium. These features were also observed in trench exposures for the Soil Testing and Engineers, Inc. (STE&I, 1988). Additionally, PSE observed these features during their field review of the GSI trenches. Also, as documented in LOR Geotechnical, Inc. (LOR, 1994) and GSI (2008a), high perched groundwater was observed in some PA 8 trench exposures. Considering the depth to groundwater and the lack of induration or cementation, GSI reasonably posited a potential for liquefaction to occur within the young alluvial fan deposits exposed at PA 8. In contrast, no indications of paleoliquefaction were observed in Pleistocene-age or younger alluvial fan deposits in trench and quarry exposures (GSI, 1994 and 2006). However, as indicated in GSI (2006), a possible paleoliquefaction feature (i.e., gravel dike) was observed in the Pleistocene-age alluvial fan deposits exposed in a small localized area in Fault Trench FT-4 within Neighborhood II. Owing to field relationships, however, it is likely that liquefaction occurred around or shortly after the time of deposition, when these sediments were saturated and less indurated or cemented, since the dike was contained within, and did not extend through the entire unit.

Further, based on our review of accepted recurrence intervals for major earthquakes on the Cucamonga, San Jacinto, and San Andreas faults (2007 Working Group on California Earthquake Probabilities [2007 WGCEP], 2008; California Geological Survey [CGS], 1996; Kendrick and Fumal, 2005; Matti et al., 1992; and Southern California Earthquake Center [SCEC], 2006a and 2006b), and the Pleistocene or younger age of the alluvial fan deposits in Neighborhoods II, III, and IV, paleoliquefaction features should have been pervasive throughout the sediments in the trench and quarry exposures, if these sediments were susceptible to liquefaction (Obermeir, 1996).

In sum, County of San Bernardino (2007), and Matti and Carson (1986), are provided to delineate areas where geologic hazards have the potential to exist. Actual determination should be based on subsurface exploration and appropriate geologic and geotechnical analyses. Matti and Carson (1986) do not indicate any subsurface exploration within the Lytle Creek Ranch project area. In contrast, there have been many subsurface geologic and geotechnical investigations utilized in GSI's assessment of liquefaction potential within Lytle Creek Ranch. As previously indicated above, the GSI (2007 and 2008a) subsurface exploration exposed paleoliquefaction in areas of Neighborhood I delineated as non-susceptible to liquefaction per the County of San Bernardino (2007) and Matti and Carson (1986). Conversely, subsurface exploration did not expose paleoliquefaction in areas of Neighborhoods II , III, and IV delineated by County of San Bernardino (2007), and Matti and Carson (1986), as susceptible to liquefaction. Thus, GSI points out that in areas where the County has not even considered liquefaction to be a hazard, GSI has classified portions of this area as high (Neighborhood I), based on paleoliquefaction. On the other hand, where GSI has direct subsurface information, and conditions conducive to liquefaction have a low potential or do not have the potential to exist, GSI has reasonably indicated a low liquefaction susceptibility. As pointed out by Obermeier (1996), paleoliquefaction features should have also been observed within the Neighborhoods II, III, and IV trench and quarry exposures if these proposed development areas had been subject to liquefaction in the past. Given the elevated groundwater levels in the past, as well as regional and local seismicity, past performance is a reasonable and relatively reliable mechanism to predict liquefaction potential, should those conditions necessary for liquefaction occur concurrently, in the future. Thus, it is GSI's opinion that the liquefaction assessment for Lytle Creek Ranch (GSI, 2008b) is reasonable, and more accurate than the County's.

SLOPE STABILITY/MASS WASTING

Similar to above, the County has classified slope stability based on regional mapping and elementary criteria. In contrast, GSI's data is based on subsurface exploration and appropriate geologic and geotechnical analyses. Again, in areas where the County has indicated that slope stability issues are of no concern, GSI has indicated that in portions of Neighborhoods I and II, slope stability/mass wasting should be further evaluated with respect to specific modes of occurrence or failure. Elsewhere, within Lytle Creek Ranch, the areas proposed for development either fall outside of the County zones, and/or are within an open-space/joint use area (such as a golf course). Regardless, as indicated in GSI (2008b), slope stability/mass wasting should be further evaluated when project-level plans are available, based on proposed use. As indicated previously, GSI has plotted Lytle Creek Ranch on Exhibit A, using the County of San Bernardino's Geologic Hazard Overlays as a base map (County of San Bernardino, 2007).

OTHER COMMENTS

GSI has revised Figure 3, and Plates 1 through 4, to emphasize lightly shown features more clearly. These accompaniments are provided herein.

LIMITATIONS

The materials encountered on the project site and utilized for our analysis are believed representative of the area; however, soil and bedrock materials vary in character between excavations and natural outcrops or conditions exposed during mass grading. Site conditions may vary due to seasonal changes or other factors.

Inasmuch as our study is based upon our review and engineering analyses and laboratory data, the conclusions and recommendations are professional opinions. These opinions have been derived in accordance with current standards of practice, and no warranty, either express or implied, is given. Standards of practice are subject to change with time. GSI assumes no responsibility or liability for work or testing performed by others, or their inaction; or work performed when GSI is not requested to be onsite, to evaluate if our recommendations have been properly implemented. Use of this report constitutes an agreement and consent by the user to all the limitations outlined above, notwithstanding any other agreements that may be in place. In addition, this report may be subject to review by the controlling authorities. Thus, this report brings to completion our scope of services for this portion of the project.

The opportunity to be of service is sincerely appreciated. If you should have any questions, please do not hesitate to contact the undersigned.

Respectfully submitted,

GeoSoils, Inc.

Ryan Boehmer
Staff Geologist

John P. Franklin
Engineering Geologist, CEG 1340

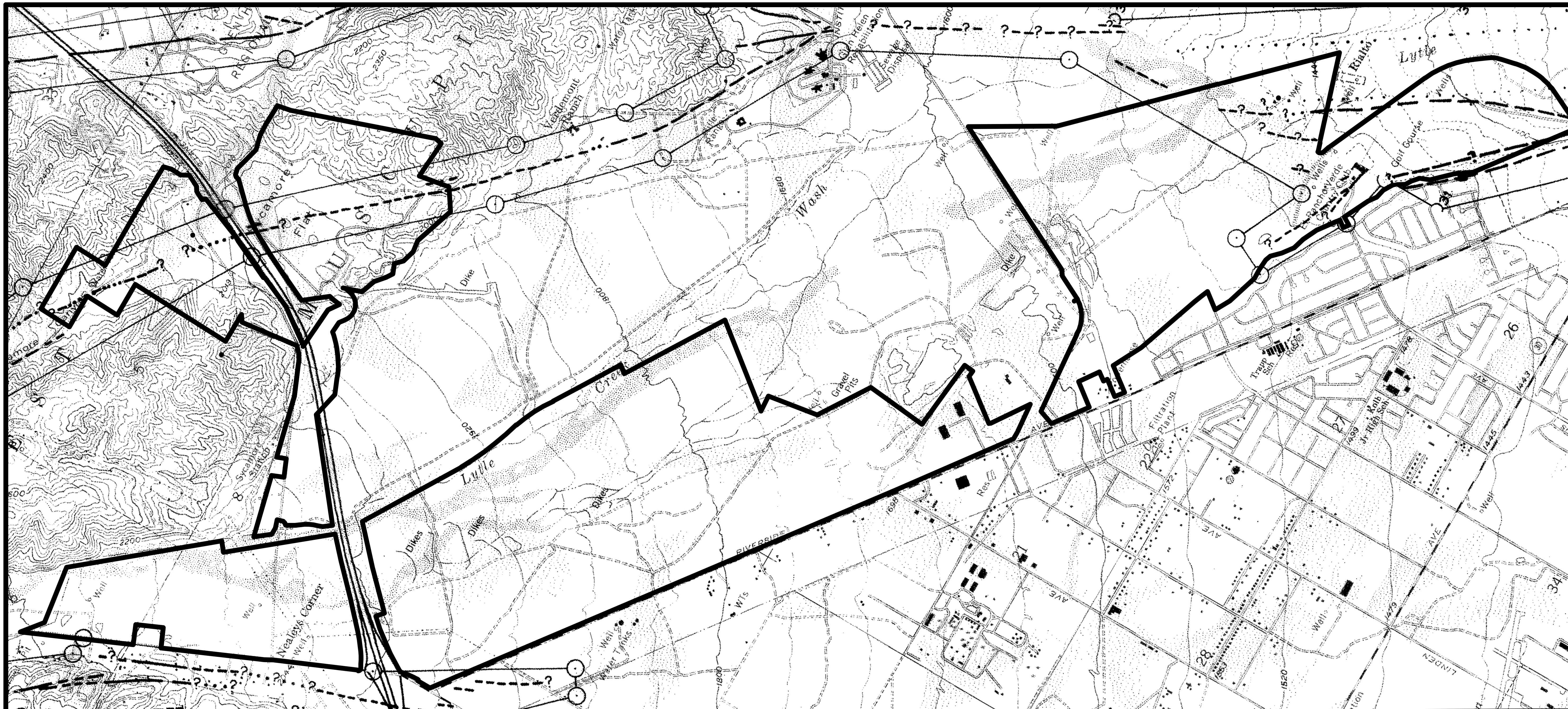
David W. Skelly
Civil Engineer, RCE 47857

Paul L. McClay
Engineering Geologist, CEG 1117

RB/JPF/PLM/DWS/jk/jh

Attachments: Revised Figure 3 - Earthquake Fault Zone Map
Revised Plates 1 through 4 - Geologic Hazards Maps
Appendix - References

Distribution: (6) Addressee (wet signed)



LEGEND

MAP EXPLANATION

Active Faults

Faults considered to have been active during Holocene time and to have potential for surface rupture; solid line where accurately located, long dash where approximately located, short dash where inferred, dotted where concealed; query (?) indicates additional uncertainty. Evidence of historic offset indicated by year of earthquake-associated event or C for displacement caused by fault creep.

Earthquake Fault Zone Boundaries

These are delineated as straight-line segments that connect encircled turning points so as to define Earthquake Fault Zone segments.

Seaward projection of zone boundary.

Approximate limits of site area

N

2000 0 2000

Scale Feet

Base Map from State of California, 1995; State of California, 1974

GeoSoils, Inc.

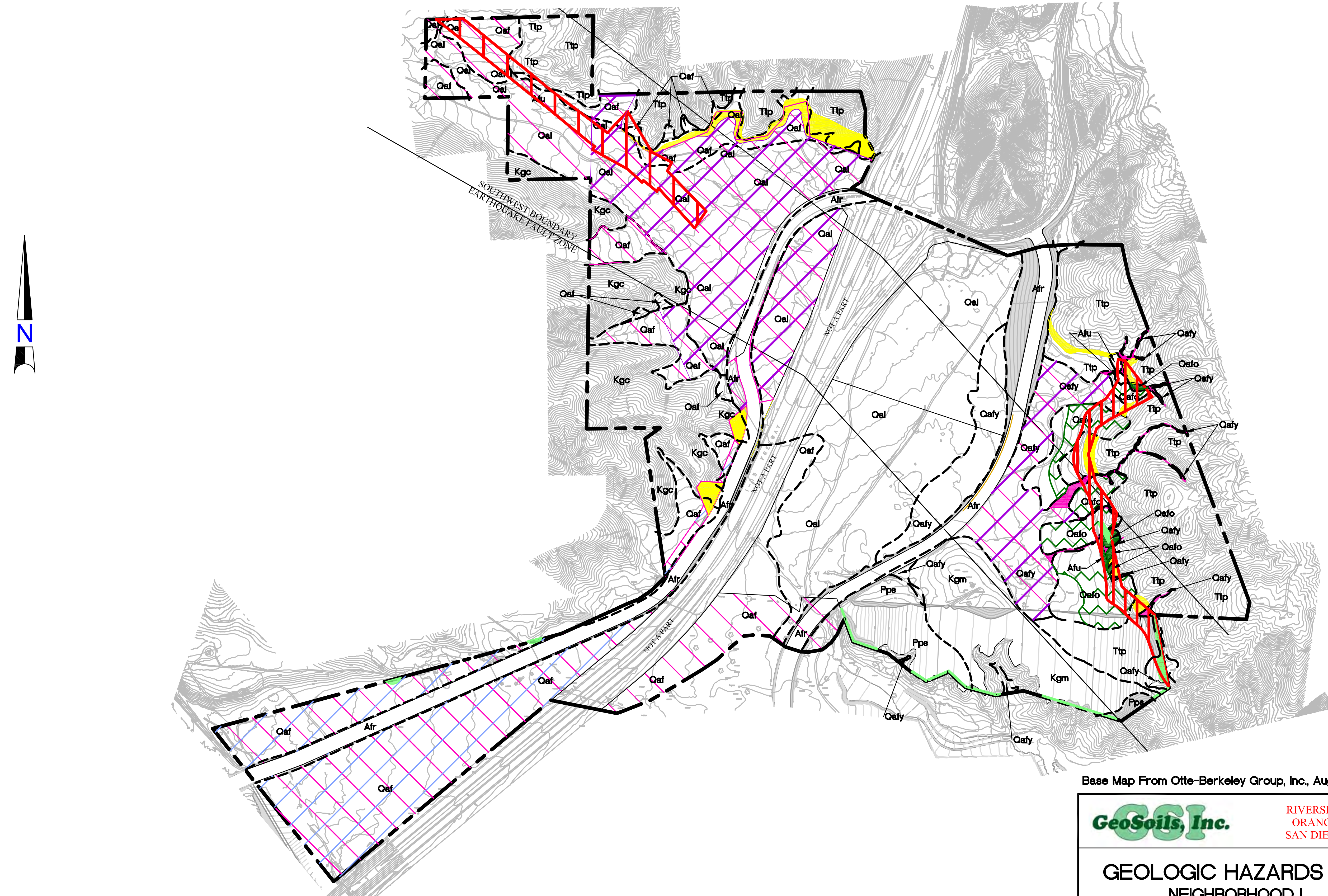
RIVERSIDE CO.
ORANGE CO.
SAN DIEGO CO.

EARTHQUAKE FAULT ZONE MAP

REVISED

Figure 3

W.O. 5049-A3-SC	DATE 05/08	SCALE 1"=2000'



Base Map From Otte-Berkeley Group, Inc., August 18, 2006

GeoSoils, Inc.

RIVERSIDE CO.
ORANGE CO.
SAN DIEGO CO.

GEOLOGIC HAZARDS MAP

NEIGHBORHOOD I

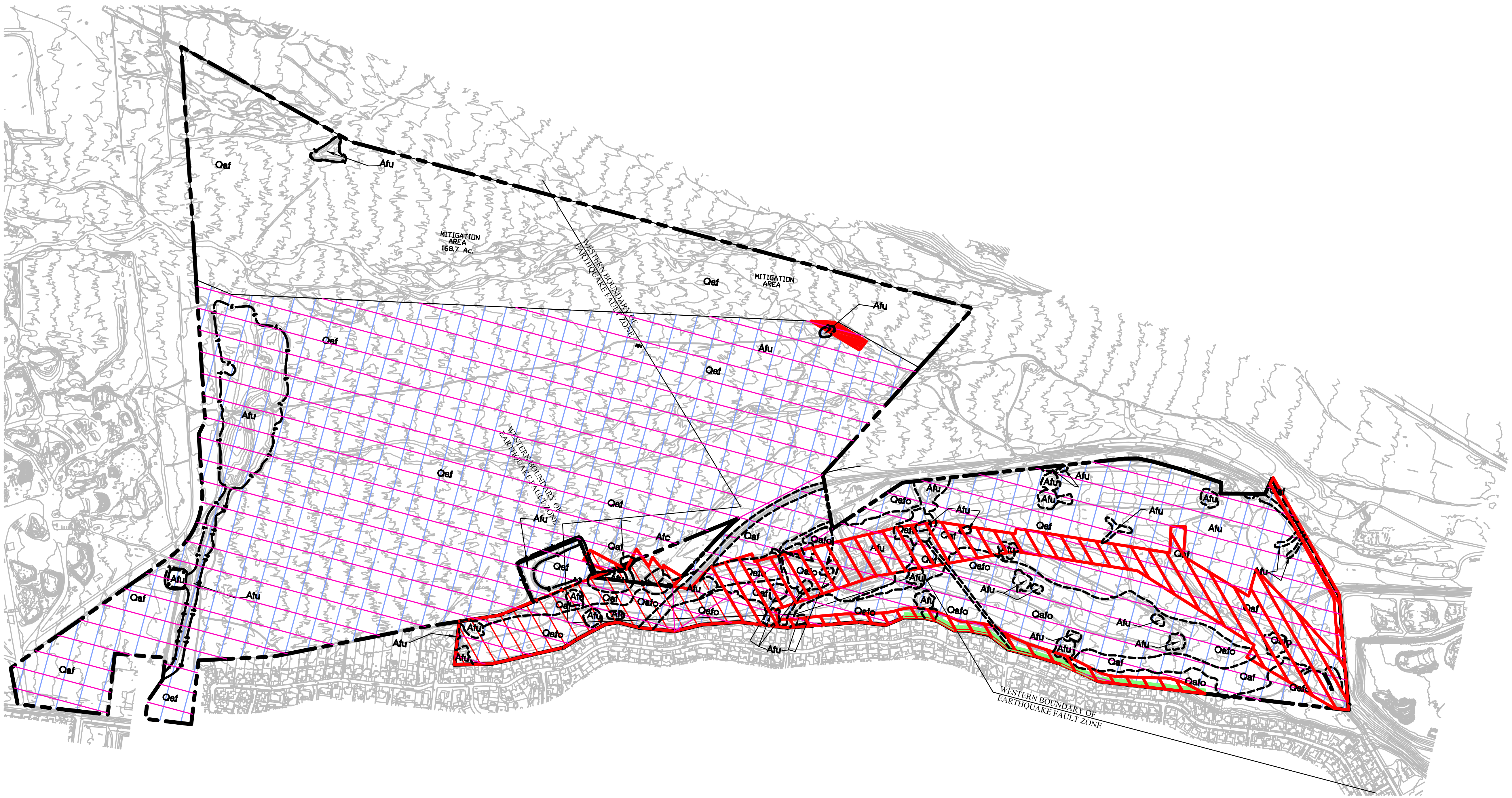
REVISED

Plate 1

W.O. 5409-A3-SC	DATE 05/08	SCALE 1"=800'

SEE EXHIBIT 1 FOR LEGEND

ALL LOCATIONS ARE APPROXIMATE



Base Map From Otte-Berkeley Group, Inc., August 18, 2006

GeoSoils, Inc.

RIVERSIDE CO.
ORANGE CO.
SAN DIEGO CO.

GEOLOGIC HAZARDS MAP

NEIGHBORHOOD II

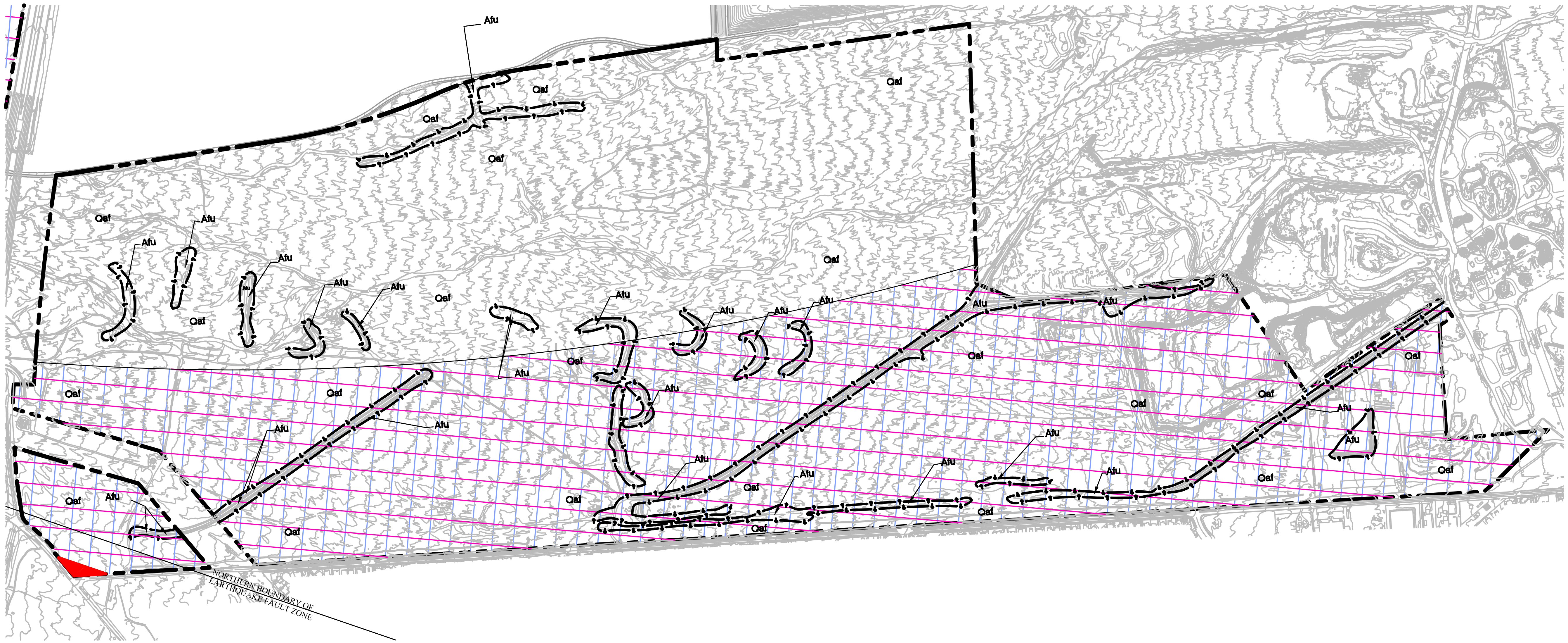
REVISED

Plate 2

W.O. 5409-A3-SC	DATE 05/08	SCALE 1"=1000'

SEE EXHIBIT 1 FOR LEGEND

ALL LOCATIONS ARE APPROXIMATE



SEE EXHIBIT 1 FOR LEGEND

ALL LOCATIONS ARE APPROXIMATE

Base Map From Otte-Berkeley Group, Inc., August 18, 2006

GeoSoils, Inc.

RIVERSIDE CO.
ORANGE CO.
SAN DIEGO CO.

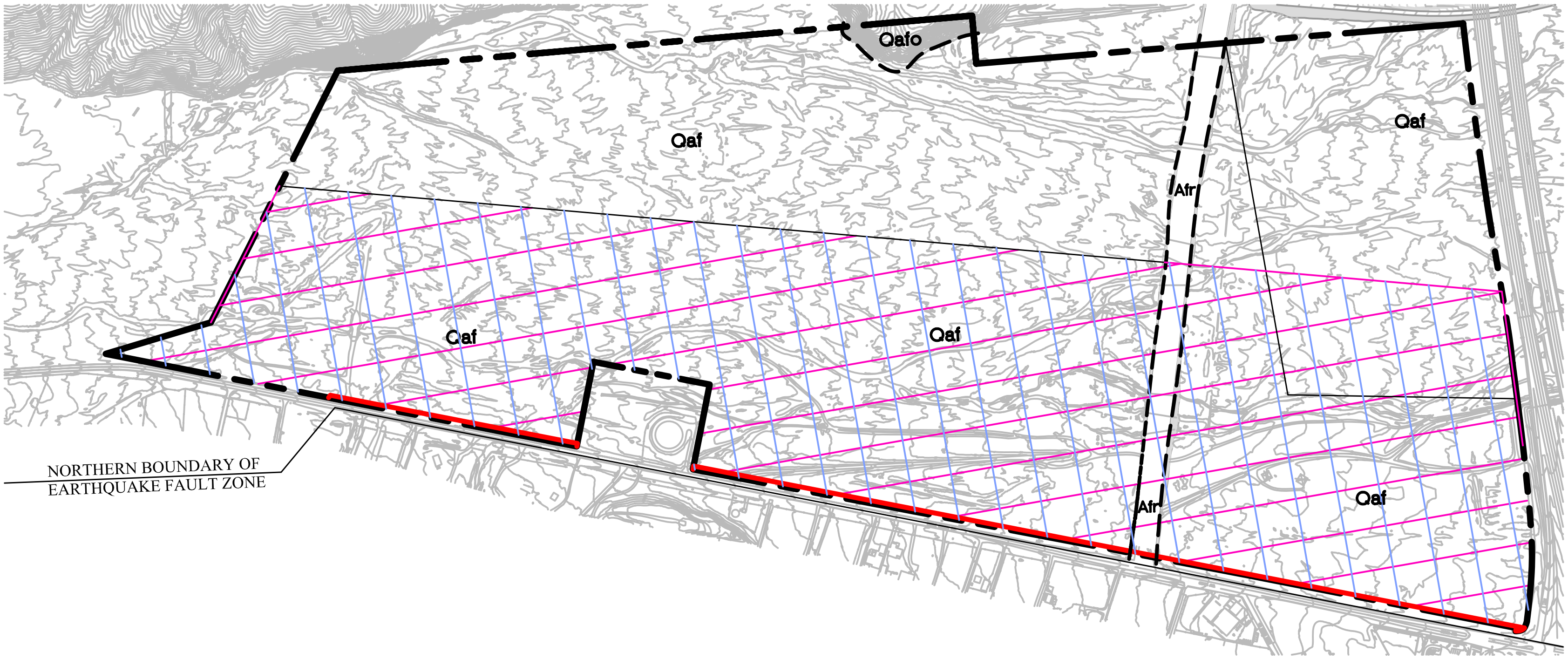
GEOLOGIC HAZARDS MAP

NEIGHBORHOOD III

REVISED

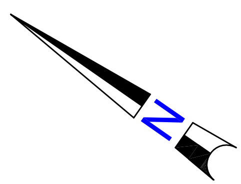
Plate 3

W.O. 5409-A3-SC	DATE 05/08	SCALE 1"=1000'



ALL LOCATIONS ARE APPROXIMATE

Base Map From Otte-Berkeley Group, Inc., August 18, 2006



SEE EXHIBIT 1 FOR LEGEND

GeoSoils, Inc.

RIVERSIDE CO.
ORANGE CO.
SAN DIEGO CO.

GEOLOGIC HAZARDS MAP
NEIGHBORHOOD IV
REVISED

Plate 4

W.O. 5049-A3-SC	DATE 05/08	SCALE 1"=800'

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APPENDIX

REFERENCES

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Appendix III-A-C

GeoSoils, Inc.
Addendum No. 2 to "Supplemental Fault and Seismic Investigation, Lytle Creek Ranch Neighborhood I, Sycamore Canyon Area, Rialto, San Bernardino County California," dated February 13, 2007
Additional Fault Investigation Planning Area 8, Sycamore Flat Area
July 1, 2008

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ADDENDUM NO. 2 TO SUPPLEMENTAL FAULT AND
SEISMIC INVESTIGATION, LYTLE CREEK RANCH, NEIGHBORHOOD 1
SYCAMORE CANYON AREA, RIALTO
SAN BERNARDINO COUNTY, CALIFORNIA"
DATED FEBRUARY 13, 2007; ADDITIONAL FAULT INVESTIGATION
PLANNING AREA 8, SYCAMORE FLAT AREA

FOR

LYTLE DEVELOPMENT COMPANY
3281 E. GUASTI ROAD, SUITE 330
ONTARIO, CALIFORNIA 91761

W.O. 5278-A1-SC JULY 1, 2008

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July 1, 2008

W.O. 5278-A1-SC

Lytle Development Company
3281 E. Guasti Road, Suite 330
Ontario, California 91761

Attention: Mr. Ron Pharris and Mr. Jan Dabney

Subject: Addendum No. 2 to "Supplemental Fault and Seismic Investigation, Lytle Creek Ranch, Neighborhood 1, Sycamore Canyon Area, Rialto, San Bernardino County, California," dated February 13, 2007; Additional Fault Investigation, Planning Area 8, Sycamore Flat Area

Dear Mr. Pharris and Mr. Dabney:

In accordance with your request and authorization, GeoSoils, Inc. (GSI), summarizes herein our additional fault investigation of the Sycamore Flat area, Planning Area (PA) 8, of Neighborhood I of the subject project. We understand that, based on a review of the letter dated September 24, 2007 by Mr. Wessly Reeder (San Bernardino County Geologist), a fault investigation evaluating both Sycamore Canyon and Sycamore Flat (PA's 3, 4, and 8) is required. This is apparently based on GSI fault setback zones differing from those of LOR Geotechnical, Inc. (LOR, 1994a), and new unpublished data. GSI's conclusions and recommendations regarding fault rupture hazards within the Sycamore Canyon area of Neighborhood I have previously been summarized in GSI (2007a). We therefore provide this addendum to evaluate the potential for fault rupture within PA 8 by correlating data from our recent field exploration with previous information obtained by GSI and other investigators.

This document provides geologic maps, trench and fault locations, the distribution of geologic units, and setback zones for habitable structures for both the Sycamore Canyon and Sycamore Flat areas of Neighborhood I (see Plates 1 and 2). Previous investigations by GSI and others, pertinent to this addendum, were previously summarized on a compact disc (CD) included in Appendix A of GSI (2007a and 2007b). Unless specifically superceded herein, the conclusions and recommendations provided in GSI (1994, 1999, 2007a, and 2007b) are considered valid and applicable, and should be appropriately implemented during project planning, design, and construction.

INTRODUCTION

A large portion of Residential Planning Area (PA) 8 lies within an Alquist-Priolo Earthquake Fault Zone (APEFZ) associated with the San Jacinto fault zone (SJFZ). Accordingly, this addendum further evaluates onsite geologic conditions within PA 8, as they pertain to the proposed development. The APEFZ Act requires that the State establish fault investigation zones along well located,"sufficiently active and well-defined" faults. Additionally, local building officials shall not issue development permits until geologic investigations demonstrate that proposed habitable structures are not likely adversely affected by surface displacements from future faulting. Typically, "sufficiently active" refers to faults that show evidence of surface displacement within about the last 11,000 years (Holocene Epoch). In addition, current professional standards-of-practice require identification and investigation of aerial-photographic lineaments or other geomorphic or geologic features reasonably suggestive of active faulting, whether they be within or outside of existing APEFZ's.

Many previous investigations have taken place at the site (GSI, 1994 and 1999; LOR, 1994a; Eberhart and Stone [E&S], unpublished; Soil and Testing Engineers, Inc. [STEI], 1988). However, the LOR (1994a) study, in the Sycamore Flat area, is the only fault rupture hazard investigation for PA 8 that received limited approval by the County (County of San Bernardino, 1994b) and submitted to the State (California Division of Mines and Geology [CDMG], 1995). The GSI (1994) investigation was approved by the County of San Bernardino (1995b) as a feasibility level review. The faulting identified in LOR (1994a) and GSI (1994) corroborates the current APEFZ within PA 8 (CDMG, 1994 and 1995).

LOR documented Holocene faults in the north-northwestern reach of Sycamore Canyon. However, their evidence for active faulting within Sycamore Flat was equivocal. As indicated in GSI (1999 and 2007a), the postulated trend of LOR's fault through Sycamore Canyon and Sycamore Flat is not correct because unbroken Holocene sediments were documented southeast of FT-204 (Plate 2). Further, paleoliquefaction features identified in T-101 (GSI, 1999 [Plate 2]) are not faults, as interpreted by LOR, in their adjacent Trench No. 11.

GSI (1994 and 1999) showed that active faulting in the Sycamore Flat area is primarily associated with the topographic break-in-slope between the Lower Lytle Creek Ridge-Verdemont Hills and Sycamore Flat. GSI (2007b) mapped active faulting within PA 8 based on geologic logging of trenches for previous investigations (GSI, 1994, 1999, and 2007a). However, the extrapolation of the fault trend, north of T-105 (GSI, 1999 [Plate 2]), exceeded the maximum distance allowed by the County of San Bernardino (1984a). Therefore, GSI has now excavated additional trenches in PA 8 to evaluate fault trends north of T-105, in general accordance with the County of San Bernardino requirements (1984b).

For this study, GSI retained Dr. Roy Shlemon, as an independent geologic consultant to date soils (pedogenic profiles) exposed in the trenches, as well as to provide Quality Assurance/Quality Control (QA/QC) consultation (Appendix B). Mr. Michael Mills of Pacific

Soils Engineering, Inc. (PSE) provided independent third-party review for the City of Rialto. Mr. Mills attended field meetings and reviewed site trenches and geomorphology. Mr. Reeder also reviewed the trenches with Dr. Shlemon present. Current trench logging and trench/fault survey locations have been incorporated into this report. Site geologic units are presented on Plate 1 (Geologic Map). Trench locations from this and previous investigations, faults, and setbacks for habitable structures are shown on Plate 2 (Fault Setback Map). Both plates have been modified from the 200-scale topographic base map prepared by the Otte-Berkeley Groupe. Graphic logs of the trench exposures are provided as Plates 3 through 9.

EXECUTIVE SUMMARY

Based on our current geologic analyses, the proposed residential planning area (PA 8) is feasible for its intended use, provided the recommendations in this report are properly implemented during planning, design, and construction. The most significant elements of our investigation are summarized below:

1. The site lies within the San Jacinto fault zone (SJFZ), which is active (i.e., movement within the Holocene Epoch), according to the State of California (Bryant and Hart, 2007). Holocene faults were identified in some trench exposures during GSI (1994 and 1999) and this current investigation. In general, Holocene faults and their associated trends parallel the Lower Lytle Creek Creek Ridge-Verdemont Hills front. Habitable structures will require setbacks from active faults, as shown on Plate 2 (Fault Setback Map).

2. During GSI (1994 and 1999) and this study, pre-Holocene (non-active) faults were exposed in some trenches and at the surface. Surface exposures of these faults were due to previous removal of soil overburden, likely from previous agricultural use of the site circa 1955. These faults were characterized as pre-Holocene based on the following: 1) these faults did not offset a surveyed geologic contact between Tertiary- and Cretaceous-age bedrock in the borrow pit area (Plate 1); 2) these faults lacked photo-lineaments and geomorphic expression commonly associated with active faulting, such as flowering -upward structures; 3)even though the surface had been stripped of overburden, some of the older faults die-out in pre-Holocene sediments, or did not break or offset a paleosol estimated to be 35,000 years old; 4) these faults generally exhibited trends inconsistent with the N40°W regional and modern tectonic regime; and 5) these faults exhibited silica accumulation along fracture surfaces, likely the base of a silcrete duripan, part of a paleosol estimated to be at least ~100,000 years old (Appendix B). Further, the pre-Holocene fan deposits were deeply incised during the last major pluvial epoch, this occurring approximately 12,000 to 18,000 years ago when the local climate was much wetter (Dietrich and Dorn, 1984; Shlemon *et al.*, 1987). Since that time, the channels have been filled with younger fluvial sediments transported along drainage courses developed within the older fans. The flow of these drainages are normal to these

older fault trends. Thus, the modern drainage within PA 8 is gradient controlled, and not fault controlled, providing corroborating evidence that these older faults have not moved in at least ~12,000 years. Although it cannot be entirely precluded that these faults will experience some sympathetic movement, should a high magnitude earthquake occur on nearby active splays of the Cucamonga fault zone (CFZ), San Jacinto fault zone (SJFZ), or San Andreas fault zone (SAFZ), such displacements should likely be very small, and therefore readily mitigated through engineering design (i.e., overexcavation, post-tension slabs and/or mat foundations).

3. The site is subject to horizontal seismic accelerations anticipated to be near 1g, should the design earthquake occur. The potential for local ground shaking is high and thus similarly requires appropriate engineering mitigation.

4. Local perched groundwater occurs at depths as shallow as about 8½ feet where the site is underlain by young Quaternary fan deposits. Elsewhere, perched groundwater was encountered along discontinuities in the bedrock and older alluvial fan deposits, or along unconformable contacts with permeability contrasts (i.e., relatively permeable sediments underlain by aquitards).

5. Although not observed during the recent field work, paleoliquefaction features were observed in similar late Holocene sediments in some trench exposures during field work in preparation of GSI (1999 and 2007a). We therefore recommend that additional, site-specific investigations evaluate liquefaction potential, dry sand settlement, as well as other typical geotechnical conditions, such as remedial-removal depths, settlement, engineered and natural slope stability, and design criteria. In view of the site seismic setting and the potential for seismic settlement, post-tensioned and/or mat foundations appear particularly appropriate for this project.

6. Based on our current geological assessments, and excluding proposed setback zones, GSI concludes that active faults (i.e., "sufficiently active" and "well-defined") likely do not exist within the remainder of the property. If present, however, they are of such small displacement potential to be reasonably mitigated by appropriate engineering design.

7. Major underground or above-ground utility lines should cross active faults at high angles approaching perpendicular. Cut-off valves should be located on both sides of active fault zones to facilitate repair.

8. Flooding may also occur during periods of heavy precipitation. The late-Holocene alluvial fans at the site were primarily deposited by debris flows emanating from the up-gradient canyons. Therefore, the potential for flooding should be evaluated by the design civil engineer and mitigation should be provided by the design civil engineer and geotechnical consultant, as warranted.

9. Owing to local bedrock outcrops along the relatively steep hillsides of Lower Lytle Creek Ridge-Verdemont Hills, there is potential for local rockfalls. Additionally, the Pleistocene-age sediments are considered erosive and surficial slope failures along cut slopes, constructed into these sediments, cannot be entirely precluded. Therefore, these potential hazards should be evaluated and appropriately mitigated.

10. The potential for ridge-top shattering is high in elevated portions of Neighborhood I. Site-specific geotechnical investigations will be required to identify where mitigation should be performed. Mitigation measures may include a compacted fill blanket (overexcavation), and engineering design, incorporating post-tension/structural slabs, mat, or deep foundations.

The opportunity to be of service is sincerely appreciated. If you should have any questions, please do not hesitate to contact the undersigned.

Respectfully submitted,

GeoSoils, Inc.

Ryan Boehmer
Staff Geologist

John P. Franklin
Engineering Geologist, CEG 1340

Paul L. McClay
Engineering Geologist, CEG 1117

RB/JPF/PLM/jh

Distribution: (5) Addressee
(1) Dr. Roy J. Shlemon (CD Only)
(1) Pacific Soil Engineering, Inc., Attention: Mr. Michael Mills

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SCOPE OF SERVICES

The primary purpose of this addendum additional fault rupture hazard investigation was to further characterize faulting in Planning Area (PA) 8, in accordance with current standards required by State and County guidelines (Bryant and Hart, 2007; and County of San Bernardino [County], 1984b). The scope of our services included the following:

1. Review existing, site-specific and regional geologic data (Appendix A), including stereoscopic "false-color" infrared and black-and-white aerial photographs; and analyze associated aerial-photographic lineaments within PA 8. Pertinent available reports by GSI and other investigators, within and adjacent to the site, are provided on the compact disc (CD) in Appendix A of GSI (2007a and 2007b).

2. Geologic and geomorphic site reconnaissance. Site geologic units are presented on Plate 1 (Geologic Map). Exploratory trenches by GSI and others, faults, recommended setbacks for habitable structures, and aerial-photographic lineaments are presented on Plate 2 (Fault Setback Map).

3. Subsurface exploration consisting of geologic logging of 13 fault-finding/dating and/or locating trenches totaling approximately 1,361 lineal feet. Trenches by GSI and previous investigators are shown on the Fault Setback Map (Plate 2). The logs of the GSI trenches are included as Plates 3 through 9.

4. Attending field meetings and reviewing site geologic and geomorphic conditions with the QA/QC advisor, Dr. Roy J. Shlemon, the City of Rialto independent third-party reviewer, Mr. Michael Mills of Pacific Soils Engineering, Inc. (PSE), and San Bernardino County Geologist, Mr. Wessly Reeder. A summary geomorphic and soil-stratigraphy report by Dr. Shlemon is provided as Appendix B.

5. Geologic and geomorphic analysis of the data collected.

6. Preparation of this report and accompanying documents.

SITE DESCRIPTION AND CONDITIONS

PA 8 is in Neighborhood I of the Lytle Creek Ranch Master Plan Community. It is irregularly-shaped, and consists of about 85 acres in the Sycamore Flat area of San Bernardino County, California (see Figure 1, Site Location Map). It is bounded on the west by Clearwater Parkway, on the south by residential development (Tract 15900), and elsewhere by open space, consisting of the Lower Lytle Creek Ridge-Verdemont Hills. Site elevations range between 2,090 feet Mean Sea Level (MSL) in the northeast corner to about 1,935 feet MSL in the southwest corner, for an overall relief of about 155 feet. Most of the project area slopes southwest and locally north, at gentle to moderate gradients (approximately 2:1 [h:v] or flatter). The southeastern portion of the site was recently a borrow site for fill used in the adjacent Tract 15900. Maximum cuts in this area may have been on the order of 40 to 50 feet, effectively removing most, if not all, of the trench backfill associated with previous explorations. Current cut slopes, at inclinations of about 2:1 (h:v), exist on the west and east sides of the borrow area and range to about 56 feet in height. The PA 8 vegetation is low-growth weeds, grasses, and a few trees. Man-made, earthen berms locally occur along the Lower Lytle Creek Ridge-Verdemont Hills front and were probably used for previous flood control or irrigation purposes.

Site drainage is mainly sheet flow toward emphemeral drainages that ultimately discharge into Sycamore Creek. Overall site drainage is predominately west-northwest, then southeast.

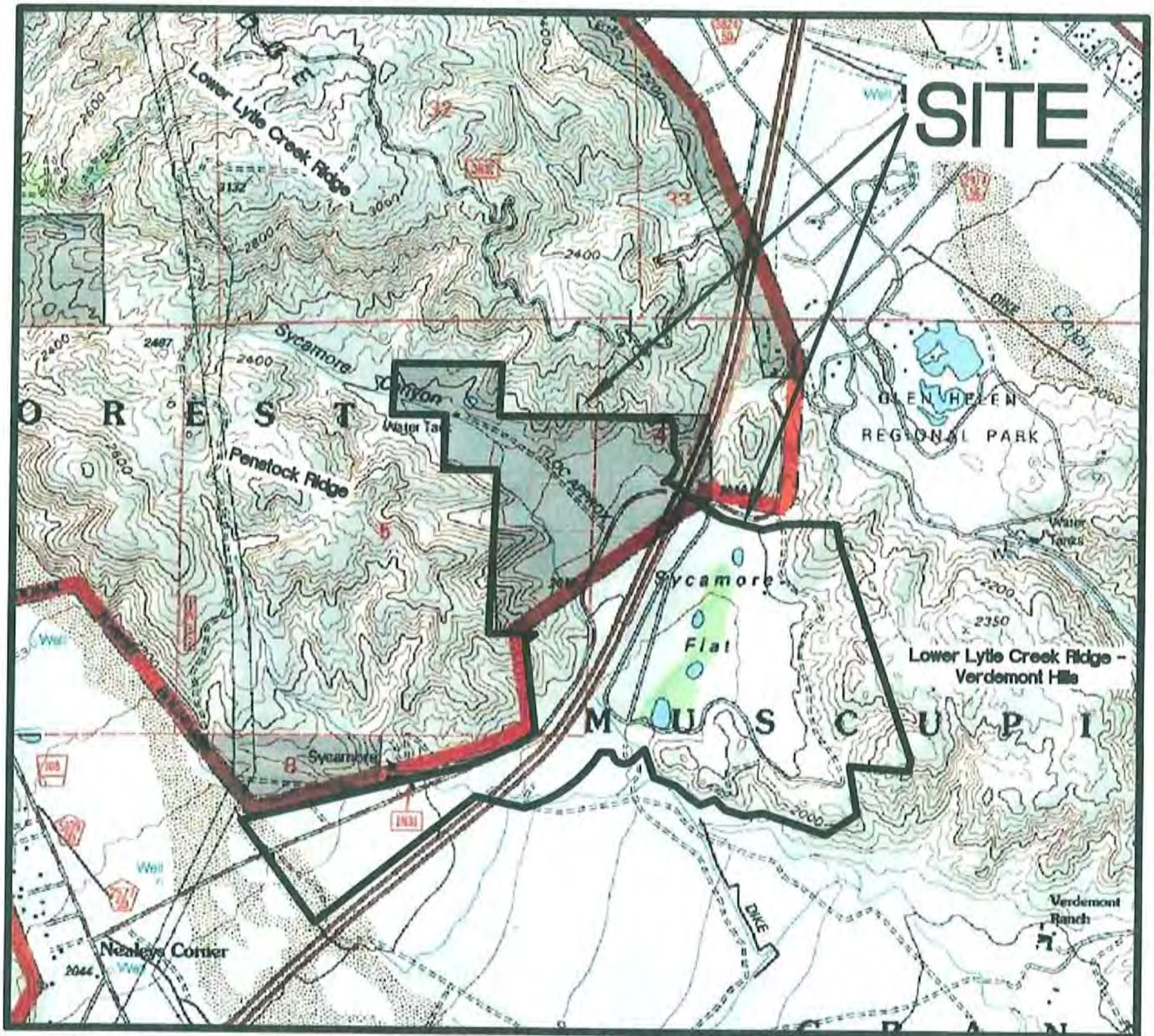
PROPOSED DEVELOPMENT

A preliminary conceptual land use plan, prepared by KTGY Group, Inc. (KTGY, 2008), indicates that proposed development within PA 8 consists of 347 single-family residential buildings and associated infrastructure (i.e., streets, underground utilities, etc; see Exhibit 1). The conceptual grading plans, prepared by Otte-Berkeley Groupe (undated), indicate that cut-and-fill grading is necessary to achieve design grades. Maximum cuts-and-fills of about 5 and 30 feet, respectively, are proposed. Maximum height 2:1 (h:v) cut and fill slopes are an anticipated 40 and 80 feet, respectively.

GSI understands that the proposed residences will be one- to two-story structures, typically wood-frames and concrete slabs-on-grade. Relatively light residential building loads are anticipated. Sewage disposal is assumed accommodated by connection into the regional municipal system. The need for import soils is currently unknown.

DEFINITIONS

As shown on Figure 2, portions of the site lie in a State of California, Alquist-Priolo Earthquake Fault Zone (Bryant and Hart, 2007). This document states that "A *fault* is defined as a fracture or zone of closely associated fractures along which rocks on one side have been displaced with respect to those on the other side" (p. 3). Bryant and Hart (2007) also indicate that: "an *active fault* is defined by the State Mining and Geology Board as one which has 'had surface displacement within Holocene time (about the last 11,000 years)'" (p. 5). Similarly, Neuendorf, *et al.* (2005) define a *fault* as: "A discrete surface or zone of



Base Map from U.S.G.S., dated 1997, current 1999, ©2005.

N

0 1000 FEET

GeoSoils, Inc.	W.O. 5278-A1-SC
SITE LOCATION MAP	
Figure 1	

LEGEND

SFR-1	Single-Family Residential 1 (2-5 du/ac)
SFR-2	Single-Family Residential 2 (5-8 du/ac)
SFR-3	Single-Family Residential 3 (8-14 du/ac)
MFR	Multi-Family Residential (14-28 du/ac)
MU	Mixed Use
ES	Elementary School
ES/MS	Elementary / Middle School
OS/R	Open Space / Recreation
OS/JU	Open Space / Joint-Use
OS	Open Space
	Single-Family Residential Overlay (2-14 du/ac)
	Mixed Use Overlay

Base Map from KTGY Group, Inc., 2008

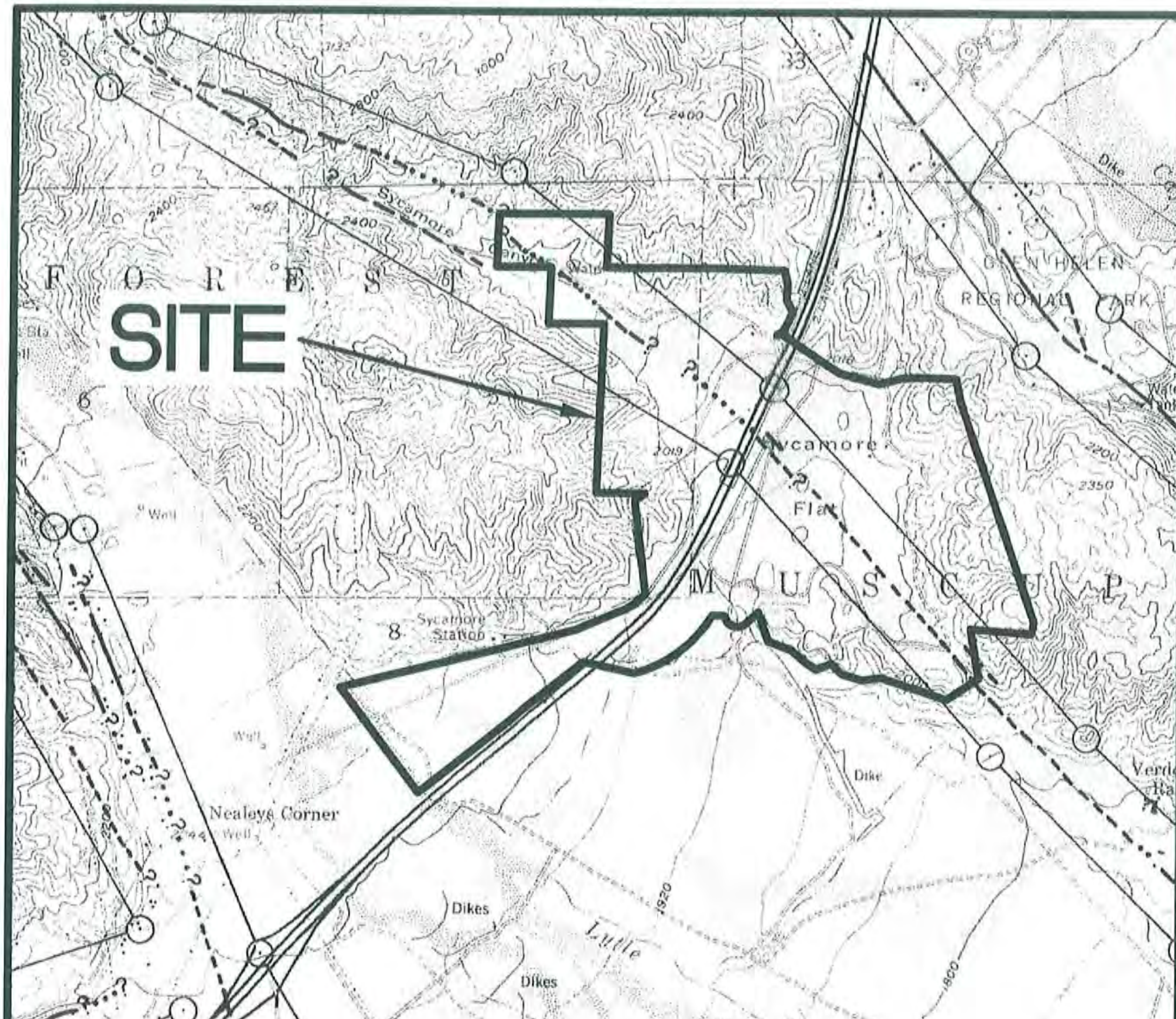
GeoSoils, Inc.

RIVERSIDE CO.
ORANGE CO.
SAN DIEGO CO.

LAND USE PLAN

Exhibit 1

W.O. 5278-A1-SC	DATE 07/08	SCALE NTS



Base Map from State of California, 1995

N

5000 0 5000

Scale Feet

GeoSoils, Inc. GSI

RIVERSIDE CO.
ORANGE CO.
SAN DIEGO CO.

ALQUIST-PRIOLO EARTHQUAKE FAULT ZONE MAP

Figure 2

W.O. 5278-A1-SC	DATE 07/08	SCALE 1"=2000'

discrete surfaces separating two rock masses across which one mass has slid past the other" (p. 230). Accordingly, the key criterion for determining whether a feature is a fault, is shear displacement. Fractures (including joints and cracks) with no shear displacement, are therefore, by definition, not classified as faults. Neuendorf, *et al.* (2005) also define a *joint* as: "A planar fracture, crack, or parting in a rock, without shear displacement..." (p. 345). A *crack* is defined by Neuendorf, *et al.* (2005) as: "A parting with crack-normal motion" (p. 148).

Further, for active-fault definition, faults should be "sufficiently active" and "well-defined" (Bryant and Hart, 2007). As summarized by Bryant and Hart (2007), "the more recent the faulting, the greater the probability for future faulting" (p. 28) The State also notes that, "A fault is deemed sufficiently active if there is evidence of Holocene surface displacement along one or more of its segments or branches..." (p. 5) and "A fault is considered well-defined if its trace is clearly detectable by a trained geologist as a physical feature at or just below the ground surface" (p. 5). Surface is defined by Neuendorf, *et al.* (2005) as: "... top of the ground...." (p. 646). The critical consideration by the State is that the fault, or some part of it, can be located in the field with sufficient accuracy and confidence to indicate that the required site-specific investigations would meet with some success.

If a fault that clearly demonstrates Holocene activity crosses an area proposed for human occupancy, the State of California requires an appropriate setback distance. This distance depends on uncertainty in fault character and trend. Thus, several closely spaced, well-documented trenches, may provide sufficient geologic information to reduce setbacks to ~10 feet. In contrast, faults that step, flower upward or have other "uncertain" characteristics, require a greater setback distance. The setback distance is therefore determined by the geologist based mainly on site-specific data and sound professional judgement. A *structure for human occupancy* is defined by Bryant and Hart (2007) "as any structure used or intended for supporting or sheltering any use or occupancy, which is expected to have a human occupancy rate of more than 2,000 person-hours per year" (p. 26).

FIELD STUDIES AND INVESTIGATIVE PROCEDURES

1. Review of pertinent literature.

2. Aerial-photographic lineament analysis.

3. Subsurface exploration consisting of the geologic logging of 13 fault-finding/dating and/or locating trenches totaling approximately 1,361 lineal feet. Trench locations and principal faulting in each trench were surveyed. The trenches have been backfilled with non-engineered fill.

4. Geologic mapping of outcrops within the Lower Lytle Creek Ridge-Verdemont Hills.

5. Field meetings and assessment of site geologic and geomorphic conditions with QA/QC advisor, Dr. Roy Shlemon, the City of Rialto's independent third-party reviewer, Mr. Michael Mills of PSE, and the County of San Bernardino Geologist, Mr. Wessly Reeder.

The GSI fault trenches were logged by geologists from our firm. The trench and principal fault locations, and fault setback zones are indicated on Plate 2. Graphic logs of the GSI trenches are presented as Plates 3 through 9. The trenches were logged at a 1 inch equals 5 feet scale. Dr. Shlemon's quality assurance assessment of relative fault activity is provided in Appendix B.

Review of Pertinent Literature

Readily available soils, geologic (including previous fault investigations performed at the site by GSI and others) and related literature were reviewed to evaluate prior work that could bear on proposed explorations. Additional cited references are listed in Appendix A. A compact disc (CD), including available geologic reports by GSI and other investigators that pertain to this investigation, is provided in Appendix A of GSI (2007a and 2007b).

Aerial-Photographic Lineament Analysis

An aerial-photographic lineament analysis identified possible unmapped faults and evaluated topographic expressions of published fault traces. The analysis used stereoscopic "false-color," infrared aerial photographs at a scale of approximately 1:40,000 and stereoscopic black-and-white aerial photographs at scales ranging from approximately 1:12,000 to 1:24,000.

We classified lineaments as strong, moderate, or weak. A strong lineament is a well defined feature that is traceable from several hundred to a few thousand feet. A moderate lineament is less well defined, somewhat discontinuous, and can be traced for only a few hundred feet. A weak lineament is discontinuous, poorly defined, and can be traced for less than a few hundred feet.

Several weak to strong photo-lineaments were observed within the study area (Plate 2). Some lineaments are sub-parallel to previous mapped traces of the SJFZ (LOR, 1994a; Morton and Matti, 2001) and were previously explored by Eberhart and Stone (E&S, unpublished) and GSI (1994 and1999). According to interpretation of data provided in GSI (1994 and 1999), excepting GSI Trenches T-7, T-8, T-103, and T-105, no active faults occur in trenches excavated across these lineaments. Additional evidence for a non-fault origin of the lineaments is the unbroken contact between Tertiary-and Cretaceous-age bedrock in the borrow pit area (Plate 1).

Several moderate to strong aerial-photographic lineaments sub-parallel the Lower Lytle Creek Ridge-Verdemont Hills front. These lineaments were intercepted by GSI

Trenches T-7, T-8 (GSI, 1994), T-103, T-105 (GSI, 1999), and FT-300, FT-305, FT-306, and FT-307 (this study). These trenches show that aerial-photographic lineaments, coincident with the front of the Lower Lytle Creek Ridge-Verdemont Hills were produced by active faulting. Aerial-photographic lineaments identified within PA 8 are shown on Plate 2.

Subsurface Exploration

Initial fault-finding trenches were located to intercept reasonable fault projections northwest of T-105 (GSI, 1999 [Plate 2]). Based on trench exposures, additional trenches were then excavated. Trench spacing and geologic extrapolation of data (Plate 2), generally conformed with the criteria of the County of San Bernardino (1984b). Photographs of a typical trench and the type of excavating equipment used for this investigation were previously provided in GSI (2007a). The trench locations are shown on Plate 2, and logs of the GSI exploratory trenches are provided as Plates 3 through 9.

Outside Consultation and Sediment Dating

Most site trenches were observed by QA/QC Advisor, Dr. Shlemon who provided independent geologic consultation and guidance for investigative techniques. Although not requested to provide detailed soil-stratigraphic measurements and documentation, Dr. Shlemon observed the general stratigraphy, identified the relative development of buried paleosols, and provided estimates of sediment age. A summary of the findings by Dr. Shlemon is provided in Appendix B.

Relative ages for the older alluvial fan deposits at the site were based mainly on soil-stratigraphic and geomorphic assessments. Fault Trenches FT-300, FT-300A, FT-302, FT-303, and FT-305 also exposed a "well developed" buried paleosol, typified by its reddish subsoil, by its blocky pedogenic structure, and by common to many clay films lining ped faces. Based on the grain size (relative permeability) of the sediments, clay translocation, and probable soil climate, Dr. Shlemon estimated the paleosol to represent about 35,000 years of weathering. Further, Dr. Shlemon identified a silcrete duripan in the basal portions of FT-300 and 300A, a pedogenesis phenomenon typically requiring approximately 100,000 years to form. Thus, from a relative dating standpoint, fault trenches exposing similar old fan deposits and paleosols recorded at least ~35,000 and 100,000 years of sedimentation, and thus stratigraphic markers useful to date any encountered faults.

Fault Trenches FT-301, FT-304, and FT-310 generally exposed younger fan deposits derived from modern drainages. Based upon the presence of anthropogenic artifacts transported by debris flows near the bottom of FT-301 and FT-310, the age of the exposed younger fans in FT-301 and FT-310 is estimated to be no greater than 100 years. The estimated age of the younger fans in FT-304 are probably no older than 1,000 years (Appendix B).

SAN JACINTO FAULT ZONE

The San Jacinto fault zone (SJFZ) forms several en-echelon faults among its member strands. The Glen Helen-Claremont and Claremont-Casa Loma fault pairs probably define zones of shallow crustal extension or elongation beneath San Bernardino and San Jacinto, respectively (Sharp, 1975).

The Claremont fault is clearly the dominant trace of the SJFZ immediately southeast of San Bernardino Valley. At the north edge of the valley, the zone includes two major strands, one nearly on line with the Claremont fault, and the other is called the Glen Helen fault (Sharp, 1975). Between the San Jacinto Valley and the San Gabriel Mountains, the SJFZ cuts Quaternary alluvial units and sedimentary rocks. The Glen Helen fault is associated with scarps and sag ponds in young Holocene alluvium at the northern edge of the valley. In contrast, the Claremont fault is devoid of obvious neotectonic expression in this area. This suggests that displacement is transferred by crustal extension between en-echelon fault pairs (Sharp, 1975). This segment, postulated to extend from the San Gabriel Mountains to Anza, is referred to as the Burro Flats section (2007 WGCEP, 2008). In contrast to Sharp (1975), the northern terminus of the Burro Flats section is thought by the 2007 WGCEP to represent slip transfer between the SJFZ and the SAFZ. Southeast of San Bernardino, the main trace of the SJFZ displaces Quaternary units, but southeast and northwest of this break the youngest floodplain deposits of the Santa Ana River and Cajon and Lytle Creeks are not broken (Matti, *et al.*, 1992).

Matti, *et al.* (1992) indicated the name "San Jacinto" traditionally has been applied to a northwest-oriented fault zone developed in crystalline rocks east of the mouth of Lytle Creek canyon. There, the zone consists of two or more, vertically oriented, closely spaced faults with shear zones up to 300 meters wide in crystalline bedrock. These, however, do not displace Quaternary deposits (Morton and Matti, 1987). Eastward, the Glen Helen fault forms scarps and sag ponds in probable Holocene alluvial deposits (Sharp, 1975; Matti and Morton, 1993). To the west, the Lytle Creek fault forms a scarp in latest Pleistocene alluvium (Morton and Matti, 1987). Metzger and Weldon (1983) calculated a late Quaternary right-slip rate of about 2 mm/yr for the Lytle Creek fault. Matti, *et al.* (1992) postulate that the Glen Helen fault is probably the active strand of the SJFZ in the San Gabriel Mountain region.

Morton and Matti (1987) also concluded that the San Jacinto fault cannot be mapped into either the Punchbowl or San Andreas faults; instead, faults attributed to the SJFZ splay into several branches that curve west into the San Gabriel Mountains without joining the San Andreas fault at the surface (Matti, *et al.*, 1992). Matti, *et al.* (1992) proposed that the east- to northeast-oriented Evey Canyon, Icehouse Canyon, and Stoddard Canyon faults are segments of through-going structures that were regionally connected in the past; namely, the middle Miocene, left-lateral Malibu Coast-Raymond-Banning fault and the late Miocene San Gabriel-Banning fault. They further suggested that these older faults separate rocks of San Gabriel Mountains-type on the west, north, and east from rocks of Peninsular Ranges type on the south. These structures trend essentially east until they enter the Lytle Creek drainage, where they converge and trend southeast down Lytle Creek Canyon. There, they are represented by the fault zone that occurs east of the mouth of Lytle Creek Canyon. They also concluded that the name "San Jacinto fault" in Lytle Creek Canyon has been applied to an ancient fault zone that has witnessed multiple episodes of strike-slip faulting, only the latest of which can be attributed to the so-called "San Jacinto" that traverses the Peninsular Ranges Province to the southeast (Matti, *et al.*, 1992). Matti and Morton (1993) proposed that the "San Jacinto fault" in Lytle Creek Canyon was once part of the previously discussed middle-Miocene, left-lateral Malibu Coast-Raymond-Banning fault and the late-Miocene San Gabriel-Banning fault. Here these faults shared their sequential left- and right-slip histories, in addition to Quaternary right slip related to the San Jacinto fault farther south in the Peninsular Ranges.

The "San Jacinto fault zone," where it penetrates the southeastern corner of the San Gabriel Mountains near the mouth of Lytle Creek, consists of three near-vertical faults (Matti and Morton, 1993). Soils offset by the Lytle Creek fault are reportedly in the 50,000 to 60,000 years old range (Metzger and Weldon, 1983).

A variety of slip rates have been estimated for the SJFZ. Morton and Matti (1993) inferred ~10 to 20 mm/yr for the Glen Helen and Claremont segments. The Southern California Earthquake Center (SCEC, 2006) postulate a 7 to 17mm/yr slip rate; and Kendrick, *et al.* (2002) suggested slip may be greater than 20 mm/yr. According to Bennet, *et al.* (2004), San Jacinto fault slip alternates from about 0 to 26 ±4 mm/yr since its inception about 1.5 million years ago; and that the current slip is about 9 ±2 mm/yr. Bennet, *et al.* (2004) also concluded that the change in slip on the San Jacinto fault is matched by an equal and opposite change on the San Andreas fault. The 2007 WGCEP (2008), infers a slip rate of 3 to 10 mm/yr, with a preferred slip rate of 6 mm/yr, for the SJFZ nearest the project.

SCEC (2006) indicates that surface-rupture recurrence is between 100 and 300 years, per segment, for earthquake magnitudes between M6.5 and M7.5. Kendrick and Fumal (2005) reported recurrence of approximately 100 and 266 years, respectively, for the SJFZ near Colton and San Bernardino, California. The 2007 WGCEP (2008), indicates a recurrence ranging from 240 to 410 years, with a preferred return interval of about 325 years for a ±M6.7 earthquake; however, the San Bernardino Valley segment is thought to have an average interval between 132 to 187 years for earthquakes of such magnitude.

Matti and Morton (1993) point out that the San Andreas system between Cajon Pass and Coachella Valley is characterized by complex fault strand development, by strand switching, and by strand abandonment related to formation of a structural knot in San Gorgonio Pass. Two major structural features resulted from progressive development of the structural knot. For the SAFZ, this is manifested by an apparent lack of a through-going surface fault. The SJFZ is the most recent tectonic feature and simply has bypassed the San Gorgonio knot since its inception about 2.5 to 1.5 ma. In the convergence area between the San Andreas and San Jacinto faults, the Glen Helen fault is the northernmost fault within the SJFZ in the Peninsular Ranges (Matti and Morton, 1993). Contraction and uplift occurring in the eastern San Gabriel Mountains, between the

Cucamonga fault zone (CFZ) and the San Andreas fault, is interpreted as strain accumulation owing to slip transfer between the San Jacinto and San Andreas fault zones.

SITE GEOLOGIC UNITS

As observed in the field, site geologic units, are mainly roadway fill, undocumented artificial fill, Quaternary-age colluvium, Quaternary-age slopewash, younger and older Quaternary-age alluvial fan deposits, Tertiary-age "Granodiorite of Telegraph Peak", Cretaceous-age Leucocratic Muscovite Monzogranite, and Paleozoic-age Pelona Schist. The distribution of mappable units is shown on Plate 1. Supplemental descriptions for subsurface units are shown on Plates 3 through 9. The major geologic units are generally described below (from youngest to oldest):

Roadway Fill (Map Symbol - Afr)

Surface fill is associated with construction of Clearwater Parkway. Roadway fill was not exposed in our trenches.

Artificial Fill - Undocumented (Map Symbol - Afu)

Locally encountered, undocumented fill is mostly trench backfill from previous subsurface investigations by Soil and Testing Engineers, Inc. (STE, 1988), E&S (unpublished), LOR (1994a), and GSI (1994 and 1999). Recent grading likely removed most of the backfilled trenches in the borrow area (see Plate 1). However, shown on Plate 1 are the limits of the backfill should it exist. Future subsurface explorations, during the 40- or 100-scale grading plan review stage, will help delineate trench backfill in this area. Undocumented fill was also locally encountered within and near existing dirt roadways for previous agricultural purposes and haul routes. Localized areas of undocumented fill were observed in man-made berms near the topographic break-in-slope between Lower Lytle Creek Ridge-Verdemont Hills and Sycamore Flat. These earthen berms were likely used for flood control and/or retention basins. Where encountered, the artificial fill consists of dark olive gray, sandy silt to dark olive gray, olive, yellow, pale brown, brown, brownish yellow, light brownish gray, and very pale brown silty sand with rare to locally abundant, angular to sub-rounded pebble- to cobble-sized clasts. Based upon the available data, the undocumented fill ranges in thickness from less than 1 foot to approximately18½ feet. Trench backfill associated with some of E&S's trenches may be thicker than that reported above, since some of their trench logs were never published. All undocumented fill is potentially compressible and may settle appreciably under loading. Therefore, mitigation by removal and recompaction is recommended should undocumented fill be encountered in settlement-sensitive areas.

Quaternary Colluvium (Not Mapped)

Quaternary-age colluvium was locally encountered at the surface and buried by younger alluvial fan deposits in some trenches. It consists of light yellowish brown, dark gray, light brownish gray, black, very pale brown, and very dark gray, silty sand to dark brownish gray and dark gray sand with silt. The colluvium locally contains rare angular to subangular pebble- to cobble-sized clasts. All colluvium is potentially compressible and may settle under load. Removal and recompaction is thus recommended in areas of proposed settlement-sensitive improvements. The colluvium is late Holocene in age.

Quaternary Slopewash (Not Mapped)

Quaternary-age slopewash was locally encountered in Fault Trenches FT-305 and FT-306 (Plate 2) and generally consisted of very pale brown silty sand, with rare to locally abundant angular to subangular pebble- to cobble-sized clasts. The slopewash is generally dry, loose, and porous, and therefore may similarly settle under loads. In order to provide suitable support of settlement-sensitive improvements and/or engineered fill, all slopewash should be removed and reused as properly compacted fill. The slopewash is late Holocene in age.

Quaternary Alluvial Fan Deposits-Younger (Map Symbol - Qafy)

Younger Quaternary-age alluvial fan deposits discontinuously occur in low-lying parts of the site and within drainage meanders. The younger alluvial fan deposits are generally olive, yellow, very pale brown, yellow, light yellowish brown, dark yellowish brown, brown, and pale brown silty sand to pale yellow, yellow, and very pale brown fine- to medium-grained sand with minor silt to grayish brown silt. Rare to locally abundant sub-rounded to sub-angular pebble- to cobble-sized clasts are also present. The younger alluvial fan deposits also exhibit local, low-angle cross bedding. These deposits are generally dry to saturated and poorly indurated. On a preliminary basis, these deposits appear to have a low to medium expansion potential. The younger alluvial fan deposits are generally unsuitable to support settlement-sensitive improvements and/or engineered fill. Based upon the presence of rusted wire and other anthropogenic artifacts (i.e., glass bottles, plates, agricultural equipment, etc.) that have been transported via debris flows, and reasonable age-dating estimates by Dr. Shlemon, the age of these deposits are no older than ~1,000 years

Quaternary Alluvial Fan Deposits-Older (Map Symbol - Qafo)

Discontinuous, older alluvial fan deposits were present along much of the Lower Lytle Creek Ridge-Verdemont Hills front. These deposits generally consist of brown, light brown, pink, very pale brown, and reddish-yellow silty sand to light-brown and brown clayey sand to pink fine- to coarse-grained sand. Rare to locally abundant sub-rounded to sub-angular pebble- to boulder-sized clasts were also present. These older deposits were generally dry to moist and moderately to well indurated. Based on paleosol development observed in some of the trenches, Dr. Shlemon estimated these deposits to be on order of 35,000 to 100,000 year old, and perhaps older. The older alluvial fan deposits appear to generally have very low to perhaps medium expansion potential. Where unweathered, these deposits appear suitable for the support of settlement-sensitive improvements and/or engineered fill. The weathered portions should be removed and reused as properly compacted fill.

Tertiary Granodiorite of Telegraph Peak (Map Symbol - Ttp)

As indicated by Morton and Matti (2001) and as observed in trench exposures, and during geologic mapping, most rock within the Lower Lytle Creek Ridge-Verdemont Hills is Oligocene-age biotite granodiorite and biotite monzogranite referred to as the "Granodiorite of Telegraph Peak" (Morton and Matti, 2001). This bedrock is medium- to coarse-grained, predominately massive, and highly fractured/sheared. As indicated by LOR (1994a), biotite dacite dikes are commonly associated with this unit. These dikes are distinctively dark green in color. Unweathered portions of the Granodiorite of Telegraph Peak are generally suitable for the support of settlement-sensitive improvements and/or engineered fill. In contrast, weathered rock should be removed and reused as compacted fill. This bedrock is generally very low in expansion potential based on preliminary evaluation. However, highly weathered dikes may have medium to possible high expansion characteristics.

Cretaceous Leucocratic Muscovite Monzogranite (Map Symbol - Kgm)

According to Morton and Matti (2001), medium- to coarse-grained, massive to semi-foliated, highly fractured, muscovite monzogranite is exposed on a knob in the southern portion of PA 8 (Plate 1). This bedrock was described as a well-banded gneiss in GSI (1994). However, it is now our opinion that the description of Morton and Matti (2001) is technically correct based on their confirmation of rock mineralogy by laboratory and microscopic testing. However, this nomenclature change does not alter our fundamental conclusions about engineering-geology characteristics of the site.

Paleozoic Pelona Schist (Map Symbol - Pps)

Pelona Schist was encountered during field mapping and subsurface explorations by LOR (1994a) and GSI (1994). According to LOR (1994a), Pelona Schist occurs along the southern portion of Sycamore Flat at Neighborhood I, and east and southeast of Interstate 15 on two of the small northwest-trending ridges (Plate 1). Within the formation, LOR identified silica-rich and greenstone units. The greenstone unit was reportedly composed of indistinct layers of chlorite-epidote-albite, and hornblende. It is dark green in color and foliated. The greenstone units weather to a dark-reddish brown silty clay. The silica-rich units were described as a fractured and foliated muscovite schist, brown to greenish gray in color that weathers to a brown, silty gravel. The Pelona Schist is a suitable bearing bedrock where unweathered. Fill derived from excavations into the Pelona Schist may be expansive, especially in weathered portions.

GEOLOGIC STRUCTURE

Field mapping indicates that joints within bedrock units generally dip at high angles, approaching vertical (Plate 1). The biotite dacite dikes of the Tertiary "Granodiorite of Telegraph Peak," generally trend northwest and dip northeast at relatively low angles. LOR (1994a) showed that foliation within the Cretaceous Leucocratic Muscovite Monzogranite and Paleozoic Pelona Schist generally trends northwest and dips northeast at relatively moderate to high angles. Where observed, bedding within the older alluvial fan deposits generally trended northeast and dipped 7 degrees to the northwest. In general, bedding within the older fan deposits is flat to sub-horizontal and is weakly to thickly bedded. The younger alluvium is generally flat to gently dipping to the west-northwest.

SUMMARY OF TRENCH EXPOSURES AND DOCUMENTATION

The documentation and interpretation for each fault-locating trench are discussed below. Additional descriptions, lithology, and field observations are provided on the Trench Logs (Plates 3 through 9). Initial exploratory trenches FT-300 and FT-301 were emplaced mainly to intercept the fault projection northwest of T-105 (GSI, 1999). Successive trenches were excavated to intercept fault trends identified in those or previous trenches, or to evaluate the origin of geomorphic features and/or aerial-photographic lineaments. Prior to excavation, the ends of proposed FT-300 and FT-301 were located in the field by Dawson Surveying, Inc. The locations of FT-300 and 301 were field adjusted approximately 30 and 50 feet, respectively, to the south of their surveyed locations to avoid bioturbation from trees growing within their alignment, and then re-surveyed.

In order to produce graphic logs, GSI provided rough line and grade along trench alignments with a 300-foot measuring tape, an eye level, and a 6-foot engineer's ruler. Except for FT-300, elevations were transferred along trench alignments relative to a zero datum located at Station No. 0. Elevations for FT-300 were transferred along the trench alignment relative to a zero datum located at approximate Station No. 278, because rapid groundwater influx within the lower elevations of FT-300 necessitated that the southwest end be logged first. All graphic logs were drawn at a scale of 1 inch equals 5 feet. We note that the typical means and methods available for line and grade inherently include some imprecision.

After graphic logging, trench locations and principal faults were surveyed as shown on Plate 2. There is a small error between surveyed trench lengths indicated on Plate 2, and those indicated on the trench logs (Plates 3 through 9) owing to slight sagging of the measuring tape and curvatures of the trench.

Fault Trench 300 (FT-300)

Fault Trench FT-300 (Plate 3) intercepted the northward projection of principal faults identified in T-105 (GSI 1999 [Plate 2]). FT-300 was approximately 278 feet long. Between Stations 0 and approximately 230, the trench exposed the Tertiary "Granodiorite of Telegraph Peak" which consists of biotite granodiorite and biotite monzogranite, with local biotite dacite intrusions. The bedrock was locally mantled by Quaternary alluvial fan deposits, Quaternary colluvium, and undocumented artificial fill. Between about Stations 191 and 250, FT-300 generally exposed Quaternary alluvial fan deposits overlain by undocumented artificial fill. The trench also exposed undocumented artificial fill (roadway and trench backfill) between approximate Stations 250 and 278.

A strongly developed, argillic paleosol caps the Pleistocene-age alluvial fan deposits except where truncated by undocumented fill between approximate Stations 240 and 278. Dr. Shlemon estimated the age of the paleosol to be at least 35,000 years (Appendix B). Near the base of the trench, between Stations 232 and 250, a silcrete duripan occurs within the Pleistocene-age alluvial fan deposits. The age of the silcrete duripan is an estimated 100,000 years old, indicating a total of about 135,000 years of weathering and soil formation (Appendix B).

The bedrock and Pleistocene-age fan deposits in FT-300 were faulted, sheared, and jointed. Based upon the evidence of flower structures, their proximity to the primary topographic break-in-slope (i.e., the escarpment between Sycamore Flat and the Verdemont Hills), and the general lack of weathering along fracture surfaces, the faults between approximate Stations 11 and 36 are judged to be active and to represent the principal faulting in FT-300. In contrast, other FT-300 faults and bedrock shears did not exhibit flower structures, did not offset a 35,000 year old paleosol, were not associated with a topographic break-in-slope, and exhibited silica deposition along fracture surfaces, further implying antiquity.

As stated earlier, the 35,000 year old paleosol was truncated by undocumented fill near the southwest end of the trench. Due to the absence of the paleosol in this locale, GSI reasonably judged the fault at approximate Station 244 (N14°W, vertical) non-active based on a lack of a similar trend within the intercepting Fault Trench FT-302, documenting that the fault is not through-going. Further, this fault strand is associated with a tectonic regime where other strands exhibit similar displacement but do not offset a 35,000 year old paleosol. A summary of principal faulting in FT-300 is provided in Table 1.

TABLE 1 - FAULT TRENCH 300 (FT-300)			
APPROXIMATE STATION NO. AS INDICATED ON FIELD LOG	FAULT ATTITUDE (STRIKE, DIP)	MAXIMUM APPARENT VERTICAL DISPLACEMENT	FAULT NO. INDICATED ON PLATE 2 (SURVEYED AT THE SURFACE PROJECTION OF FAULT)
11½'	N1°-3°E, 52°SE	Not Determined	16
20½'	N26°W, 56°SW	4"	17NS**
32'	N14°W, 82°NE	Not Determined	18
36'	N39°W, Vertical	Not Determined	19
* - Maximum displacement was measured from the northwest wall of the trench **-Not Surveyed (field measured from a surveyed location)			

Fault Trench 300A (FT-300A)

FT-300A (Plates 2 and 4) was excavated to intercept the projection and determine the recency of a significant fault observed within the Pleistocene-age fan deposits in FT-300 at approximate Station No. 224½ (Plate 3). This FT-300 fault trended N3°W/47°SW, had several feet of normal displacement, and appeared to upwardly project into the 35,000 year old paleosol on the south wall of FT-300. However, due to the massive structure and coarse-grained grain-size of the paleosol in FT-300, it was unclear whether this paleosol was offset; thus FT-300A was excavated.

As depicted on Plate 4, FT-300A generally exposed Quaternary fan and colluvial deposits, and undocumented artificial fill. Near the base of the trench, a silcrete duripan was observed, strongly suggesting that the sediments in this trench were generally similar in age to the sediments in the adjacent FT-300. One fault was observed in FT-300A at approximate Station No. 20 (bottom of trench). The fault trended N19°W/67°SW, displayed apparent normal movement, and approximately 6 feet of vertical offset. The fault exhibited silica accumulation along the fracture surface and no flower structure, thus reasonably suggesting that much sediment overburden had been removed by erosion and that movement had likely not occurred in the Holocene. Additionally, the upward projection of this fault terminated within the Pleistocene-age fan deposits, and was not associated with a topographic break-in-slope, similarly indicative of pre-Holocene movement. The N3°W/47°SW trend observed in FT-300 was not identified in FT-300A, providing positive evidence that it is associated with a short and discontinuous zone of faulting.

Fault Trench 300B (FT-300B)

Fault Trench 300B (FT-300B [Plates 2 and 4]) was emplaced southeast of FT-300 to intercept a bedrock shear zone with preferential weathering observed in that trench (Plate 3). FT-300B generally exposed the Tertiary "Granodiorite of Telegraph Peak" locally intruded by a biotite dacite dike (Stations 0 through 15). The bedrock was mantled by

Quaternary colluvium and locally incised by Holocene-age alluvial fan deposits (stream channel deposits). The channel thalweg trended N45°W. The biotite granodiorite was observed to be highly jointed; but the preferentially weathered shear zone in FT-300 was not encountered, nor was any faulting.

Fault Trench 301 (FT-301)

FT-301 (Plates 2 and 4) was excavated approximately 570 feet northwest of FT-300 in order to intercept the northwest projection of the fault zone identified in T-105 (GSI, 1999 [Plate 2]). During trenching, perched water was encountered at an approximate depth of 8½ feet below the ground surface, thus constraining the trench depth to less than about 8 feet. FT-301 exposed Holocene colluvium and overlying alluvial fan deposits. Between about Stations 60 and 122, the alluvial fan deposits were covered by undocumented artificial fill. As noted between approximate Stations 10 and 25, the Holocene sediments were underlain by probable Pleistocene-age alluvial fan deposits. Groundwater was perched along this younger and older fan contact. No faults were observed in FT-301 to the depths explored. Seven hand-auger borings were advanced along the bottom of the trench at less than 30-foot intervals. These borings showed that the depth of the contact between the younger and older fan deposits remained consistent along the trench alignment, particularly between approximate Stations 10 and 77. A boring at near Station 80 (Plate 4) indicated that the contact was below the limit of the hand-auger. As evidenced by rounded, coarse-grained sands and gravels, it appeared that the contact had been truncated by an erosional unconformity, which extends between about Stations 80 and 110 (Plate 4).

Fault Trench 302 (FT-302)

FT-302 (Plates 2 and 5) was emplaced to intercept the southeastward projection of the N3°W/47°SW fault observed in FT-300 (Plate 3). As shown on Plate 5, FT-302 generally exposed Pleistocene- and Holocene-age fan deposits. The Pleistocene-age fan deposits were locally overlain by undocumented artificial fill between approximate Stations 40 and 97. A moderately to strongly developed, discontinuous paleosol capped the Pleistocene fan deposits, similar to that observed in FT-300. Dr. Shlemon estimated the age of the paleosol to be on the order of 35,000 years (Appendix B). The silcrete duripan, identified in FT-300 and FT-300A, was not observed in FT-302. The Pleistocene-age fan deposits were faulted and probably locally displaced the 35,000 year old paleosol. The N3°W/47°SW fault, observed in FT-300 was identified near Station 46 based upon similar relative vertical movement and trend. Its vertical offset was not readily determined, based on the absence of matching beds across the fault. However, the FT-302 faults did not exhibit flower structures, were not associated with topographic breaks-in-slope, were confined solely to the Pleistocene-age fan deposits, and displayed silica accumulation along their fracture surfaces. Due to the massive structure and coarse-grained grain-size of the ~35,000 paleosol, it could not be readily determined if the faults near Stations 31 and 36 displaced this stratigraphic marker and therefore the relative ages of these faults could not be easily determined. However, the fault trends correlate with a FT-300 fault zone near approximate Stations 218 through 246 (Plate 3) that did not offset a pre-Holocene paleosol. We therefore reasonably judged these FT-302 faults to also be pre-Holocene. Cumulatively, these lines of evidence, along with the undisplaced ~12,000 year old drainage pattern provides positive evidence that the faulting in FT-302 is pre-Holocene in age.

Fault Trench 303 (FT-303)

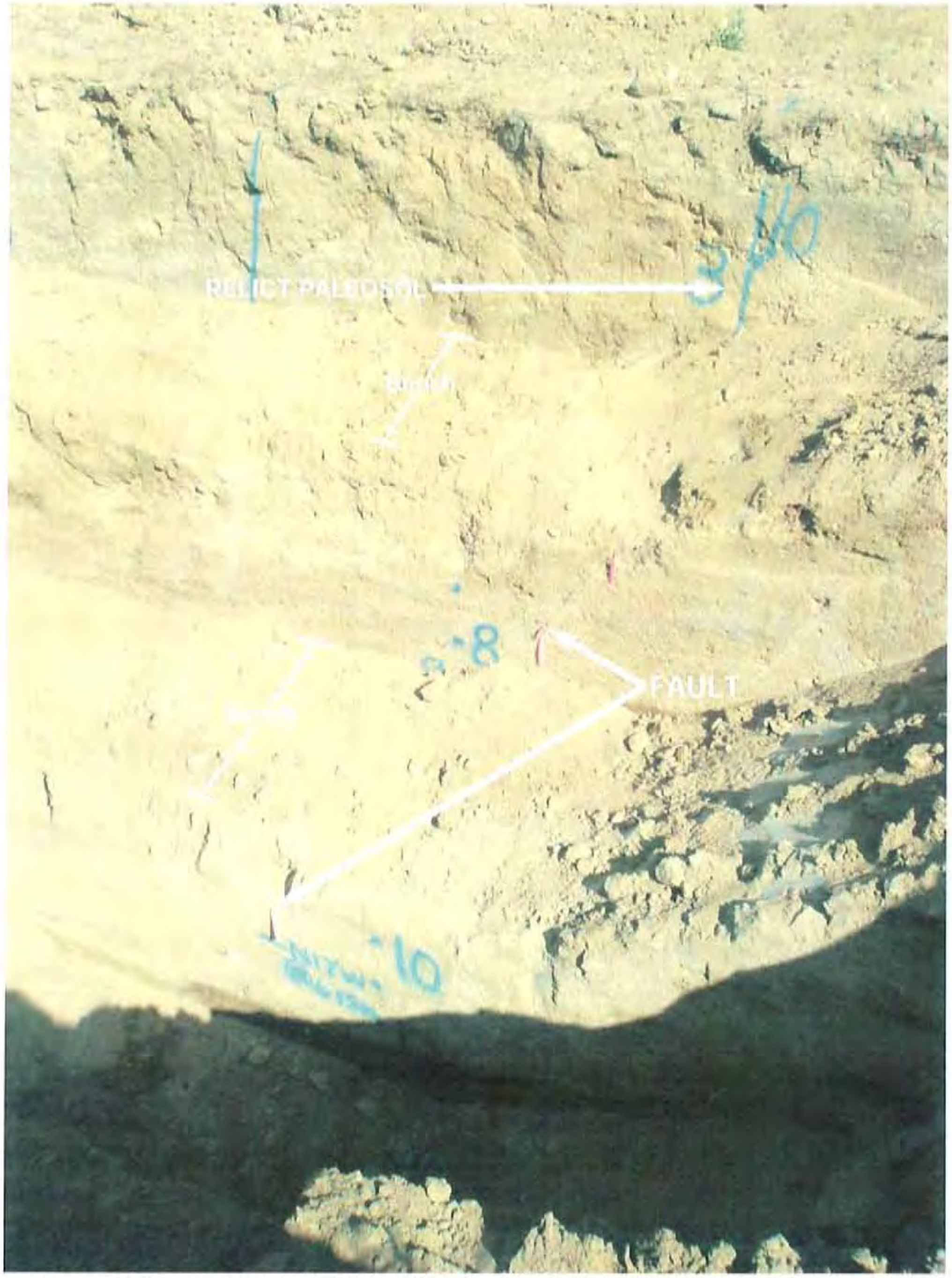
FT-303 (Plates 2 and 5), southeast of FT-302, evaluated the origin of an apparent, offset ridge identified in the field (Plate 2). As illustrated on Plate 5, FT-303 generally exposed Pleistocene-age fan deposits locally overlain by Holocene-age fan deposits and colluvium. Encountered between approximate Stations 0 and 16, was undocumented artificial fill possibly associated with the backfill of LOR's T-16 (Plate 2). Faults were observed within FT-303. However, these faults were reasonably judged pre-Holocene in age based on decreasing upward displacement (dying-out), confinement to pre-Holocene sediments, and the presence of an unbroken 35,000 year old paleosol (Figure 3).

Fault Trench 304 (FT-304)

FT-304 (Plates 2 and 6), excavated southeast of FT-302 in a topographic depression, intercepted the southeastward projection of N-S trending faults identified in FT-300 (Plate 3) and FT-302 (Plate 5). This trench location was also selected in order to provide a thicker, undisturbed section of Holocene sediments, so that recency of fault movement could be better evaluated. Unfortunately, groundwater limited trenching depths and thus only exposed perhaps ~1,000 year old sediments. As shown on Plate 6, the sediments in FT-304 generally consist of Holocene-age colluvium and fan deposits that are locally overlain by trench backfill from previous explorations and other miscellaneous fill. Faults were not observed in FT-304 to the depths explored.

Fault Trench 305 (FT-305)

FT-305 (Plates 2 and 6) was excavated southeast of FT-300 and northwest of T-105 (GSI, 1999 [Plate 2]) in order to substantiate that active faulting, within PA 8, was associated with the escarpment between Lower Lytle Creek Ridge-Verdemont Hills and Sycamore Flat. As shown on Plate 6, FT-305 generally exposed both proximal and distal, Pleistocene-age fan deposits (in fault contact) locally overlain by undocumented artificial fill and Holocene-age colluvium and slopewash. Two faults were observed in this trench at approximate Stations 24 and 31. The faults have reverse offset with approximately 1 to 1½ feet of apparent vertical displacement. The hanging wall contains relatively fine-grained, distal fan deposits, whereas the foot wall consisted of fairly coarse-grained, proximal fan deposits (Figure 4). We consider these faults to be active splays of the SJFZ based upon the presence of flower structures and their position near a topographic break-in-slope that forms an escarpment. Table 2 summarizes the faults exposed in FT-305.



Photograph showing pre-Holocene fault between approximate Station Nos. 8 and 13 trending N17°W, 67°SW in Fault Trench FT-303. The fault does not reach the surface and does not offset a 35,000 year old paleosol.

GeoSoils, Inc.

SITE PHOTOGRAPHS

Fault Trench FT-303

Figure 3

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tation No. 24 and 31 trending N41°W, 79°NE and N37°W, 73°NE, respectively. The hanging wall and proximal fan deposits comprising the footwall. The faults were toward the right, Stations 40 and 50 toward the left.

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SITE PHOTOGRAPHS

Fault Trench FT-305

Figure 4

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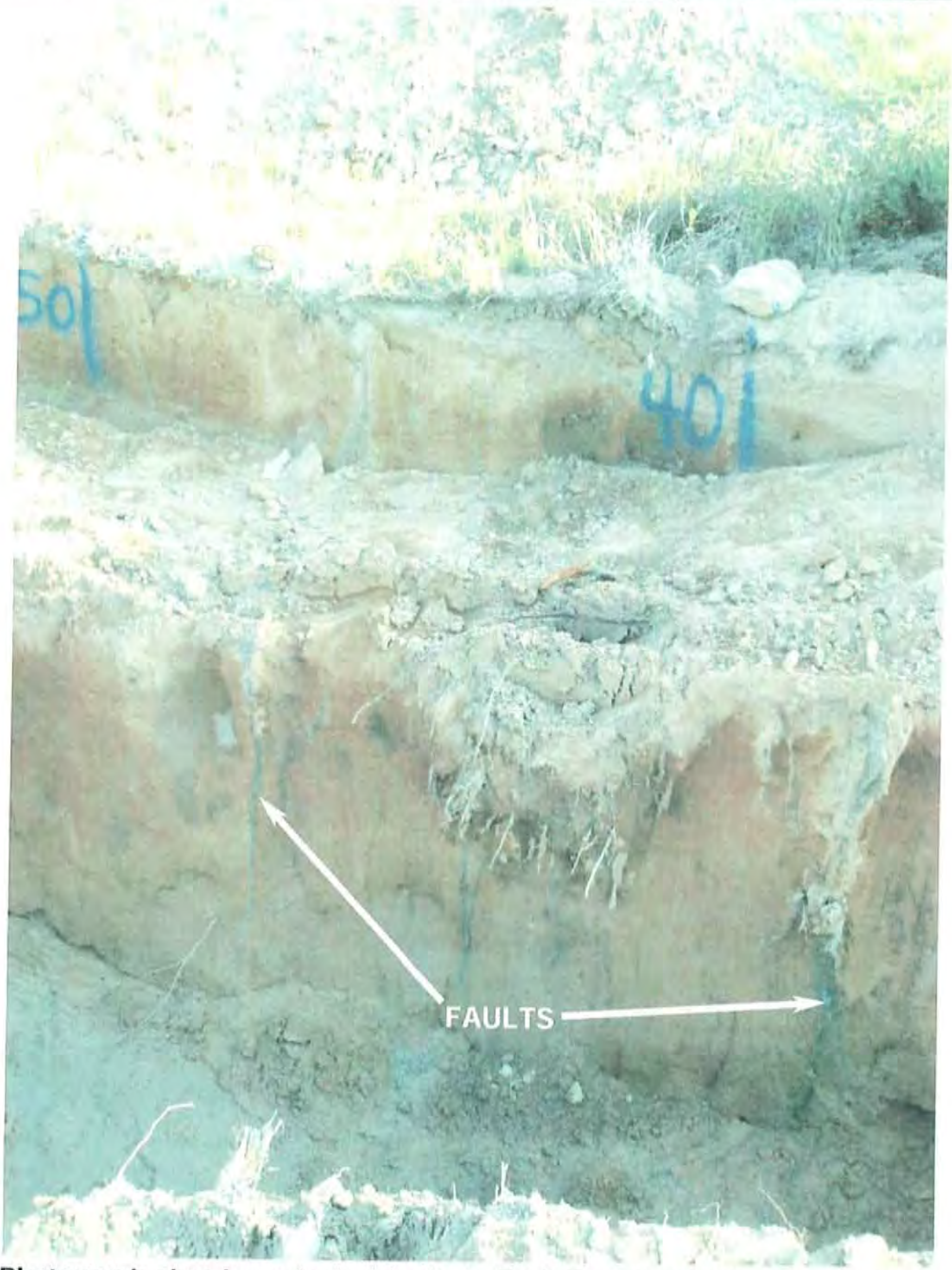

Photograph showing principal faults in Fault Trench FT-306 at approximate Station Nos. 36 and 45 trending N20°E, 84°SE to vertical and N10°E vertical, respectively. The faults are coincident with a topographic break-in-slope. The fault at approximate Station No. 36 exhibits a flower structure. The fault

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SITE PHOTOGRAPHS

Fault Trench FT-306

Figure 5

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TABLE 2 - FAULT TRENCH 305 (FT-305)			
APPROXIMATE STATION NO. AS INDICATED ON FIELD LOG	FAULT ATTITUDE (STRIKE, DIP)	MAXIMUM APPARENT VERTICAL DISPLACEMENT	FAULT NO. INDICATED ON PLATE 2 (SURVEYED AT THE SURFACE PROJECTION OF FAULT)
24'	N41°W, 79°NE	12"	20
31'	N37°W, 73°NE	18"	21
* - Maximum displacement was measured from the northwest wall of the trench.			

Fault Trench 306 (FT-306)

FT-306 (Plates 2 and 7) evaluated the origin of the topographic break-in-slope north of FT-300. During initial trenching, perched groundwater, emanating from discontinuities, quickly filled lower portions of the trench and severely restricted geologic logging. The trench was later daylighted and drained. As shown on Plate 7, this trench generally exposed the Tertiary "Granodiorite of Telegraph Peak" overlain by Pleistocene-age fan deposits. These were locally overlain by Holocene-age colluvium and slopewash between approximate Stations 0 and 34. Between approximate Stations 34 and 190, the trench exposed Pleistocene-age fan deposits locally overlain by Holocene-age fan deposits and continuously overlain by Holocene-age colluvium at the surface. The Pleistocene-age fan deposits were truncated by undocumented trench backfill, most likely associated with E&S's Trench No. 8 (ES-8 [Plate 2]), between approximate Stations 139 and 162. Seven faults were observed in this trench. However, only the faults located at approximate Stations 36 and 45 were determined to be active based on the presence of a flower structure, and their coincidence with a topographic break-in-slope (Figure 5). The remaining faults do not exhibit these characteristics, nor displace the drainage pattern that formed at least 12,000 years ago, and thus are reasonably judged pre-Holocene in age. Characteristics of the FT-306 faults are summarized in Table 3.

TABLE 3 - FAULT TRENCH 306 (FT-306)			
APPROXIMATE STATION NO. AS INDICATED ON FIELD LOG	FAULT ATTITUDE (STRIKE, DIP)	MAXIMUM APPARENT VERTICAL DISPLACEMENT	FAULT NO. INDICATED ON PLATE 2 (SURVEYED AT THE SURFACE PROJECTION OF FAULT)
36'	N20°E, 84°SE to Vertical	Not Determined	22
45'	N10°E, Vertical	Not Determined	23
* - Maximum displacement was measured from the northwest wall of the trench.			

Fault Trench 307 (FT-307)

FT-307 (Plates 2 and 8), north of FT-300 and south of FT-306, further evaluated the origin of the escarpment between Lower Lytle Creek Ridge-Verdemont Hills and Sycamore Flat. As depicted on Plate 8, FT-307 generally exposed the Tertiary "Granodiorite of Telegraph Peak" between approximate Stations 0 and 64. The bedrock was locally overlain by Holocene-age colluvium and fan deposits, as well as by undocumented artificial fill. Between approximate Stations 64 and 106, FT-307exposed Holocene-age fan deposits and colluvium overlain by very young (recent) fan deposits. GSI identified a reverse fault in bedrock at approximate Station 30, but it did not offset Holocene-age fan deposits. However, due to an incomplete sequence of Holocene-age sediments, the presence of a flower structure, perched water seepage emanating along the fracture surface, and proximity to a topographic break-in-slope or escarpment, GSI judged this fault to be active. A bedrock shear, near Station 34, was determined to be pre-Holocene based on its confinement within the Tertiary-age bedrock. A summary of principal faulting in FT-307 is provided in Table 4.

TABLE 4 - FAULT TRENCH 307 (FT-307)			
APPROXIMATE STATION NO. AS INDICATED ON FIELD LOG	FAULT ATTITUDE (STRIKE, DIP)	MAXIMUM APPARENT VERTICAL DISPLACEMENT	FAULT NO. INDICATED ON PLATE 2 (SURVEYED AT THE SURFACE PROJECTION OF FAULT)
30'	N5°W, 33°NE	Not Determined	24
* - Maximum displacement was measured from the northwest wall of the trench.			

Fault Trench 308 (FT-308)

FT-308 (Plates 2 and 8) evaluated the origin of a surface-exposed, bedrock/fan deposit contact observed in a nearby dirt road. As shown on Plate 8, FT-308 generally exposed biotite granodiorite and biotite dacite dikes overlain by Pleistocene- and Holocene-age fan deposits, and by Holocene colluvium. Undocumented trench backfill, most likely from E&S's Trench No. 8 (ES-8 [Plate 2]), occurs between approximate Stations 0 and 17. Three reverse faults were encountered in FT-308. The fault near Station 15 exhibited flower structure. The remaining faults were truncated by Holocene-age fan deposits. Owing to incomplete sequence of Holocene stratigraphy, the flower structure, and proximity to a topographic break-in-slope or escarpment, all FT-308 faults are presently designated as active splays of the SJFZ. A summary of faulting in FT-308 is provided in Table 5.

TABLE 5 - FAULT TRENCH 308 (FT-308)			
APPROXIMATE STATION NO. AS INDICATED ON FIELD LOG	FAULT ATTITUDE (STRIKE, DIP)	MAXIMUM APPARENT VERTICAL DISPLACEMENT (INCHES)	FAULT NO. INDICATED ON PLATE 2 (SURVEYED AT THE SURFACE PROJECTION OF FAULT)
12'	N27° - 39°E, 48°SE	Not Determined	25
31½'	N18°E, 72°SE	6"	26
32'	N-S, 75°E	14"	27
* - Maximum displacement was measured from the northwest wall of the trench.			

Fault Trench 309 (FT-309)

FT-309 (Plates 2 and 9), emplaced immediately north of FT-308 (Plate 2), evaluated the origin of discontinuities observed at the surface, near a topographic break-in-slope. It also intercepted the FT-308 faults near approximate Stations 31 and 32. As portrayed on Plate 9, FT-309 primarily exposed Pleistocene-age fan deposits. Between approximate Stations 10 and 52, Holocene-age fan deposits mantled the Pleistocene-age fan deposits. Holocene-age colluvium was discontinuously exposed near the surface. No faults were observed in FT-309. Rather, FT-309 exposed joints within older alluvium. Based on these observations, we judge that the topographic break-in-slope is man-made. Additionally, the FT-308 faults, located at approximate Stations 31½ and 32 (Plate 8), are not through-going, but are associated with the uplift of the Lower Lytle Creek Ridge-Verdemont Hills.

Fault Trench 310 (FT-310)

FT-310 (Plates 2 and 9), excavated northeast of FT-301, evaluated a surface-exposed bedrock/fan deposit contact. Between approximate Stations 0 and 16, the trench exposed Tertiary "Granodiorite of Telegraph Peak" overlain by a thin (less than 6 inches) layer of Holocene-age colluvium. Between approximate Stations 16 and 57, the bedrock was incised and overlain by Holocene-age fan deposits and colluvium. Based upon the presence of rusted wire near the bottom of the trench, it is likely that the sediments are younger than about 100 years old. The bedrock was sheared. However, the shears were completely confined to the bedrock, did not exhibit flower structures, and were not associated with a topographic break-in-slope. We thus infer that the shears are pre-Holocene in age, and probably related to batholithic emplacement.

SUMMARY OF FAULTING

In PA 3 and 8 (Sycamore Canyon and Sycamore Flat areas, respectively) of Neighborhood I, Holocene faults are most likely associated with active traces of the SJFZ. These were documented in FT-203, FT-203A, and FT-204 (GSI, 2007a), FT-300, FT-305, FT-306, FT-307, and FT-308 (this study) as well as T-7, T-8 (GSI, 1994), T-103, and T-105

(GSI, 1999). These faults generally do not trend with those identified by LOR (1994a) within Sycamore Canyon and Sycamore Flat. The LOR fault zone has been accepted with "limited approval" by the County of San Bernardino, and submitted to the State of California and is largely correct northwest of FT-202 (GSI, 2007a). However, previous GSI investigations (GSI; 1994, 1999, and 2007a) and this study indicate that the LOR fault does not transect the entire Sycamore Canyon and Sycamore Flat. Rather, the LOR fault zone, within the Sycamore Canyon area, terminates somewhere between FT-202 and FT-204 (GSI, 2007a). We then concluded in GSI (2007a) that the termination of active faulting southeast of FT-204 may be related to a right step-over of the San Jacinto strands to the more active Glen Helen fault based on: 1) the short and discontinuous nature of faulting; 2) the decrease in vertical displacements to the southeast; and, 3) the absence of faults southeast of FT-204. We further concluded that the faults in Sycamore Canyon are likely not seismogenic, but probably relate to slip partitioning along en-echelon tears that respond to major events on the Glen Helen fault.

Within PA 8 of the Sycamore Flat area, the active splay of the SJFZ enters the site from the southeast, where local transtension typically forms rift and graben features, characteristic of pull-apart regions (GSI, 1994 and 1999). Heading northwest, north of FT-103, the style of faulting changes from transtension, to transpression, thus giving rise to reverse faults, characteristic of restraining bends along fault trend. In essence, they are generally short and discontinuous, parallel the Lower Lytle Creek Ridge-Verdemont Hills front, and are probably imbricated with a series of topographically up-gradient, over-riding reverse faults. These faults tend to exhibit contractional horsetail splays where they bend, and are areas of regional topographic uplift of crystalline bedrock (Cunningham and Mann, 2007), such as at PA 8 and along the Lower Lytle Creek Ridge-Verdemont Hills ridgeline. The horsetail splays also characteristically exhibit flowering upward features, where fault slip is distributed as faults step over to more active splays (such as the Glen Helen fault), or die out.

Several faults in older fan deposits were exposed in FT-300, 300A, 302, and 303 as well as the surface. These faults were characterized as pre-Holocene based on: 1) they did not offset a surveyed geologic contact between Tertiary- and Cretaceous-age bedrock in the borrow pit area (Plate 1); 2) they lack aerial-photographic lineaments and geomorphic expression commonly associated with active faulting, such as flowering upward structures; 3) even though the surface had been stripped of overburden, the older faults typically die-out in pre-Holocene sediments, or do not break or offset a paleosol estimated to be 35,000 years old; 4) they generally exhibit trends inconsistent with the N40°W regionally modern tectonic regime; and 5) they contain pedogenic silica along fracture surfaces, estimated to be about 100,000 years old. Further, the pre-Holocene fan deposits were deeply incised during the last major pluvial epoch, this occurring approximately 12,000 to 18,000 years ago when the climate was much wetter (Dietrich and Doru, 1984; Shlemon and others, 1987). Since that time, with the change of climate, these incisions have been filled with younger alluvial sediments transported within drainages within the older fans, that roughly trend normal to these faults. Also, the modern drainage within PA 8 is gradient-, and not fault-controlled, thus corroborating that these older faults have not moved in at least 12,000 years. Although, it cannot be entirely precluded that these faults will experience some sympathetic movement should a high magnitude earthquake occur on nearby active splays of the CFZ, SJFZ, or SAFZ, such displacements should likely be small, and thus readily mitigated by engineering design (i.e., overexcavation, post-tension slabs and/or mat foundations).

RATIONALE FOR FAULT SETBACK ZONES

As indicated on Plate 2, the recommended fault setback zone within PA 8 of Neighborhood I is based on the locations and trends of active faults exposed in GSI trenches FT-300, FT-305, FT-306, FT-307, FT-308 (this study), T-103, T-105 (GSI, 1999), T-7, and T-8 (GSI, 1994). The active faulting is associated with the Lower Lytle Creek Ridge-Verdemont Hills uplift. Bedrock structure (i.e.,stress orientation), observed during mapping along the Lower Lytle Creek Ridge-Verdemont Hills, northeast of PA 8, was also used to evaluate fault setbacks north of FT-308. Consistent with current standards-of-practice for the number and spacing of trenches, setbacks for habitable structures are recommended for a distance of 50 feet outside the most southwestern or northwestern principal faults identified in these trenches. Due to uncertainty, this zone widens 150 feet northeast of FT-308. Additionally, setbacks for habitable structures are recommended northeast and southeast of these principal faults to the development boundary between PA 7 and 8, because the most youthful faults in a reverse/thrust fault regime are typically located near the peaks of thrust belts (i.e., Lower Lytle Creek Ridge-Verdemont Hills). Although not indicated on KTGY (2008), should habitable structures be proposed in PA 7, further fault rupture hazard investigations will be necessary.

FAULT RUPTURE RECURRENCE

The GSI identified faults within PA 8 are part of the SJFZ. Although some are "active," the on-site faults are not "main splays" of the SJFZ. Rather, as indicated by Sharp (1975), the Glen Helen fault (now referred to as the Burro Flats section [2007 WGCEP, 2008]) appears to be the dominant trace of the SJFZ within the San Bernardino Valley, for the Glen Helen fault has scarps and sag ponds in young Holocene alluvium. Matti, *et al.* (1992) also believe that the Glen Helen fault is the active trace of the SJFZ in the San Gabriel Mountain region.

SCEC (2006) indicates that recurrence for the Glen Helen and Claremont segments is between 100 and 300 years for earthquake magnitudes M6.5 and M7.5. CDMG (1996) reported that recurrence for the San Jacinto fault (San Bernardino Segment) is 100 years. Fault investigations, within the SJFZ, at two sites near Colton and San Bernardino, California (Kendrick and Fumal, 2005) identified approximately 100- and 266-year return periods, respectively.

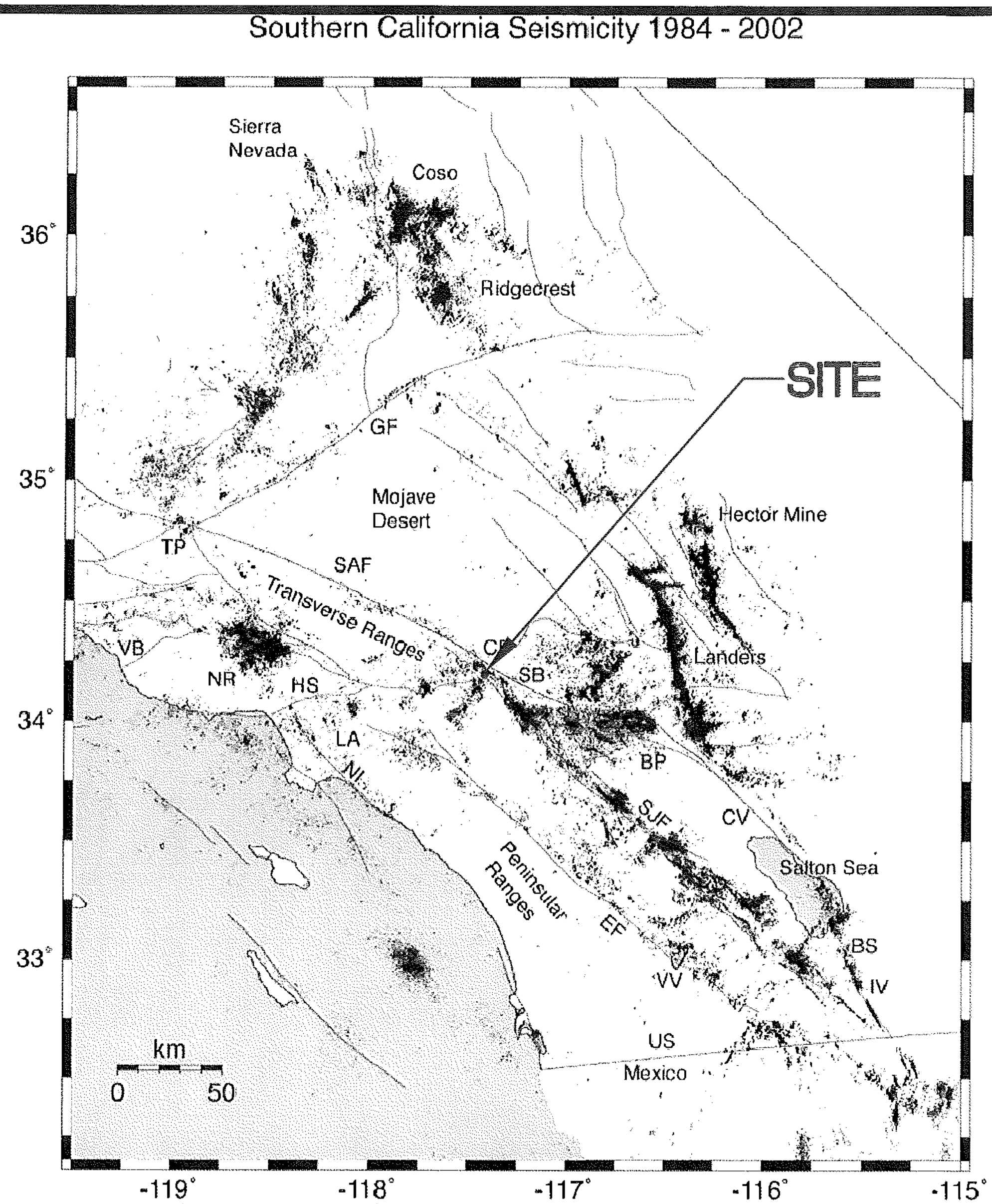
Previous site grading removed sediments amenable to age-dating of the principal faults. Therefore, GSI used geomorphic evidence (i.e., fault scarp degradation) to evaluate earthquake recurrence for this splay of the SJFZ. According to Chen *et al.* (2002), short earthquake recurrence intervals produce well-preserved fault scarps, whereas fault dormancy allows for greater fault scarp degradation. Since reverse faults created the Lower Lytle Creek Ridge-Verdemont Hill front, the measured slope inclination of consolidated old fan sediments along the front date the age of the scarp, as indicated in Wallace (1977). Based on an average 25 degree slope for consolidated sediments along the front and based on Wallace's (1977) scarp-dating procedures, the fault-scarp age is about 1,000 years. Because fault scarps degrade during relative dormancy, and are well preserved when the earthquake recurrence interval is short, GSI concludes that the recurrence interval for the active strand of the SJFZ in Sycamore Flat (PA 8) probably ranges from several hundred to ~2,000 years per major fault event. Accordingly, we reasonably judge that possible surface fault rupture over the lifetime of any structure is very low. Nonetheless, setbacks for structures for human occupancy are warranted for the principal faults identified in our trenches. Such setbacks are shown on Plate 2. Additionally, owing to the site's proximity to active seismic sources, structures for human occupancy and supporting infrastructure should be designed for strong ground motion (approximately 1g) produced by nearby earthquakes.

SEISMICITY AND SEISMIC HISTORY

The seismicity and seismic history of the project and site have been described in GSI (2007a). The seismicity of the region has not changed appreciably since the issuance of that report. Regional faults and epicenters are also presented graphically on Plate C-9 of GSI (2007a). For context, and as corroborating evidence for the data presented herein, a plot of southern California seismicity from 1984 to 2002 is presented as Figure 6. As shown in Figures 6 and 7 (taken from the latest USGS publication [Catching, et. al, 2008]), the site is relatively quiescent compared to the surrounding area, where nearby faults have recurrence intervals of approximately several hundred years. Further, Holocene faults have not been mapped by the USGS on the entire Lytle Creek Ranch, based on the latest mapping (Morton and Miller, 2006a and 2006b).

CONCLUSIONS AND RECOMMENDATIONS

Based on our current geologic analyses, the proposed residential planning area (PA 8) is feasible for its intended use, provided the recommendations in this report are properly implemented during planning, design, and construction. The most significant elements of our investigation are summarized below:



The relocated southern California seismicity 1984–2002 by using the double-difference method. BP, Banning Pass; BS, Brawley seismic zone; CP, Cajon Pass; CV, Coachella Valley; EF, Elsinore fault; GF, Garlock fault; HS, Hollywood-Santa Monica fault; IV, Imperial Valley; LA, Los Angeles; NI, Newport-Inglewood fault; NR, Northridge; SAF, San Andreas fault; SB, San Bernardino Mountains; SJF, San Jacinto fault; TP, Tejon Pass; VB, Ventura Basin; VV, Vallecitos Valley

From Hauksson and Shearer, 2005

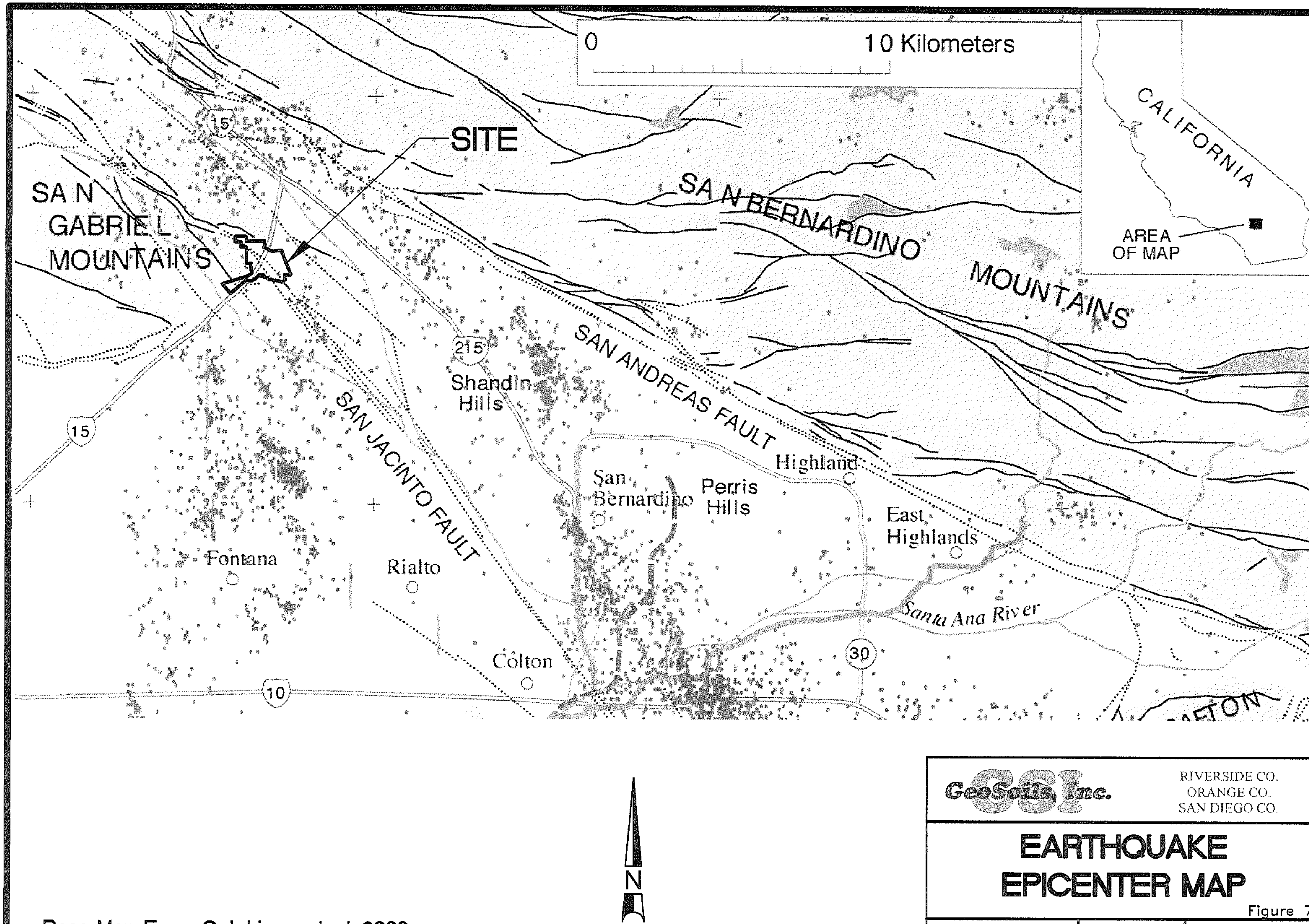
GeoSoils, Inc.

RIVERSIDE CO.
ORANGE CO.
SAN DIEGO CO.

SOUTHERN CALIFORNIA SEISMICITY 1984-2002

Figure 6

W.O. 5278-A1-SC	DATE 07/08	SCALE Bar Scale



Base Map From Catchings, et. al, 2008

GeoSoils, Inc.

RIVERSIDE CO.
ORANGE CO.
SAN DIEGO CO.

EARTHQUAKE EPICENTER MAP

Figure 7

W.O. 5278-A1-SC	DATE 07/08	SCALE Bar Scale

1. The site lies within the San Jacinto fault zone (SJFZ), which is active (i.e., movement within the Holocene Epoch), according to the State of California (Bryant and Hart, 2007). Holocene faults were identified in some trench exposures during GSI (1994 and 1999) and this current investigation. In general, Holocene faults and their associated trends parallel the Lower Lytle Creek Creek Ridge-Verdemont Hills front. Habitable structures will require setbacks from active faults, as shown on Plate 2 (Fault Setback Map).

2. During GSI (1994 and 1999) and this study, pre-Holocene (non-active) faults were exposed in some trenches and at the surface. Surface exposures of these faults were due to previous removal of soil overburden, likely from previous agricultural use of the site circa 1955. These faults were characterized as pre-Holocene based on the following: 1) these faults did not offset a surveyed geologic contact between Tertiary- and Cretaceous-age bedrock in the borrow pit area (Plate 1); 2) these faults lacked photo-lineaments and geomorphic expression commonly associated with active faulting, such as flowering -upward structures; 3) even though the surface had been stripped of overburden, some of the older faults die-out in pre-Holocene sediments, or did not break or offset a paleosol estimated to be 35,000 years old; 4) these faults generally exhibited trends inconsistent with the N40°W regional and modern tectonic regime; and 5) these faults exhibited silica accumulation along fracture surfaces, likely the base of a silcrete duripan, part of a paleosol estimated to be at least ~100,000 years old (Appendix B). Further, the pre-Holocene fan deposits were deeply incised during the last major pluvial epoch, this occurring approximately 12,000 to 18,000 years ago when the local climate was much wetter (Dietrich and Dorn, 1984; Shlemon *et al.*, 1987). Since that time, the channels have been filled with younger fluvial sediments transported along drainage courses developed within the older fans. The flow of these drainages are normal to these older fault trends. Thus, the modern drainage within PA 8 is gradient controlled, and not fault controlled, providing corroborating evidence that these older faults have not moved in at least ~12,000 years. Although it cannot be entirely precluded that these faults will experience some sympathetic movement, should a high magnitude earthquake occur on nearby active splays of the CFZ, SJFZ, or SAFZ, such displacements should likely be very small, and therefore readily mitigated through engineering design (i.e., overexcavation, post-tension slabs and/or mat foundations).

3. The site is subject to horizontal seismic accelerations anticipated to be near 1g, should the design earthquake occur. The potential for local ground shaking is high and thus similarly requires appropriate engineering mitigation.

4. Local perched groundwater occurs at depths as shallow as about 8½ feet where the site is underlain by young Quaternary fan deposits. Elsewhere, perched groundwater was encountered along discontinuities in the bedrock and older alluvial fan deposits, or along unconformable contacts with permeability contrasts (i.e., relatively permeable sediments underlain by aquitards).

5. Although not observed during the recent field work, paleoliquefaction features were observed in similar late Holocene sediments in some trench exposures during field work in preparation of GSI (1999 and 2007a). We therefore recommend that additional, site-specific investigations evaluate liquefaction potential, dry sand settlement, as well as other typical geotechnical conditions, such as remedial-removal depths, settlement, engineered and natural slope stability, and design criteria. In view of the site seismic setting and the potential for seismic settlement, post-tensioned and/or mat foundations appear particularly appropriate for this project.

6. Based on our current geological assessments, and excluding proposed setback zones, GSI concludes that active faults (i.e., "sufficiently active" and "well-defined") likely do not exist within the remainder of the property. If present, however, they are of such small displacement potential to be reasonably mitigated by appropriate engineering design.

7. Major underground or above-ground utility lines should cross active faults at high angles approaching perpendicular. Cut-off valves should be located on both sides of active fault zones to facilitate repair.

8. Flooding may also occur during periods of heavy precipitation. The late-Holocene alluvial fans at the site were primarily deposited by debris flows emanating from the up-gradient canyons. Therefore, the potential for flooding should be evaluated by the design civil engineer and mitigation should be provided by the design civil engineer and geotechnical consultant, as warranted.

9. Owing to local bedrock outcrops along the relatively steep hillsides of Lower Lytle Creek Ridge-Verdemont Hills, there is potential for local rockfalls. Additionally, the Pleistocene-age sediments are considered erosive and surficial slope failures along cut slopes, constructed into these sediments, cannot be entirely precluded. Therefore, these potential hazards should be evaluated and appropriately mitigated.

10. The potential for ridge-top shattering is high in elevated portions of Neighborhood I. Site-specific geotechnical investigations will be required to identify where mitigation should be performed. Mitigation measures may include a compacted fill blanket (overexcavation), and engineering design, incorporating post-tension/structural slabs, mat, or deep foundations.

LIMITATIONS

The materials encountered on the project site and utilized for our analysis are believed representative of the area; however, soil and bedrock materials vary in character between excavations and natural outcrops or conditions exposed during mass grading. Site conditions may vary due to seasonal changes or other factors.

Inasmuch as our study is based upon our review and engineering analyses and laboratory data, the conclusions and recommendations are professional opinions. These opinions have been derived in accordance with current standards of practice, and no warranty, either express or implied, is given. Standards of practice are subject to change with time. GSI assumes no responsibility or liability for work or testing performed by others, or their inaction; or work performed when GSI is not requested to be onsite, to evaluate if our recommendations have been properly implemented. Use of this report constitutes an agreement and consent by the user to all the limitations outlined above, notwithstanding any other agreements that may be in place. In addition, this report may be subject to review by the controlling authorities. Thus, this report brings to completion our scope of services for this portion of the project.

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APPENDIX A

REFERENCES

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APPENDIX A

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APPENDIX B

QUALITY ASSURANCE ASSESSMENT OF RELATIVE FAULT ACTIVITY, PLANNING AREA 8, NEIGHBORHOOD I SYCAMORE FLAT, SAN BERNARDINO COUNTY, CALIFORNIA

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Quaternary Geology
Economic Geomorphology
Soil Stratigraphy
Geoarchaeology
PG: 2867
CPG: 1766; CPESC: 2167

APPENDIX B

QUALITY ASSURANCE ASSESSMENTS GEOSOILS, INC., "ADDENDUM 2, SUPPLEMENTAL FAULT-ACTIVITY INVESTIGATIONS, LYTLE CREEK RANCH, NEIGHBORHOOD 1, SYCAMORE CANYON AREA, RIALTO, SAN BERNARDINO COUNTY, CALIFORNIA"

INTRODUCTION

This Appendix summarizes field observations and a Quality Assurance (QA) review of the above-titled, GeoSoils, Inc. (GSI) report. The GSI document focuses on supplemental investigations concerning the presence, relative activity and age of sediments exposed in trenches emplaced in the Sycamore Flat area of the proposed Neighborhood 1 development at Rialto in San Bernardino County.

The main purposes of the QA observations and report review were three-fold:

1. To provide internal QA on behalf of the Lytle Development Company (Ontario);

2. To assist GSI in dating site sediments and faults based mainly on soil (pedogenic) and geomorphic field observations; and

3. To critique the GSI draft report, logs and related graphics for documentation adequacy, reasonableness of interpretation and compliance with current geologic standards of practice.

The QA and soil-stratigraphic field procedures were previously provided in appendices for earlier GSI fault investigations at this and adjacent Lytle Creek Ranch neighborhoods, but are here summarized for context (see literature cited in accompanying GSI report).

The field observations were carried out on April 7, 2008, and focused mainly on the regional geomorphic setting and on exposures in GSI trenches FT-300, FT-300A, and FT-301. Trench- and cut-slope reconnaissance also took place on April 17, particularly emphasizing sediments exposed in FT-300, FT-300B, FT-302, FT-303, FT-304 and FT-305 (locations and trench logs given in GSI Plates 1 through 9, respectively). Formal soil-stratigraphic sections were not measured and described; however, field comparison of relative profile development with those in similar soil-climatic regimes provides reasonable minimal age estimates for the underlying sediments.

Logistical support was kindly provided by the GSI staff, particularly R. Boehmer, J. Franklin and P. McClay. Field observations and provisional conclusions were reviewed with the GSI staff, with the San Bernardino County Reviewer, W. Reeder, and with Lytle Development representatives. Pertinent location and geologic maps and references are provided in the accompanying GSI report and hence are referred to, but not replicated in this Appendix. Soil terminology and field documentation techniques follow those of the U.S. Natural Resources Conservation Service (Soil Survey Division Staff, 1963; 1999; Schoeneberger and others, 2002). Application of soil stratigraphy to engineering geology is summarized in Shlemon (1985), Birkeland (1999), Birkeland and others (1991), Noller and others (2000), and Schaetzl and Anderson (2005).

GSI INVESTIGATION PROCEDURES

GSI investigated potential on-site faults using traditional and well accepted procedures. In accordance with present standards-of-practice, GSI reviewed pertinent literature, analyzed aerial-photographic lineaments, mapped the site geologically (Plate 1), emplaced and logged trenches across suspect lineaments and previously mapped or inferred on-site faults; and documented sediment age and relative fault activity using well established geomorphic and soil-stratigraphic methods. Additionally, GSI compared site-fault age, recurrence and characteristics with nearby splays of the active (Holocene) San Jacinto fault. They also completed their analysis by reconstructing the regional neotectonic framework, by technical interpretation and by documenting their findings and conclusions in the accompanying report.

TRENCH OBSERVATIONS

For fault-assessments, GSI excavated and logged 13 discrete trenches in the investigated area (Plate 2). These trenches, placed mainly across photo-lineaments and geomorphic escarpments, exposed granitic bedrock, several alluvial units, buried and relict paleosols, and locally much artificial fill. For this QA critique, three trenches were specifically documented: FT-300, FT-304 and FT-305. Additionally reviewed were FT–300A, FT-300B, FT-301, FT-302, FT-303, all trench logs, maps and fault-activity interpretations as presented in the GSI report and related graphics.

Trench FT-300

GSI emplaced the ~270-ft long and up to 20-ft deep FT-300 across a projection of a previously identified on-site fault and a geomorphic escarpment (GSI Plate 2). As shown on the GSI log (Plate 3), the trench exposed Tertiary granitic rocks fault-juxtaposed against older alluvium. The surface of the older alluvium ("Qafo") bears a moderately developed buried paleosol, an extensive stratigraphic marker useful to date the underlying sediments and hence provide a minimum age for last fault offset. Characterized by a reddish-brown argillic horizon with few to common, thin to moderately thick clay films lining ped faces, the post-Qafo paleosol represents at least ~35 ka of weathering. As documented on the GSI log, this unbroken buried paleosol provides a minimum age for last fault displacement (Plate 3).

In contrast, between stations 12 and 36 (Plate 3), the faults tend to "flower upward," usually indicative of "recent," surface and near-surface fault displacement. Further, the faults generally coincide with a prominent break-in-slope. These lines of evidence thus indicate probable Holocene displacement. Accordingly, GSI judges these faults as "active" and recommends an appropriate setback for building construction (Plate 2).

Trench FT-300 also exposed remnants of a deeper, strongly developed buried paleosol within the older alluvium. As shown between stations ~220 and 250 (Plate 3), this paleosol bears only a remnant argillic horizon. However, still preserved is a silcrete (duripan) that marks the base of the remnant paleosol. These silcretes typify ~100 ka relict and buried paleosols forming on "old" granitic alluvium elsewhere in California; notably, the San Joaquin series, the designated "State Soil of California" (http://www.pssac.org/castatesoil.htm). Accordingly, the buried silcrete marks a major hiatus in deposition of the site "older alluvium" and represents at least ~100 ka of weathering. GSI identifies the silcrete in other trenches and thus effectively uses it as a site-specific stratigraphic marker to date sediments and hence the likely time of last fault displacement.

Trench FT-304

GSI emplaced the ~7-8-ft deep, FT-304 in a general topographic depression in order to verify the trace of FT-300 faults and to expose Holocene sediments amenable to soil-stratigraphic dating (Plate 2). As observed in the field and as depicted on the GSI log (Plate 6), FT-304 encountered a veneer of Holocene alluvium, capping artificial fill, and shallow groundwater. The natural sediments, given their minimal thickness, their stratigraphic position and lack of appreciable soil development, are probably less than ~1 ka old.

Trench FT-305

The FT-300 observations documented that likely Holocene faults coincide with a readily observable, break-in-slope of an escarpment at the base of the "Lower Lytle Creek Ridge-Verdemont Hills" (GSI Fig. 1). In order to trace these faults and to confirm their likely "recent" movement, GSI emplaced the ~120-ft long and up to 15-ft deep FT-305 (Plate 2). As documented on the GSI log (Plate 6), two NW-trending faults were encountered almost exactly where anticipated (stations 0+24 and 0+31). Last surface displacement of these faults, offsetting two older alluvial units and a capping, moderately developed buried paleosol, thus took place after ~35 ka ago. Based on coincidence with the escarpment base, on a general flowering-upward structure, and on continuity with similar reverse faults exposed elsewhere along the granitic and alluvial fan contact, GSI reasonably considers these faults to be "active," and thus recommends an appropriate structural setback zone (Plate 2).

SUMMARY OF FAULT-ACTIVITY ASSESSMENTS

As summarized in the GSI report, several discrete fault zones were identified in the study area. Some faults are deemed active; that is, Holocene surface displacement is either documented or cannot reasonably be precluded; others are demonstrably pre-Holocene; and yet still others have such small offsets and limited lateral extent that they are readily mitigated by geotechnical and structural design.

Both geomorphic expression, or lack thereof, and soil-stratigraphic evidence provide above-average field evidence to constrain relative fault activity. The GSI investigation thus shows that the base of escarpments, specifically along the lower Lytle Creek Ridge-Verdemont Hills, generally coincide with reverse faults having throws generally >~3-4 ft. Additionally, these faults displace fan sediments capped by ~35 ka soils (Plate 6).

Elsewhere, older fan deposits are either not displaced, or faults are characterized by less than a few inches of slip. Additionally, GSI points out that most on-site faults cross distributaries of modern alluvial fans, geomorphic features inherently sensitive to recurrent or major neotectonic displacement. These distributaries are not beheaded, deranged or similarly affected by either lateral or horizontal offsets. This lack of surface deformation is also corroborated by quiescence of contemporary seismicity in most of the study area (see GSI documentation). In contrast, seismic events and recurrence are much greater along previously documented traces of the regionally extensive San Jacinto and Glen Helen faults.

In sum, the GSI Addendum 2 to the Supplemental Report provides additional field evidence concerning the presence and relative activity of faults potentially affecting proposed development in a portion of the Sycamore Flat area.

GSI reviewed literature, identified aerial-photographic lineaments and geomorphic expression of possible faults. They emplaced, logged and photographed new trenches. And they identified and dated faults using well accepted geomorphic and soil-stratigraphic techniques. GSI therefore now provides structural setback zones that realistically vary in width stemming from fault characterization, from trench spacing, and from general uncertainty about fault projection. Based on the April 7 and 17, 2008 field observations and on report review, from a QA perspective, the GSI investigation meets the current standards-of-practice for fault-activity assessments; the documentation is practical, and the conclusions are reasonable.

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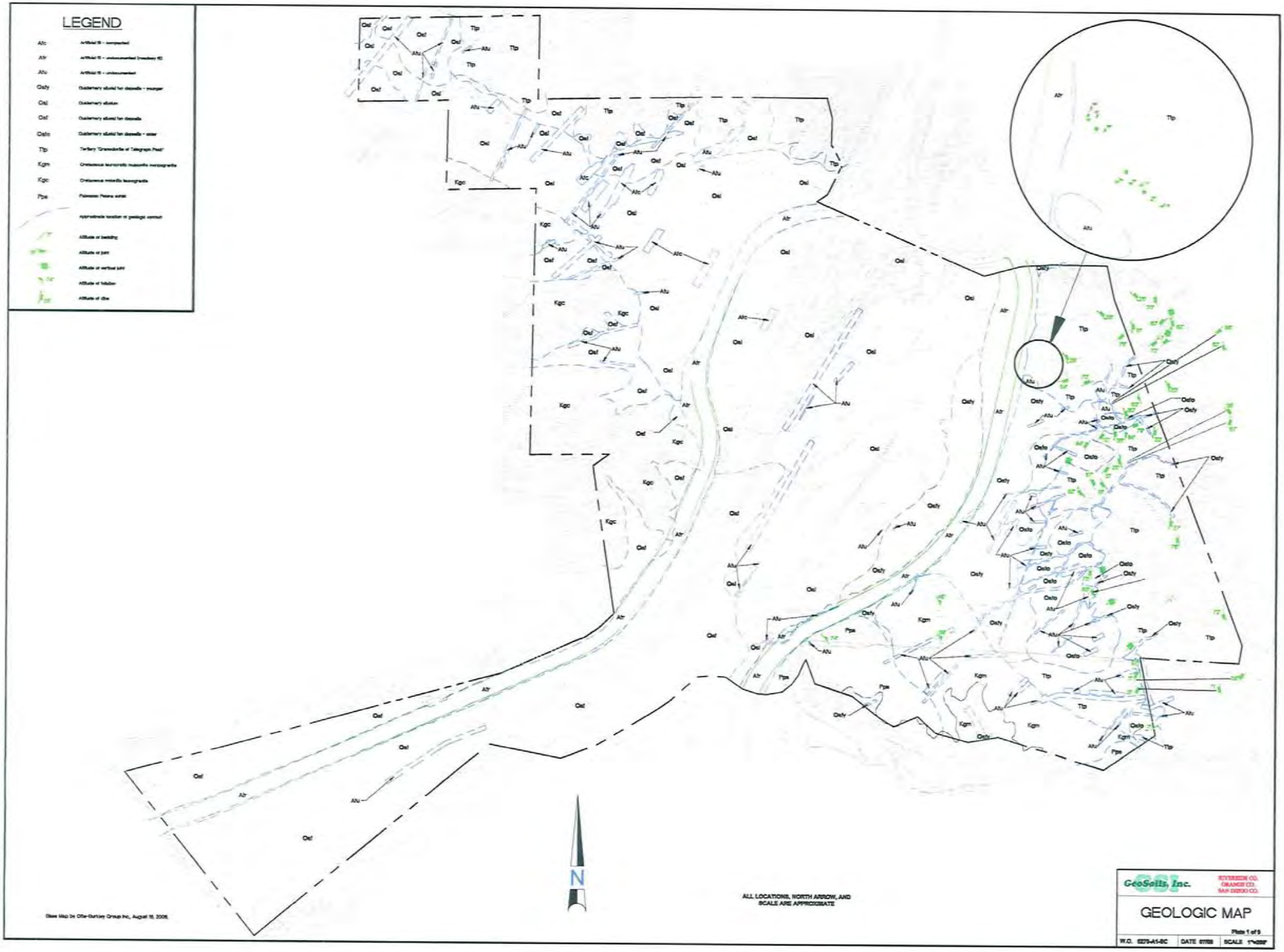
Roy J. Shlemon, Ph.D.
June 2008

PG: 2867
CPG: 1766
CPESC: 2167



LEGEND
Afc
Artificial fill - compacted
Afr
Afu
Artificial fill - undocumented
Qafy
Quaternary alluvial fan deposits - younger
Qal
Quaternary alluvium
Qaf
Quaternary alluvial fan deposits
Qafo
Quaternary alluvial fan deposits - older
Ttp
Kgm
Kgc
Pps
Approximate location of geologic contact
Attitude of bedding
Attitude of joint
Attitude of vertical joint
Attitude of foliation
Attitude of dike
N
ALL LOCATIONS, NORTH ARROW, AND SCALE ARE APPROXIMATE
GeoSoils, Inc.
RIVERSIDE CO.
ORANGE CO.
SAN DIEGO CO.
GEOLOGIC MAP
Plate 1 of 5

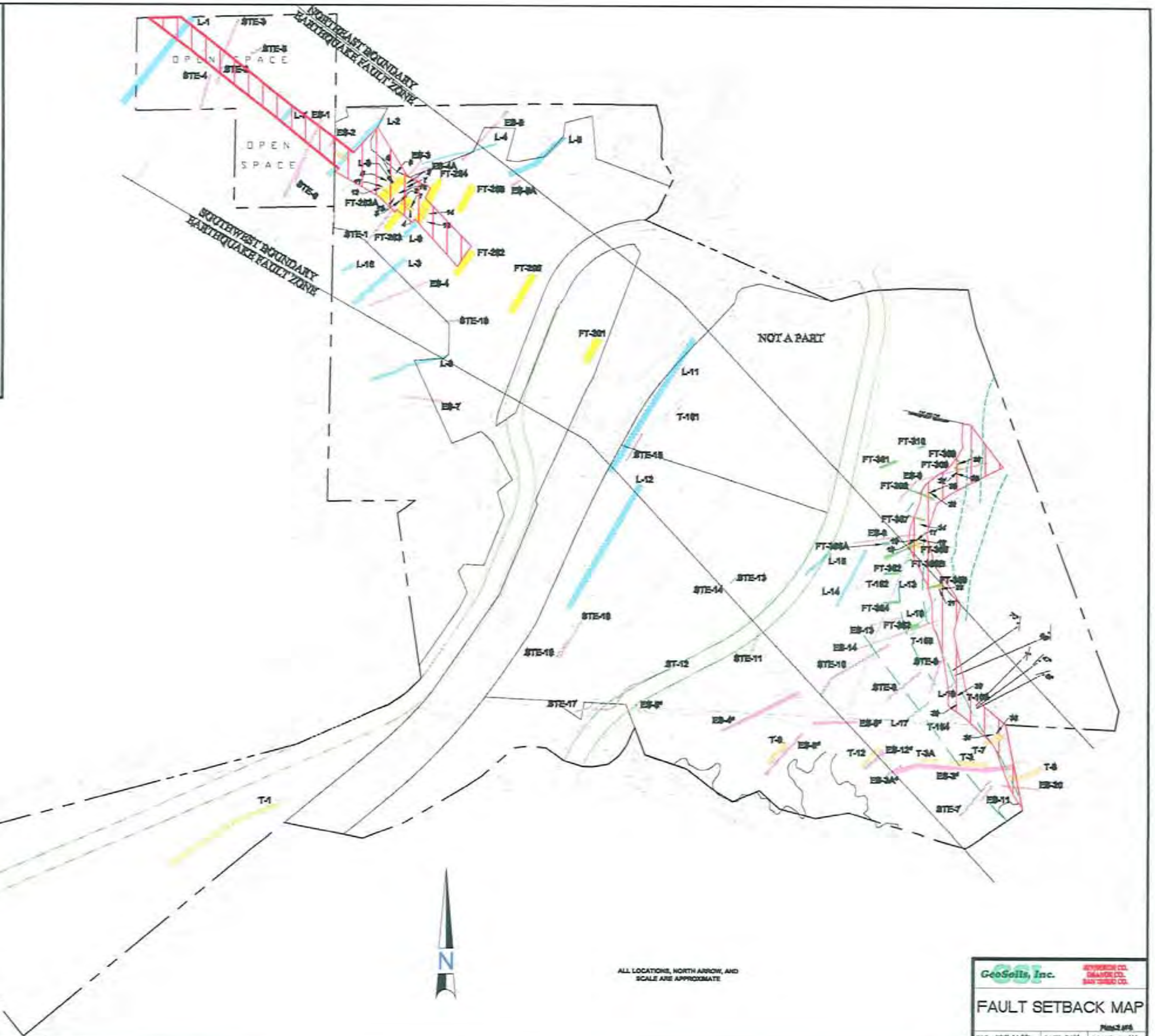
LEGEND

- Approximate location of plotted fault (this study GS, 2007a, 1990, 1994)
- Approximate location of inferred fault
- Approximate location of photo lineament
- Attitude of fault
- Attitude of vertical fault
- Approximate location of setback limit for habitable structures (this study GS, 2007a)
- Approximate location of setback limit for habitable structures (LOR Geotechnical Group, Inc, 1994a)
- FT-309 — Approximate location of fault-locating trench (this study)
- FT-205 — Approximate location of fault-locating trench (GS, 2007a)
- T-105 — Approximate location of fault-locating trench (GS, 1990)
- T-8 — Approximate location of fault-locating trench (GS, 1994)
- L-15 — Approximate location of fault-locating trench (LOR Geotechnical Group, Inc, 1994a)
- ES-26 — Approximate location of fault-locating trench (GS, 1994, LOR Geotechnical Group, Inc, 1994a; Eberhart and Stone, Inc, unpublished 1980-1985)
- ES-12* — Approximate location of fault-locating trench (GS, 1994; Eberhart and Stone, Inc, unpublished 1980-1985) - trench logs provided in GS (1994)
- STE-19 — Approximate location of fault-locating trench (Soil Testing and Engineers, Inc, 1982)

TABLE OF HOLOCENE FAULTS

Fault Trench	Approximate Station No. as Indicated on Field Log (feet)	Fault Attitude Strike, Dip (degrees)	Maximum Apparent Vertical Displacement (inches)*	Fault No. Indicated on Plate 2 (Surveyed at the Surface Projection of Fault) NS - Not Surveyed
FT-203	-31½	N47 W, Vertical	12	1
	-23	N52 W, 82 SW	8	2
	-15	N52 W, 74 SW	7	3
	-5	N51 W, 75 NE	35*	4
FT-203A	63	N31 W, 51 SW	Not Determined	5
	67	N65 W, 45 SW	11	6
	75	N53 W, 76 SW	2½ - 3	7
	92	N55 W, 73 SW	3 - 4	8
	142½	N42 W, 69 SW	2	9
	146	N55 W, 51 SW	5	10
	183*	N41 W, 82 NE	5	11
	187*	N61 W, 74 NE	9½	12
	190*	N47 W, 58 NE	35	13
FT-204	229½	N44 W, 80 SW	3	14
	275	N42 W, 86 SW	16	15
FT-304	11½	N1-3 E, 52 SE	Not Determined	16
	25½	N26 W, 56 SW	4	17 NS
	32	N14 W, 82 NE	Not Determined	18
	39	N39 W, Vertical	Not Determined	19
FT-305	24	N41 W, 79 NE	12	20
	37	N37 W, 71 NE	16	21
FT-306	38	N26 E, 84 SE to Vertical	Not Determined	22
	45	N10 E, Vertical	Not Determined	23
FT-307	30	N5 W, 31 NE	Not Determined	24
FT-308	12	N27-29 E, 48 SE	Not Determined	25
	31½	N18 E, 72 SE	8	26
	33	N-S, 75 E	14	27
T-163	30	N7 E, 56 NW	6	28
	42½	N9 W, 40 SW	12	29
T-7	19	N48 W	Not Determined	30
	33	N48 W	Not Determined	31

* Maximum displacement was measured from the northwest wall of the trench.
NS - Not Surveyed [illegible]



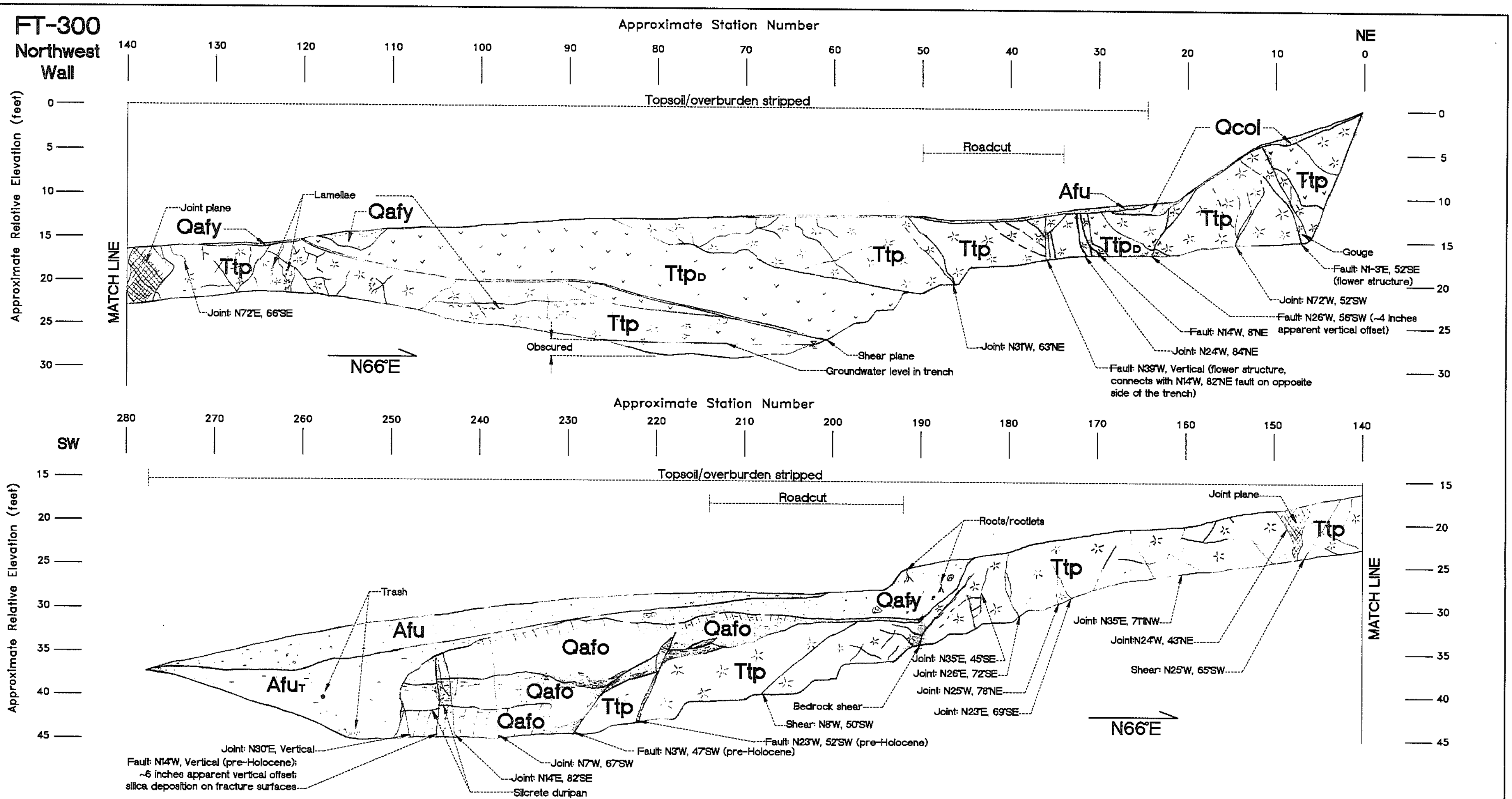
ALL LOCATIONS, NORTH ARROW, AND SCALE ARE APPROXIMATE

Base Map by Otte-Gumay Group Inc, August 18, 2006

GeoSoils, Inc.

FAULT SETBACK MAP

W.O. | DATE | SCALE



T-300 LEGEND

Afu	Artificial fill - undocumented: Sandy silt to silty sand, dark olive gray (5Y 3/2), dry, soft/loose to stiff/medium dense; abundant angular pebble- to cobble-sized clasts, trace trash
Afu_T	Artificial fill - undocumented (trench backfill): silty sand, olive (5Y 5/4 to 5Y 5/6), dry to moist, loose; trace trash
Qafy	Quaternary alluvial fan deposits - younger: Silty sand, olive (5Y 5/4), dry, loose to medium dense; trace subrounded to subangular, pebble-sized clasts
Qcol	Quaternary colluvium: Silty sand, light yellowish brown (10YR 6/4), dry, loose; porous
Qafo	Quaternary alluvial fan deposits - older: Silty sand, brown (7.5YR 5/4 [moist]), damp, dense, weakly to thickly bedded, fining upward sequences, trace to locally abundant subrounded to subangular pebble- to cobble-sized clasts, discontinuously capped by argillic paleosol, reddish yellow (7.5YR 6/6 [dry]) to strong brown (7.5 YR 5/6 [dry])
Ttp_D	Tertiary "Granodiorite of Telegraph Peak": Biotite dacite dike, olive gray (relatively weathered) to light greenish gray (moderately weathered) to olive yellow (highly weathered and oxidized), dry, dense; fine grained to aphanitic, partially porphyritic with phenocrysts of biotite displaying schistocity, locally highly fractured
Ttp	Tertiary "Granodiorite of Telegraph Peak": Biotite granodiorite to Biotite monzogranite, olive gray to white to olive, dry, dense; medium to coarse grained, locally massive, highly fractured

Scale: 0 5 10 20 Feet

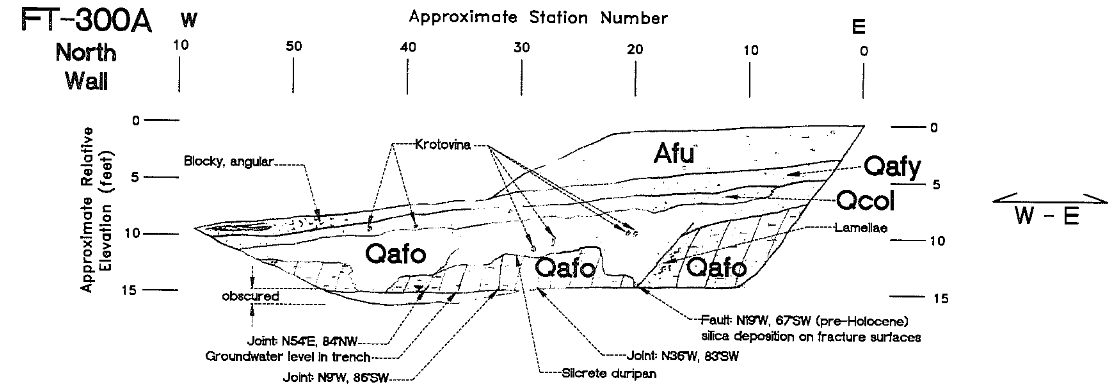
ALL LOCATIONS, STATION NUMBERS, AND DEPTHS ARE APPROXIMATE

GeoSoils, Inc. — RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.

FAULT TRENCH LOG FT-300

Plate 3 of 9

W.O. 5278-A1-SC | DATE 07/08 | SCALE 1"=5'



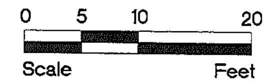
T-300A LEGEND

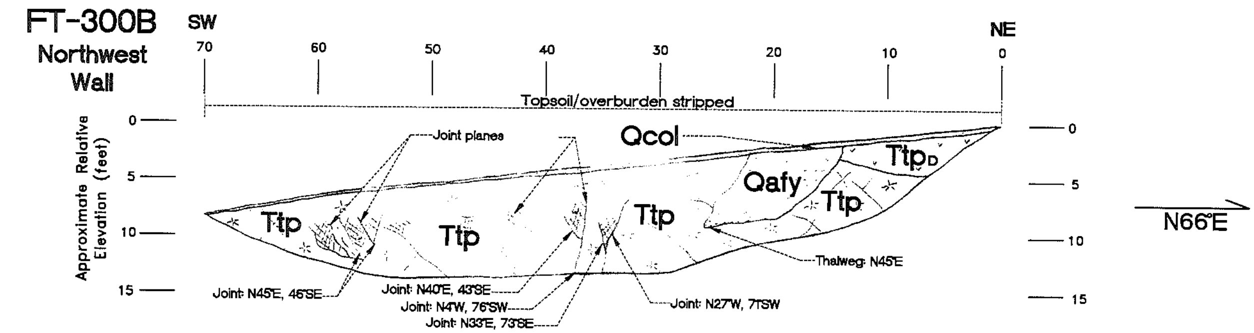
Afu — Artificial fill - undocumented: Sandy silt to silty sand with gravel, dark olive gray (5YR 3/2), dry, soft/loose to stiff/medium dense; abundant angular, pebble- to cobble-sized clasts

Qafy — Quaternary alluvial fan deposits - younger: Silty sand, olive (10YR 7/3), dry, loose to medium dense; trace subrounded to subangular, pebble-sized clasts

Qcol — Quaternary colluvium: Silty sand, dark gray (10YR 4/1), dry, medium dense; massive

Qafo — Quaternary alluvial fan deposits - older: Silty sand, light brown (7.5YR 6/4) to brown (7.5YR 5/4) to reddish yellow (7.5YR 6/6), dry to damp, dense; thickly bedded to massive





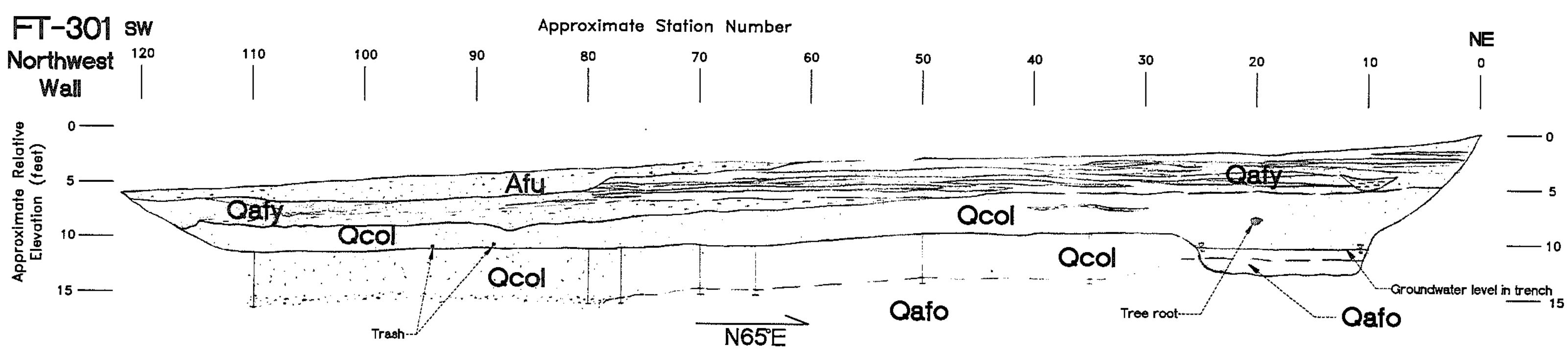
T-300B LEGEND

Qcol — Quaternary colluvium: Silty sand, light yellowish brown (10YR 6/4), dry, loose; porous

Qafy — Quaternary alluvial fan deposits - younger: Silty sand, very pale brown (10YR 7/4), dry, loose; abundant subrounded, pebble- to cobble-sized clasts; porous; weakly bedded

TtpD — Tertiary "Granodiorite of Telegraph Peak": Biotite dacite dike, olive gray, dry, dense; highly fractured

Ttp — Tertiary "Granodiorite of Telegraph Peak": Biotite granodiorite to biotite monzogranite, olive brown to light gray, dry, dense; highly fractured



T-301 LEGEND

Afu — Artificial fill - undocumented: Sandy silt to silty sand with gravel, dark olive gray (5Y 3/2), dry, soft/loose to stiff/medium dense; abundant angular, pebble- to cobble-sized clasts

Qafy — Quaternary alluvial fan deposits - younger: Sand with silt, pale yellow (2.5Y 7/3), damp to moist, loose; medium to coarse grained, low-angle cross beds, to silt, grayish brown (10YR 5/2), damp, soft

Qcol — Quaternary colluvium: Silty sand, dark gray (10YR 4/1), damp to saturated, loose to medium dense; rare debris flow deposits

Qafo — Quaternary alluvial fan deposits - older: Sand with silt, dark reddish brown (5YR 3/4), saturated, dense

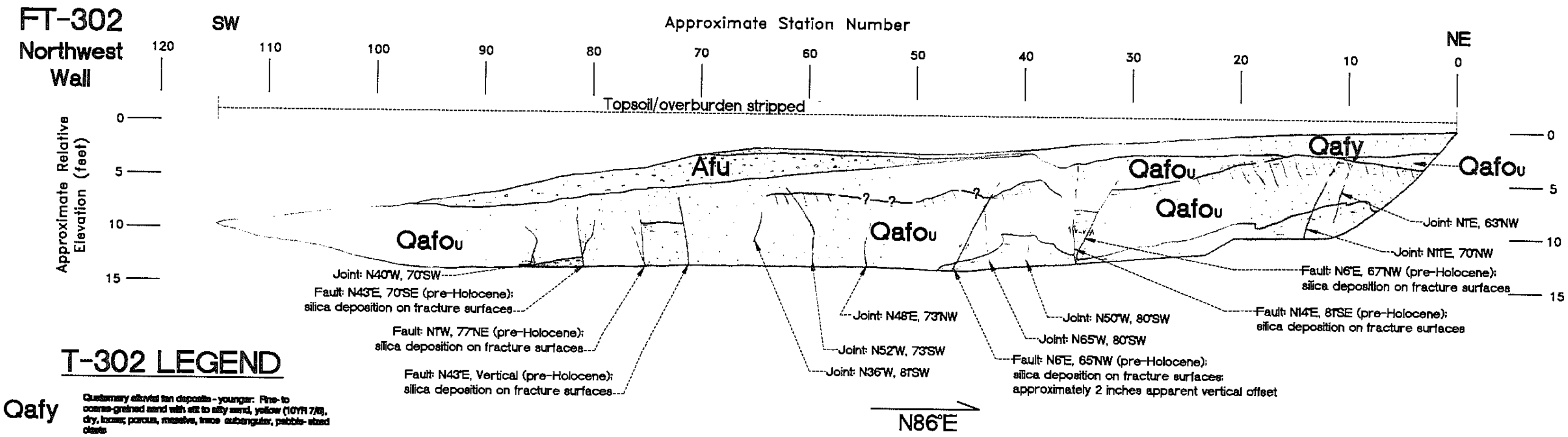
ALL LOCATIONS, STATION NUMBERS, AND DEPTHS ARE APPROXIMATE

GeoSoils, Inc. — RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.

FAULT TRENCH LOGS
FT-300A, FT-300B, FT-301

Plate 4 of 9

W.O. 5278-A1-SC	DATE 07/08	SCALE 1"=5'



T-302 LEGEND

Qafy Quaternary alluvial fan deposits - younger: Fine- to coarse-grained sand with silt to silty sand, yellow (10YR 7/6), dry, loose; porous, massive, trace subangular, pebble-sized clasts

Afu Artificial fill - undocumented: Sandy silt, to silty sand with gravel, dark olive gray (5Y 3/2), dry, soft/loose to stiff/medium dense; abundant angular, pebble- to cobble-sized clasts, trace trash

Qafou Quaternary alluvial fan deposits - older (undifferentiated): Fine- to coarse-grained sand (upper unit), pink (7.5YR 8/3 [dry]) to silty sand (lower unit), brown (7.5YR 5/4 [moist]), dry to wet, medium dense to dense; contains discontinuous buried paleosol, reddish yellow (7.5YR 4/6)

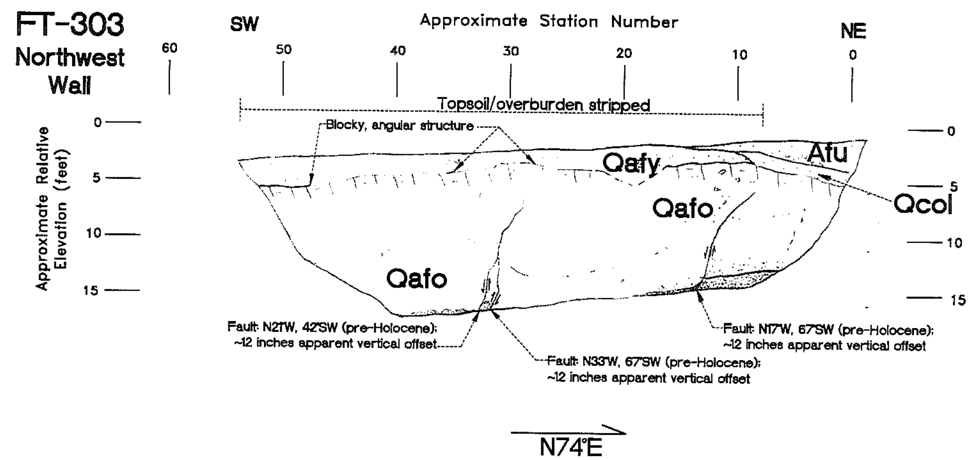
T-303 LEGEND

Afu Artificial fill - undocumented: Silty sand, pale brown (10YR 6/3), dry, loose; porous, trace subrounded to subangular, pebble-sized clasts

Qafy Quaternary alluvial fan deposits - younger: Silty sand, light yellowish brown (10YR 6/4), dry, loose; porous, trace of subrounded to subangular, pebble- to cobble-sized clasts; locally abundant blocky angular structure

Qcol Quaternary colluvium - Silty sand, light brownish gray (10YR 6/2), dry, loose to medium dense; slightly porous

Qafo Quaternary alluvial fan deposits - older: Silty to clayey sand, light brown (7.5YR 6/4), damp to moist, dense; trace of subrounded, pebble- to cobble-sized clasts; generally massive to thickly bedded; rare weak beds, discontinuously capped by an argillic paleosol, reddish yellow (7.5YR 7/6)



0 5 10 20
Scale Feet

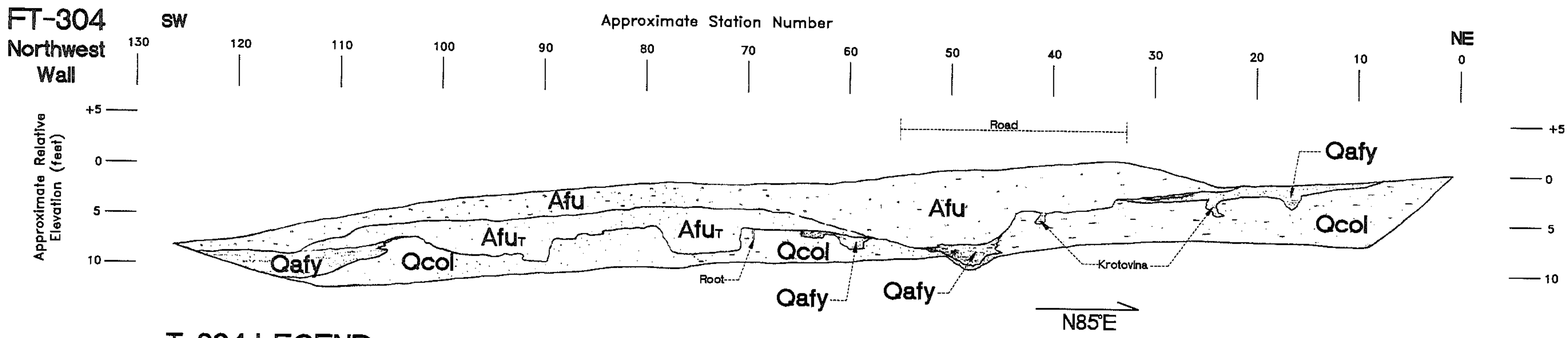
ALL LOCATIONS, STATION NUMBERS, AND DEPTHS ARE APPROXIMATE

GeoSoils, Inc. — RIVERSIDE CO. / ORANGE CO. / SAN DIEGO CO.

FAULT TRENCH LOGS FT-302 AND FT-303

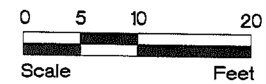
Plate 5 of 9

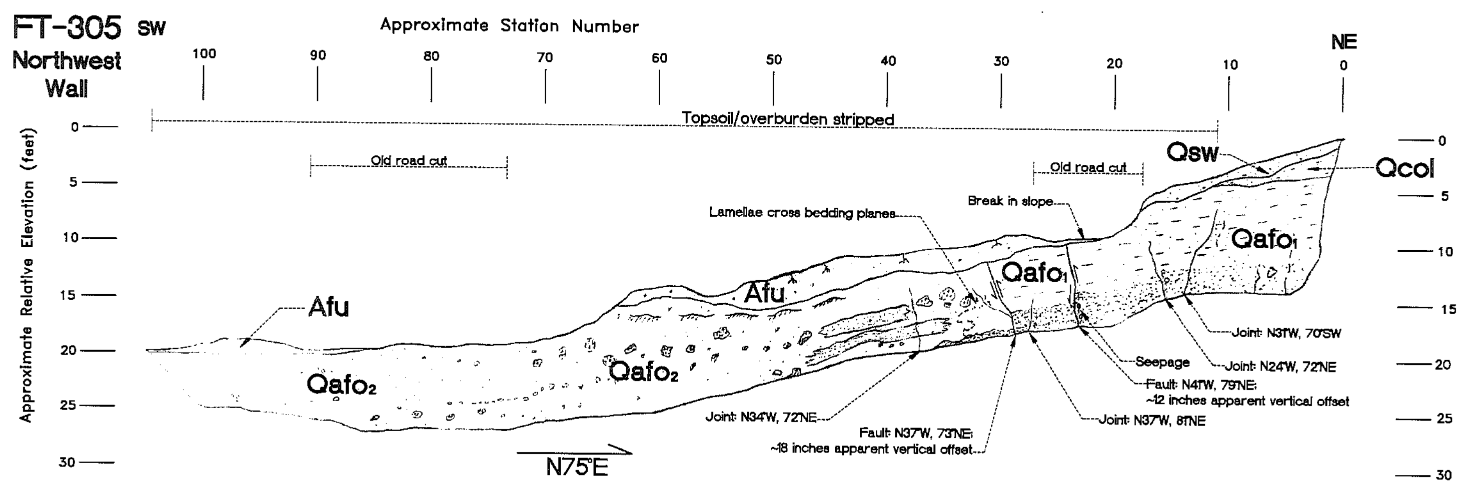
W.O. 5278-A1-SC	DATE 07/08	SCALE 1"=5'



T-304 LEGEND

Qafy	Quaternary alluvial fan deposits - younger: Sand, very pale brown (10YR 8/3 to 10YR 7/3), dry, loose; fine to coarse grained, weakly cross bedded, to silty sand, dark yellowish brown (10YR 4/4), moist, loose
Afu	Artificial fill - undocumented: Silty sand, mottled brown (10YR 5/3) and yellow (10YR 7/6), dry, loose to medium dense; trace of subrounded to subangular, pebble-sized clasts
Afu_T	Artificial fill - undocumented (trench backfill): Silty sand, mottled brown (10YR 5/3), brownish yellow (10YR 6/6), and light brownish gray (10YR 6/2), dry, loose to medium dense; trace subangular, pebble-sized clasts
Qcol	Quaternary colluvium: Sand with silt, dark grayish brown (10YR 4/2) to dark gray (10YR 4/1), dry to saturated, medium dense; fine to coarse grained, massive





T-305 LEGEND

Afu	Artificial fill - undocumented: Silty Sand, very pale brown(10YR 7/4), dry, loose; porous
Qsw	Quaternary slopewash: Silty sand, very pale brown (10YR 8/4), dry, loose; porous, trace angular, pebble- to cobble-sized clasts
Qcol	Quaternary colluvium: Silty sand, dark gray (10YR 4/1), dry, loose; porous
$Qafo_2$	Quaternary alluvial fan deposits - older (proximal): Silty sand, reddish yellow (7.5YR 6/6 [dry]) to brown (7.5YR 4/4 [moist]), dry to damp, dense; locally abundant subangular to subrounded, pebble- to boulder-sized clasts
$Qafo_1$	Quaternary alluvial fan deposits - older (distal): Silty sand to clayey sand, brown (7.5YR 4/4 [moist]), dry to saturated, dense; massive to thickly bedded; rare subrounded, pebble-sized clasts

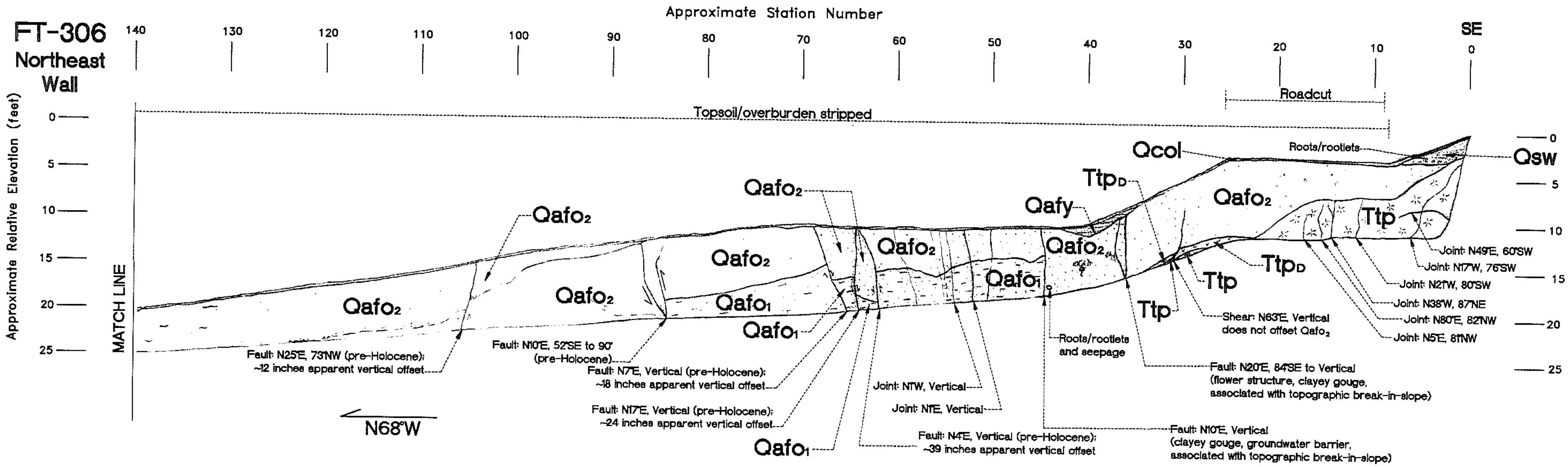
ALL LOCATIONS, STATION NUMBERS, AND DEPTHS ARE APPROXIMATE

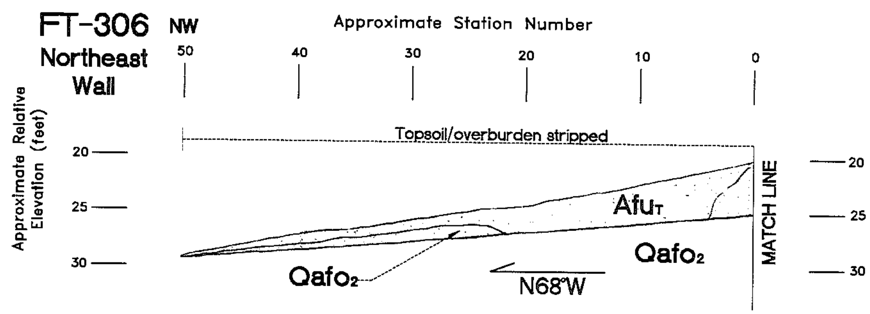
GeoSoils, Inc. RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.

FAULT TRENCH LOGS FT-304 AND FT-305

Plate 6 of 9

W.O. 5278-A1-SC	DATE 07/08	SCALE 1"=5'





T-306 LEGEND

AfuT	Artificial fill - undocumented (trench backfill): Silty sand, olive (5Y 5/4 to 5Y 5/6), dry, loose; porous, trace subangular, pebble-sized clasts
Qcol	Quaternary colluvium: Silty sand, light yellowish brown (10YR 6/4), dry, loose; porous
Qafy	Quaternary alluvial fan deposits - younger: Silty sand, olive (5Y 5/4), dry, loose to medium dense; trace subrounded to subangular, pebble-sized clasts
Qsw	Quaternary slopewash: Silty sand, very pale brown (10YR 8/4 to 10YR 7/3), dry, loose; locally abundant subangular, pebble-sized clasts
Qafo2	Quaternary alluvial fan deposits - older (proximal): Silty sand, reddish yellow (7.5YR 6/6 [dry]) dry to strong brown (7.5YR 5/6 [moist]) moist, dry to saturated, dense; trace to locally abundant subrounded, pebble- to cobble-sized clasts
Qafo1	Quaternary alluvial fan deposits - older (distal): Silty sand with minor clay, brown (7.5YR 5/4 to 7.5YR 4/4), moist, dense; rarely occurring subrounded, pebble-sized clasts
TtpD	Tertiary "Granodiorite of Telegraph Peak": Biotite dacite dike, olive gray to light greenish gray; fine grained to aphanitic, partially porphyritic with phenocrysts of biotite
Ttp	Tertiary "Granodiorite of Telegraph Peak": Biotite granodiorite, olive gray, dry, dense; coarse grained, moderately fractured

0 5 10 20

Scale Feet

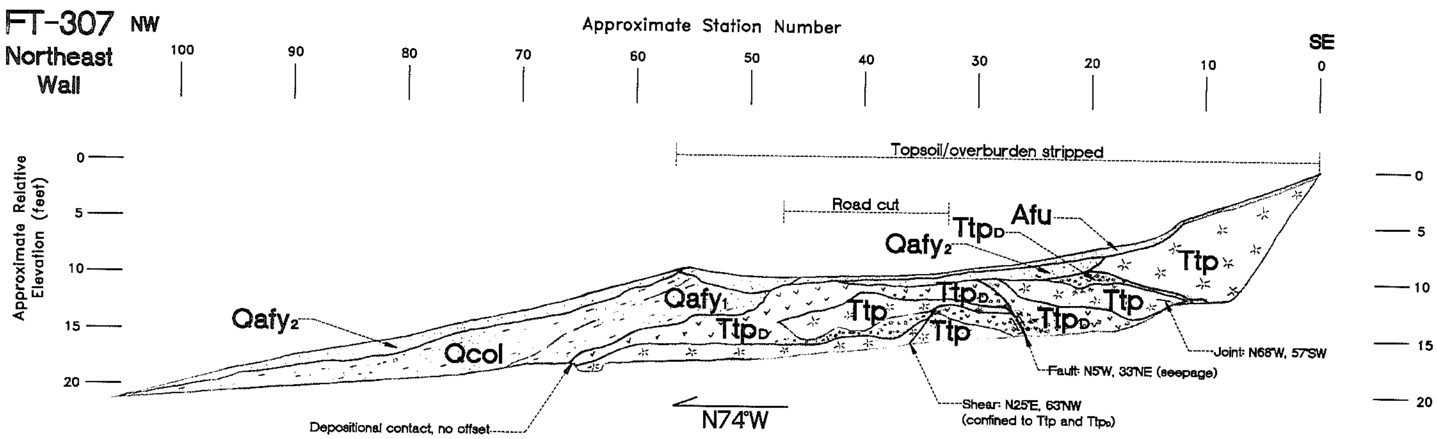
ALL LOCATIONS, STATION NUMBERS, AND DEPTHS ARE APPROXIMATE

GeoSoils, Inc. RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.

FAULT TRENCH LOG FT-306

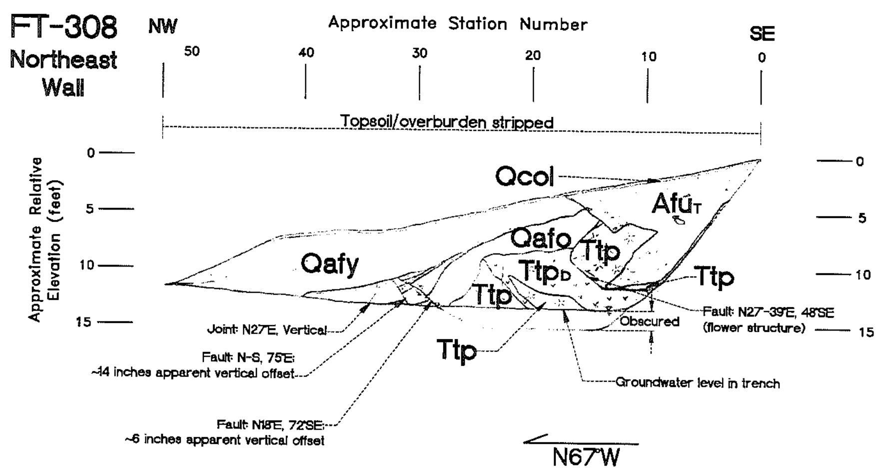
Plate 7 of 9

W.O. 5278-A1-SC	DATE 07/08	SCALE 1"=5'



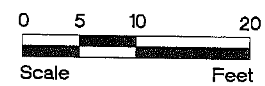
T-307 LEGEND

Afu	Artificial fill - undocumented: Silty Sand, pale brown (10YR 6/3) to brownish yellow (10YR 6/6), dry, loose; trace angular pebble-sized clasts
$Qafy_2$	Quaternary alluvial fan deposits - younger: Sand with silt, very pale brown (10YR 7/3), dry, loose; rare weak beds
Qcol	Quaternary colluvium: Silty sand, black (10YR 2/1), dry medium dense; trace organics, trace subrounded pebble-sized clasts
$Qafy_1$	Quaternary alluvial fan deposits - young: Silty to clayey sand, brown (10YR 5/3) to brown (7.5YR 5/4), dry, dense; thickly bedded to massive
Ttp_D	Tertiary "Granodiorite of Telegraph Peak": Biotite dacite dike, olive gray to light greenish gray (moderately weathered) to olive yellow (highly weathered and oxidized), fine grained to aphanitic, partially porphyritic with phenocrysts of biotite, highly fractured
Ttp	Tertiary "Granodiorite of Telegraph Peak": Granodiorite, olive gray, coarse grained, moderately fractured



T-308 LEGEND

Qcol	Quaternary colluvium: Sandy silt to silty sand, dark gray (10YR 4/1), dry, soft/loose; porous
Afu_T	Artificial fill - undocumented (trench backfill): Silty sand, very pale brown (10YR 7/4), dry to saturated, loose; abundant subangular to subrounded pebble- to cobble-sized clasts
Qafy	Quaternary alluvial fan deposits - younger: Silty sand, light yellowish brown (10YR 6/4), dry, loose to medium dense; trace to locally abundant pebble- to cobble-sized clasts
Qafo	Quaternary alluvial fan deposits - older: Silty sand, pink (7.5YR 7/3) to very pale brown (10YR 7/3), dry to damp, dense; trace subrounded to subangular, pebble-sized clasts
Ttp_D	Tertiary "Granodiorite of Telegraph Peak": Biotite dacite dike, gray (unweathered) to olive yellow (weathered), dry to damp, dense; locally highly fractured
Ttp	Tertiary "Granodiorite of Telegraph Peak": Biotite granodiorite, light olive brown to light gray, dry, dense; massive, coarse grained



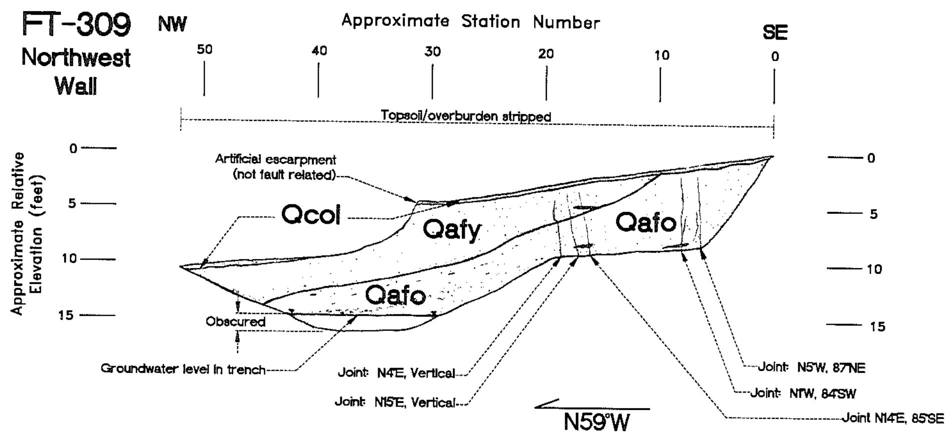
ALL LOCATIONS, STATION NUMBERS, AND DEPTHS ARE APPROXIMATE

GeoSoils, Inc. — RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.

FAULT TRENCH LOGS FT-307 AND FT-308

Plate 8 of 9

W.O. 5278-A1-SC	DATE 07/08	SCALE 1"=5'

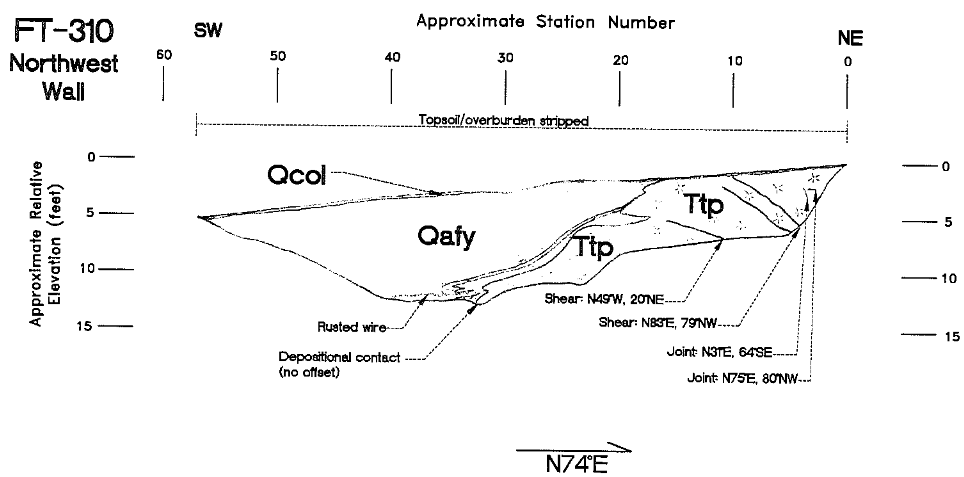


T-309 LEGEND

Qcol Quaternary colluvium: Sandy silt to silty sand, very dark grey (10YR 3/1), dry, soft/loose; porous

Qafy Quaternary alluvial fan deposits - younger: Sand to silty sand, very pale brown (10YR 8/4), dry, loose to medium dense; fine to coarse grained; locally abundant subrounded, pebble-sized clasts

Qafo Quaternary alluvial fan deposits - older: Silty sand, reddish brown (7.5YR 6/6), dry to damp, dense; trace to locally abundant, subrounded, pebble- to cobble-sized clasts; thickly bedded; trace sand and gravel lenses

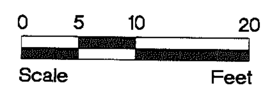


T-310 LEGEND

Qcol Quaternary colluvium: Silty sand, light yellowish brown (10YR 6/4), dry, loose; porous

Qafy Quaternary alluvial fan deposits - younger: silty sand, pale brown (10YR 6/3) to light brown (2.5YR 7/2) to yellowish brown (10YR 5/4), dry to damp, loose to medium stiff; trace subangular to subrounded pebble- to cobble-sized clasts

Ttp Tertiary "Granodiorite of Telegraph Peak": Biotite granodiorite, very pale brown to dark yellowish brown, dry, medium dense to dense; highly weathered, coarse grained, moderately fractured



ALL LOCATIONS, STATION NUMBERS, AND DEPTHS ARE APPROXIMATE

GeoSoils, Inc. — RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.

FAULT TRENCH LOGS
FT-309 AND FT-310

Plate 9 of 9

W.O. 5278-A1-SC	DATE 07/08	SCALE 1"=5'

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Appendix III-A-D

GeoSoils, Inc.
EIR Level Geotechnical Review
Lytle Creek Ranch Land Use Plan
City of Rialto
San Bernardino County, California
May 22, 2008

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EIR LEVEL GEOTECHNICAL REVIEW
LYTLE CREEK RANCH LAND USE PLAN, CITY OF RIALTO
SAN BERNARDINO COUNTY, CALIFORNIA

FOR

LYTLE DEVELOPMENT COMPANY
3281 E. GUASTI ROAD, SUITE 330
ONTARIO, CALIFORNIA 91761

W.O. 5049-A3-SC MAY 22, 2008

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GeoSoils, Inc.
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26590 Madison Avenue • Murrieta, California 92562 • (951) 677-9651 • FAX (951) 677-9301

May 22, 2008

W.O. 5049-A3-SC

Lytle Development Company
3281 E. Guasti Road, Suite 330
Ontario, California 91761

Attention: Mr. Ron Pharris and Mr. Jan Dabney

Subject: EIR Level Geotechnical Review, Lytle Creek Ranch Land Use Plan, City of Rialto, San Bernardino County, California

Dear Mr. Pharris and Mr. Dabney:

In accordance with your request and authorization, GeoSoils, Inc. (GSI) is providing this report that summarizes previous geologic and geotechnical studies, including fault investigation data by GSI and other geotechnical/geologic firms. The purpose of this review was to summarize previous preliminary studies, and generally evaluate the effects of the onsite soils and geologic conditions on the proposed land use and development, from a geotechnical viewpoint. Once actual locations of the proposed structures and infrastructure have been finalized, additional geologic or geotechnical investigations will likely be required to address site specific geologic and geotechnical conditions, so that appropriate mitigation can be provided.

Pertinent data from prior geologic, geotechnical, fault investigations, and other relevant reports have been summarized in this report, and are listed in Appendix A (see References). An executive summary of site conditions is provided below:

EXECUTIVE SUMMARY

Based on our previous and current field exploration, laboratory testing, our engineering and geologic analyses, and review of background information (see Appendix A), it is GSI's opinion that the overall project is compatible and favorable with respect to the geologic constraints onsite, from a geologic and geotechnical viewpoint, provided our recommendations are properly incorporated in the planning, design, grading, and construction considerations. The geologic hazards on the site are indicated on Exhibit 1 (Index Map), and Plates 1 through 4, included herein.

1. Active faulting has been identified by GSI (1994, 1999b, 2006a, 2007a, and the in-progress investigation within PA 8), Gary S. Rasmussen and Associates, Inc. ([GSRA], 1980, 1982a, 1982b, 1994a, and 1994b), and LOR Geotechnical Group, Inc. (LOR, 1994b) within the Lytle Creek Ranch project area. Setbacks for structures for human occupancy are therefore warranted. Setback zones are also warranted for portions of the site, located within, or adjacent to Alquist-Priolo Earthquake Fault Zones (APEFZ) where subsurface investigation was limited due to existing infrastructure (roads and underground utilities), or was not performed due to proposed land use. Setback zones are indicated on Plates 1 through 4.

2. Active faults, identified in GSI (2006a), project toward residential PA 98 and Open Space/Recreational PA's 95 and 97 (Neighborhood II). Additional investigation in PA 98 is recommended to evaluate residential development constraints due to potential, active faulting. Similarly, additional investigation in Open Space/Recreational PA's 95 and 97 (Neighborhood II) is recommended to evaluate development constraints due to potential, active faulting, should structures for human occupancy (i.e., golf course, clubhouse, community centers, etc.) be proposed in those areas.

3. With the exception of the aforementioned areas, our review of available data and literature, subsurface investigations, and soil stratigraphy indicates that active faults likely do not exist within the remainder of the property, or are not sufficiently active or well-defined to satisfy Alquist-Priolo criteria for an active fault, or exist in areas that are not proposed for human occupancy (open space). Further, such hypothetical faults would have far less recurrence than typical activity associated with the San Jacinto fault zone (SJFZ) and should have such small, cumulative displacements that they should be effectively mitigated by engineering design, engineering design includes the use of post-tension foundations/structural slabs, and overexcavation. Evidence of faulting associated with the previously mapped onsite groundwater barriers was not observed on the site, in the field, or on the aerial photographs reviewed.

4. The site is in an area of potentially high seismic activity and horizontal seismic accelerations are anticipated to be near 1g, should the design earthquake occur. Accordingly, there is a potential for more onerous, near-field seismic effects (based on the type and size of the seismic source, distance, and geological aspects), and therefore appropriate mitigation, should be provided based on site specific geotechnical investigations.

5. Ground lurching or deformation and/or tectonic subsidence or uplift at the site as a result of seismic activity should be inherently mitigated by the recommended setback zones, and by typical engineering design/mitigation.

6. Major underground or above-ground utility lines should cross active faults at high angles approaching perpendicular. Cut-off valves should be located on either sides of active fault zones to facilitate repair.

7. Historical well water data for near-site wells indicate that regional groundwater levels have significantly fluctuated in the past, depending upon the amount of up-gradient precipitation. High groundwater stands and artesian conditions have been recorded within parts of the El Rancho Verde Golf Course area of Neighborhood II. Historic groundwater levels in a well near Neighborhood II, ranged from 25 and 171 feet deep between the years 1928 and 2000. Historic groundwater depths in a well near Neighborhood III between January and July 1992 fluctuated between 237 and 267 feet. Historic groundwater records in a well near Neighborhoods I and IV indicated that groundwater levels alternated between ±19 and ±108 feet between 1919 and 2000. Seeps and standing water, likely perched groundwater, were encountered in previous subsurface explorations at the site. During GSI's most recent fault investigation, localized perched groundwater was encountered within younger alluvial areas in PA 8 (Sycamore Flat) of Neighborhood I at depths as shallow as about 8½ feet. Elsewhere within PA 8, perched groundwater was encountered along discontinuities in the bedrock and older fan deposits, or along unconformable contacts with permeability contrasts (i.e., relatively permeable sediments underlain by aquitards).

   Accordingly, the use of subdrains in canyon areas, or within fill lots underlain by bedrock is recommended. Additional subdrains may be required during or after grading. Subdrain outlets should be reviewed by the project design engineer to mitigate the effects of discharge, scouring, and erosion. Further, the design of foundations should consider the potential for perched water conditions (i.e., lower water/cement ratio, more onerous slab underlayment and thickness, thicker vapor retarder, etc.). Thickened edges and cut-off walls for improvements adjoining landscaping areas may be necessary. Grading in areas of high groundwater will need to consider the time of year construction is performed, and the need for drying-back of excavated materials to be placed as compacted fill and/or mixing of such wet/saturated soils with drier materials. The need for dewatering to facilitate remedial removals cannot be entirely precluded in areas of PA 8 underlain by young alluvial fan deposits, and perhaps elsewhere.

8. GSI evaluated the potential for liquefaction to occur at a proposed school site in Neighborhood III. However, this evaluation pre-dates Special Publication 117 (CDMG, 1997), which provides currently accepted guidelines for evaluating liquefaction. Further, GSI observed paleoliquefaction in older, alluvial deposits in Neighborhood II during field work in preparation of GSI (2006a) and in mid-Holocene and younger, alluvial deposits within the Sycamore Canyon area of Neighborhood I during field work in preparation of GSI (2007a). Additionally, GSI (1999b) reports that paleoliquefaction features may have been mis-identified as faults by LOR (1994b) within the Sycamore Flat area of Neighborhood I. Thus, it is

recommended that site-specific, liquefaction analyses be performed within the overall project area. Depending upon the magnitude of liquefaction-induced settlement, engineered foundation design and/or ground-improvement techniques are considered acceptable mitigation measures of this potential condition.

9. The potential for settlement and differential settlement should be further evaluated with respect to the tolerance of proposed improvements to be affected by such, based on site-specific geotechnical studies. Depending on the results of those investigations, deep foundations may be required in areas with a high potential for liquefaction, differential settlement, or where heavy building loads are proposed. Differential settlement may be further reduced by laying-back subsurface bedrock geometry, so that the gradient below the pads is no steeper than 3:1 (h:v), keeping the thickness of fill relatively uniform, and compacting the fill to 95 percent of the laboratory standard. Typical standards of practice and industry guidelines require fills thicker than 50 feet in depth (plan and remedial), to be placed at 95 percent of the laboratory standard.

10. Subsidence should be inherently mitigated by the recommended setback zones. If improvements are proposed within setback areas, or structures for human occupancy are proposed in open space/recreation areas, this potential may need to be further evaluated by additional geotechnical investigations. Mitigation may include open space use, improvements that are not settlement sensitive, habitat corridors, etc.

11. Some of the soils on the project are considered erosive, and localized areas of slope failures have occurred onsite, primarily in Neighborhood I. Portions of Neighborhood I also have an elevated potential for rockfall from adjoining highland areas. Additionally, some cut slopes in Neighborhood I exhibit relatively cohesionless sediments. Accordingly, site-specific geotechnical studies and slope stability analyses should be performed on significant fill, cut, and natural slopes, once grading plans have been prepared. Mitigation of such conditions, identified above, may include one or a combination of the following: buttress or stabilization fills with appropriate factors-of-safety (including placing compacted non-structural fill against existing slopes subject to erosion/failure); retaining walls with sufficient freeboard to contain the failed materials; elevating pads sufficiently that they are not significantly impacted by the failed soils; constructing berms or gabions to protect pads from surficial failures or rockfall; or rock bolting. Other methods of mitigation would need to be evaluated on a case-by-case basis.

12. The potential for ridge-top shattering is elevated in portions of Neighborhood I. Site-specific geotechnical investigations will be required to identify where mitigation should be performed. Mitigation measures may include a compacted fill blanket (overexcavation), and engineering design, incorporating post-tension/structural slabs, mat, or deep foundations.

13. The project civil consultant should evaluate the potential for down-gradient flooding due to precipitation runoff or regional debris flows and/or catastrophic failure of any critical structures (flood-control levees, water tanks, and aqueducts), that may occur as a result of seismic activity.

14. The potential for seiching (and associated down-gradient flooding) in planned lakes should be performed when the location, and side and bottom configuration of the lakes become available. This potential should also be evaluated for any existing lakes that are to remain after construction, if located up-gradient or adjacent to any proposed construction.

15. As indicated above, site-specific preliminary geotechnical studies will be necessary for future development considerations. Such studies will need to address specific onsite geotechnical conditions including, but not limited to: remedial removal depths, foundation designs, slope stability, liquefaction, settlement, and soil and bedrock engineering properties based on subsurface sampling, associated laboratory testing, and engineering analyses, etc.

16. Adverse geologic structures that would preclude overall project feasibility were not encountered.

17. The recommendations presented in this report should be incorporated into the planning, design, grading, and construction considerations of the project.

The opportunity to be of service is sincerely appreciated. If you should have any questions, please do not hesitate to contact our office.

Respectfully submitted,

GeoSoils, Inc.

John P. Franklin
Engineering Geologist, CEG 1340

David W. Skelly
Civil Engineer, RCE 47857

Paul L. McClay
Engineering Geologist, CEG 1117

RB/PLM/JPF/DWS/jh

Distribution: (6) Addressee (wet signed)

TABLE OF CONTENTS

FIGURES:

ATTACHMENTS:

EIR LEVEL GEOTECHNICAL REVIEW
LYTLE CREEK RANCH LAND USE PLAN, CITY OF RIALTO
SAN BERNARDINO COUNTY, CALIFORNIA

SCOPE OF WORK

The scope of our previous and current services has included the following:

1. Review of available geologic data for the area (Appendix A) including stereoscopic "false-color" infrared and black-and-white aerial photographs, and associated lineament analyses.

2. Geologic and geomorphic site reconnaissance.

3. Subsurface exploration (GSI; 1994, 1999b, 2006a, 2007a, and in-progress), consisting of the geologic logging of approximately 19,840 linear feet of existing exposures in the open-pit mines, 39 fault-finding/dating and/or locating trenches totaling approximately 12,028 linear feet, and one geomorphic calibration test pit, at the site or in the site's vicinity.

4. Geologic analysis (GSI, 1994) of nine unpublished, fault-finding/dating trenches previously excavated in Planning Area (PA) 8 by Eberhart & Stone (E&S). These trenches totaled approximately 2,775 linear feet. Subsequently, GSI excavated and logged four calibration trenches totaling approximately 785 linear feet, adjacent to the pertinent E&S trenches.

5. Excavation of 30 test pits for geotechnical sampling and evaluation on the adjacent Tract 15900 (GSI, 1999a).

6. Field meetings and reviewing site geologic and geomorphic conditions with Dr. Roy J. Shlemon, who provided written reports of his findings in GSI (1994, 1999a, 2003, 2006a, and 2007a), and is consulting with GSI on our most current investigation.

7. Collection and radio-carbon age dating of representative alluvial samples containing carbon during our previous subsurface exploration programs (GSI, 1994 and 2007a).

8. Deterministic, historical, and probabilistic seismic analyses (Appendix B).

9. Liquefaction and slope stability analyses (GSI; 1997, 1999a, and 2003).

10. Geomorphic, geologic and engineering analysis of the data collected.

11. Preparation of this report and accompaniments.

SITE DESCRIPTION

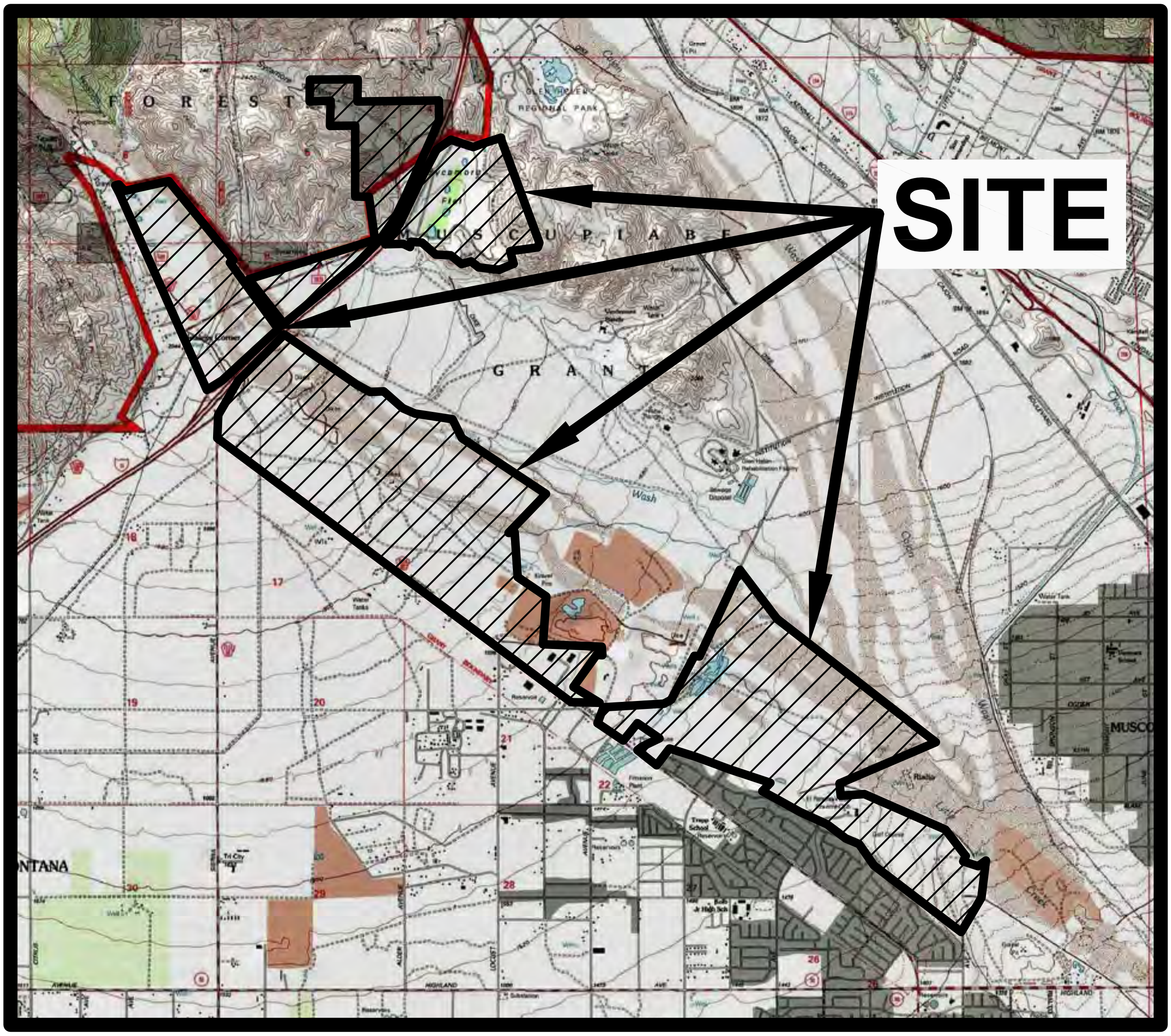
The Lytle Creek Ranch project area consists of an irregular group of parcels totaling some ±2,447.3 acres in the Rialto area of San Bernardino County, California (see the Site Location Map, Figure 1). The majority of the project area occupies the coalescing, outwash areas of Lytle Creek Wash and Sycamore Canyon Wash, as they flow out of the San Gabriel Mountains toward Rialto, at about a 2 to 4 percent slope. The Ranch includes areas both northwest and southeast of Interstate Highway 15, including the Sycamore Canyon and Sycamore Flat areas in the site's most northern extent. Gas, electric, and water utilities traverse portions of the site, and are associated with maintained and un-maintained roads. An active sand and gravel quarry, and a clay products company with 70- to perhaps 100-foot deep, open-pit mines, are located north of Riverside Avenue between proposed Neighborhoods II and III. Flood control devices were noted adjoining PA's 33, 34, 35, 40, 41, 44, 54, 58, 59, 60, 61, 62, 63, 64, 67, 95, and 99. Water wells are also located throughout the overall project area.

In general, most of the project area gently slopes to the southeast. Thus, overall drainage of the entire project area is directed to the southeast. The northern highland area (i.e., proposed Neighborhood I) consists of a relatively flat area bounded by rolling to relatively steep hills, Lower Lytle Creek Ridge-Verdemont Hills to the north and east, and Penstock Ridge to the west. These hills generally have gradients of about 1.5:1 horizontal:vertical (h:v), or flatter, although localized areas are steeper, approaching vertical. A portion of PA 8 within Neighborhood I, has been used as a borrow area during grading for an adjoining tract. Cut slopes, at inclinations of about 2:1 (h:v) exist on the west and east sides of the borrow area, ranging up to about 56 feet in overall height. Near the margins of Lytle Creek Wash, which transects the site in a southeastern direction, berms and flood control levees and facilities exist in the vicinity of Neighborhoods II, III and IV.

Topographically, site elevations range from about 2,330 feet Mean Sea Level (MSL) in the extreme northwestern Sycamore Canyon area, to about 1,355 feet MSL near the southeastern property boundary of the El Rancho Verde Golf Course, for an overall relief of about 975 feet. The project area is vegetated with a light to moderate growth of weeds, grasses, and bushes, with a few trees. Site drainage is generally by sheetflow directed into tributary canyons in the highland area that eventually discharge into the Lytle Creek drainage corridor via ephemeral drainage channels.

PROPOSED DEVELOPMENT

According to the land use plan by KTGY Group, Inc. (KTGY, 2008), the Lytle Creek Ranch project is a master-planned community consisting of single- and multi-family residential and mixed-use development with numerous open space/recreation areas and two school sites. Portions of the current project area are proposed to remain essentially natural for drainage considerations. Interior roadways and associated utility improvements are also proposed.



Base Map: TOPO!® ©2003 National Geographic, U.S.G.S Devore Quadrangle (dated 1996, current 1996) and San Bernardino North Quadrangle (dated 1996, current 1996), California -- San Bernardino, 7.5 Minute.

5000 0 5000

Scale Feet

N

GeoSoils, Inc.	W.O. 5049-A3-SC

SITE LOCATION MAP

Figure 1

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KTGY (2008) indicates that a total of 8,407 dwellings are to be constructed at the site. The quantity of proposed, commercial structures is unknown at this time. Although grading plans have not been reviewed by GSI, it is expected that typical cut and fill grading would prepare the site for construction of the proposed residential, commercial, open space/recreation, and infrastructure improvements. Excepting Neighborhood I, it is our understanding that most proposed cut and fill slope heights, and plan maximum cut and/or fill thicknesses are currently anticipated to range up to about 30 feet, or less, with slope gradients of 2:1 (h:v), or flatter. Within Neighborhood I, GSI understands that plan maximum thicknesses ranging up to about 42 and 52 feet for cut and fill, respectively, are proposed. Similarly, within Neighborhood I, maximum 2:1 (h:v) slope heights are proposed to about 70 and 90 feet, respectively, for cut and fill slopes. Actual cut and fill heights and thickness would best be determined based on a 40- or 100-scale grading plan review.

It is our understanding that the proposed buildings would generally be one- and/or two-story structures, utilizing typical wood-frame or tilt-up construction with concrete slabs-on-grade. Building loads are assumed to be typical for this type of relatively light construction. If heavy, commercial building loads are proposed, foundation design will change accordingly, and deep foundations may be necessary. Sewage disposal is assumed to be accommodated by tying into the regional municipal system. The need for import soils is unknown at this time.

REGIONAL GEOLOGIC SETTING

General

Excepting the Sycamore Canyon and northern areas of Neighborhood I, as well as Neighborhood IV, most of the project area is located at the northeastern end of the Perris block of the Peninsular Ranges Geomorphic Province. The aforementioned Sycamore Canyon and adjoining area of Neighborhood I, and Neighborhood IV, are generally considered to be located within the Transverse Ranges Geomorphic Province. These geomorphic provinces and their corresponding basement-rock assemblages (bedrock) are generally described in the following sections. A regional geologic map, modified from Morton and Matti (2001) and Miller, *et al.* (2001) is provided as Figure 2.

The Peninsular Ranges Geomorphic Province is characterized by northwest-trending, steep, elongated ranges and valleys (Norris and Webb, 1990), whereas the Transverse Ranges Geomorphic Province is characterized by a conspicuous east-west alignment of steep mountain ranges and valleys that contrast in trend, to most mountain ranges in North America (Norris and Webb, 1990). The Perris block is part of the Peninsular Ranges and is considered to be a relatively stable structural block lying between the Elsinore and San Jacinto fault zones (Morton and Matti, 2005), which are considered part of the San Andreas Transform Fault system. Within the Perris block, Dibblee (1982) considered part of the site to be located within the Cucamonga block, a smaller area with somewhat different characteristics, that generally encompasses the northwest portion of Neighborhood I, and Neighborhood IV. Cramer and Harrington (1987) indicated that the movements of the Cucamonga block are aligned with the Peninsular Ranges Geomorphic Province, which is apparently being forced northward into the Transverse Ranges by plate tectonic motion causing the northern edge of the province to be thrust under the San Gabriel Mountains.

Basement Rocks

Basement rocks in the vicinity of the site include those of the Peninsular Ranges, San Gabriel Mountains, and San Bernardino Mountains types. These rocks vary in composition, age, and deformational styles.

Matti and Morton (1993) describe basement rocks of the Peninsular Ranges as Jurassic and Cretaceous granitoid rocks (granodiorite, quartz diorite, tonalite, gabbro) that have intruded prebatholithic, metasedimentary rocks (pelitic schist, metaquartzite, marble, quartzofeldspathic gneiss, and schist).

Basement rocks of the San Gabriel Mountains consist of an eastward-elongated, parallelogram-shaped area of crystalline basement rocks. As discussed by Matti, *et al.* (1992), basement rocks of the San Gabriel Mountains type include two crustal layers separated by the Vincent thrust fault. The upper plate contains Mesozoic plutons of various compositions, ages, and deformational styles that have intruded prebatholithic, crystalline rocks; whereas, the lower plate of the Vincent thrust consists of the Pelona Schist (late Mesozoic quartzofeldspathic sandstone and siltstone, limestone, quartzite, chert, and mafic volcanic rocks) that have been metamorphosed to greenschist and lower amphibolite facies.

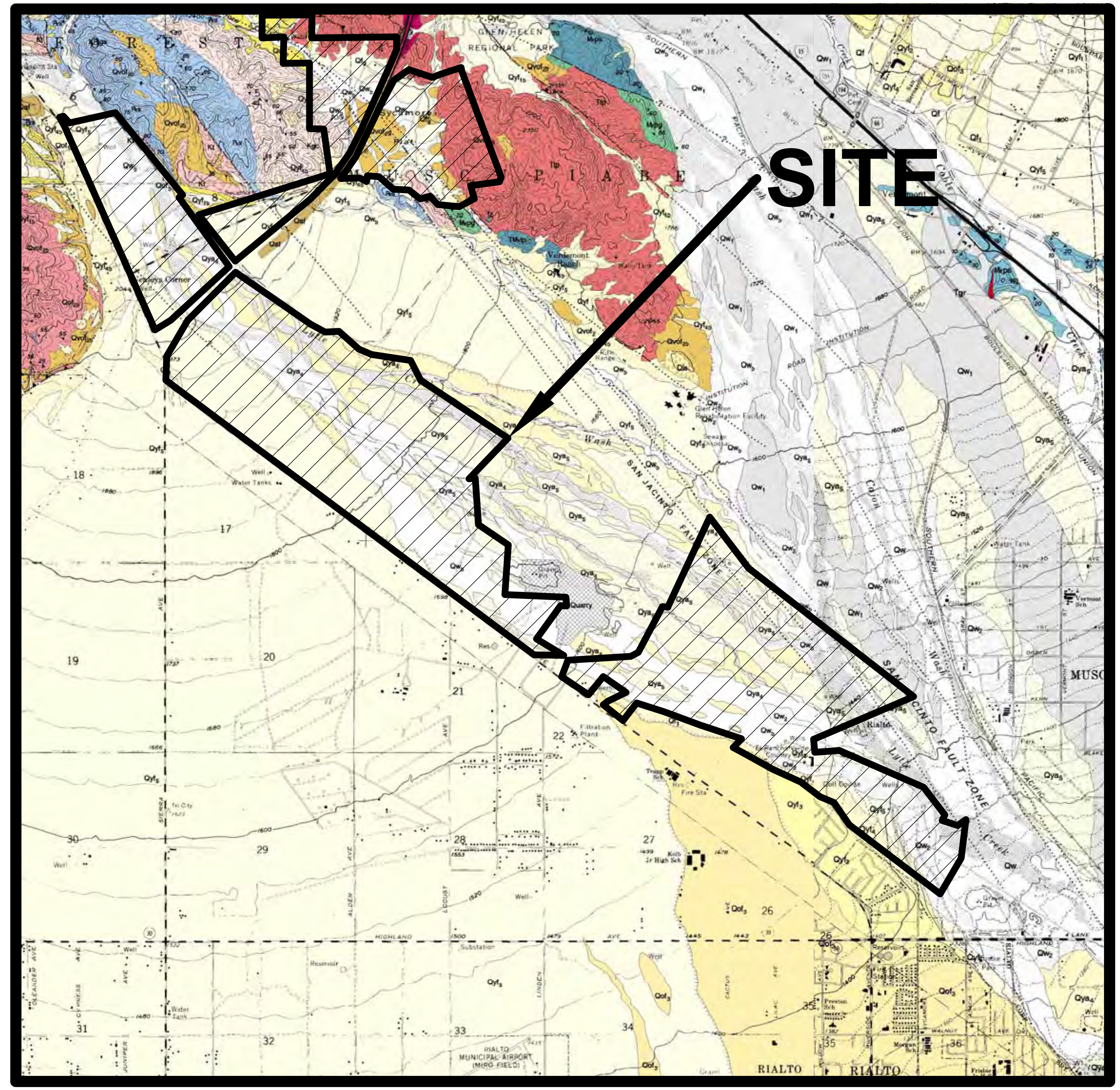
Basement rocks of the San Bernardino Mountains type are similar to those in the Mojave Desert Geomorphic Province: mainly Triassic through Cretaceous granitoid rocks of various compositions that have intruded prebatholithic orthogneiss and metasedimentary rocks.

Surficial Rocks

Tectonic forces that initiated the regional uplift of the San Gabrial Mountains are thought to have started in the late Cenozoic time, and continue today (Norris and Webb, 1990). Prominent alluvial fans occur on the range's southern flank, forming a nearly continuous coalescing alluvial apron (bajada), from Pasadena to Cajon Pass. In the project region, the Santa Ana River Valley is shaped by at least two of these coalescing alluvial fans, including the Lytle Creek Wash and Sycamore Canyon Wash, that have a range of ages coincident with the rise of the San Gabriel Mountains and climatic events. These geologically young sediments are underlain by older alluvial fan deposits, and at great depth, by crystalline bedrock similar to that exposed in the nearby mountains. Scattered, slightly elevated remnants of the older fans are locally exposed at the surface where they have not been

LEGEND

Symbol	Description
Qw	Quaternary modern wash deposits
Qw_2	Quaternary modern wash deposits - Unit 2
Qf	Quaternary modern alluvial-fan deposits
Qf_1	Quaternary modern alluvial-fan deposits - Unit 1
Qyf_5	Quaternary alluvial-fan deposits - Unit 5
Qyf_4	Quaternary young alluvial-fan deposits - Unit 4
Qyf_3	Quaternary young alluvial-fan deposits - Unit 3
Qya_5	Quaternary alluvial-valley deposits - Unit 5
Qya_4	Quaternary alluvial-valley deposits - Unit 4
Qyls	Quaternary young landslide deposits
Qof	Quaternary old alluvial-fan deposits
Qof_3	Quaternary old alluvial-fan deposits - Unit 3
$Qvof_2$	Quaternary very old alluvial-fan deposits - Unit 2
Ttp	Tertiary Granodiorite of Telegraph Peak
Mzpg	Mesozoic greenstone
Kgm	Cretaceous leucocratic muscovite monzogranite
Kgc	Cretaceous mylonitic leucogranite
Pzs	Paleozoic Pelona schist
———— — — ?··········	Contact -- solid where accurately located, dashed where approximately located, dotted where concealed, queried where inferral



N

0 1 2
Scale Feet

From Morton and Matti (2001) and Miller, et al. (2001)

GeoSoils, Inc.

RIVERSIDE CO.
ORANGE CO.
SAN DIEGO CO.

REGIONAL GEOLOGIC MAP

Figure 2

W.O. 5049-A3-SC | DATE 05/08 | SCALE Bar Scale

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buried by the younger sediments and/or they have been uplifted by bounding faults. Sediment transport and deposition now takes place largely within Lytle Creek Wash, with a lessor component from Sycamore Canyon Wash.

TECTONIC FRAMEWORK

The San Andreas Fault Zone

The proposed Lytle Creek Ranch development lies within the San Jacinto fault zone (SJFZ), a major active component of the San Andreas fault system. The San Andreas fault zone (SAFZ) extends into California at Point Arena, north of San Francisco, southeast through and along the Coast Ranges to the Transverse Ranges, where it bends obliquely across the Cajon Pass-San Gorgonio Pass region. Southward, north and south branches along with the Banning fault diverge southeast into the Salton trough (Sharp, 1975).

The SAFZ is relatively straight and continuous throughout much of its length in California, and these characteristics are hallmarks of steeply dipping strike-slip faults throughout the world. The San Jacinto fault, part of the San Andreas transform-fault system, trends southeastward to the Gulf of California from the nearby Cajon Pass area (Crowell, 1975). Matching displaced rocks on the sides of the combined faults indicate that right slip began in the Miocene about 12 million years ago. Other studies (Matti, *et al.*, 1992) indicate the inception of the modern San Andreas fault occurred 4 or 5 million years ago in latest Miocene to early Pliocene time. Movement on the SAFZ continues to the present.

In southern California, the total displacement along the SAFZ is taken up by several discrete fault strands, including the San Andreas, San Jacinto, Punchbowl, San Gabriel, and Banning faults, as well as other structures (Matti and Morton, 1993). The average slip rate on the SAFZ in the general region has been about 15 mm/yr. In contrast, the southern branch (Coachella segment) of the SAFZ has an average slip rate of 23 to 35 mm/yr near Indio, and 5 to 14 mm/yr on the southern-most SAFZ (Keller, *et al.*, 1982; Shifflett, *et al.*, 2002). More recently, the 2007 Working Group on California Earthquake Probabilities, ([2007 WGCEP] 2008) indicates that the Coachella and Mojave segments have an average slip rate of about 20 mm/yr and 27-29 mm/yr, respectively.

The California Geological Survey (CGS, 1996 and 2002) judged the slip rate on the San Bernardino segment of the San Andreas fault, near the site, was about 24 mm/yr. Recently, the United States Geological Survey (USGS) and CGS (2007 WGCEP, 2008), indicate that the slip rate has averaged about 22 mm/yr. Recurrence intervals for the San Bernardino segment for large earthquakes of about ~M6.7 to M8.0 generating surface rupture ranging from about 433 years (CGS, 1996), to about 175 years (2007 WGCEP, 2008). Historical records do not specifically indicate any ~M7.0 to M8.0 earthquakes on this strand.

San Jacinto Fault Zone

The San Jacinto fault zone (SJFZ) forms several en-echelon faults among its member strands. The Glen Helen-Claremont and Claremont-Casa Loma fault pairs probably define zones of shallow crustal extension or elongation beneath San Bernardino and San Jacinto, respectively (Sharp, 1975).

The Claremont fault is clearly the dominant trace of the SJFZ immediately southeast of San Bernardino Valley. At the north edge of the valley, the zone includes two major strands, one nearly on line with the Claremont fault, and the other, called the Glen Helen fault (Sharp, 1975). Between the San Jacinto Valley and the San Gabriel Mountains, the SJFZ traverses Quaternary alluvial units and sedimentary rocks. The Glen Helen fault has scarps and sag ponds in young Holocene alluvium at the northern edge of the valley whereas, the Claremont fault does not. This suggests that transfer of displacement by crustal extension between en-echelon fault pairs might be occurring (Sharp, 1975). This segment, which now is postulated to extend from the San Gabriel Mountains to Anza, is referred to as the Burro Flats section (WGCEP 2007, 2008). In contrast to Sharp (1975), the northern terminus of the Burro Flats section is thought by the WGCEP 2007 to represent where slip transfer occurs between the SJFZ and the SAFZ. Southeast of San Bernardino, the main trace of the SJFZ displaces Quaternary units, but southeast and northwest of this break the youngest floodplain deposits of the Santa Ana River and Cajon and Lytle Creeks are not broken (Matti, *et al.*, 1992).

Matti, *et al.* (1992) indicated the name "San Jacinto" traditionally has been applied to a northwest-oriented fault zone developed in crystalline rocks east of the mouth of Lytle Creek canyon. There, the zone consists of two or more, vertically oriented, closely spaced faults with shear zones in crystalline bedrock up to 300 meters wide. These however, do not displace Quaternary deposits (Morton and Matti, 1987). Eastward, the Glen Helen fault forms scarps and sag ponds in probable Holocene alluvial deposits (Sharp, 1975; Matti and Morton, 1993). To the west, the Lytle Creek fault forms a scarp in latest Pleistocene alluvium (Morton and Matti, 1987). Metzger and Weldon (1983) indicated a late Quaternary right-slip rate of about 2 mm/yr for the Lytle Creek fault. Matti, *et al.* (1992) postulate that the Glen Helen fault is probably the active strand of the SJFZ in the San Gabriel Mountain region.

Morton and Matti (1987) also concluded that the San Jacinto fault cannot be mapped into either the Punchbowl or San Andreas faults; instead, faults attributed to the SJFZ splay into several branches that curve west into the San Gabriel Mountains without joining the San Andreas fault at the surface (Matti, *et al.*, 1992). Matti, *et al.* (1992) proposed that the east- to northeast-oriented Evey Canyon, Icehouse Canyon, and Stoddard Canyon faults are segments of through-going structures that were regionally connected in the past, namely the middle Miocene, left-lateral Malibu Coast-Raymond-Banning fault and the late Miocene San Gabriel-Banning fault. They further believe that these older faults separate rocks of San Gabriel Mountains-type on the west, north, and east from rocks of Peninsular Ranges type on the south. These structures trend essentially eastward until they enter the Lytle

Creek drainage, where they converge and trend southeastward down Lytle Creek Canyon. There, they are represented by the fault zone that occurs east of the mouth of Lytle Creek Canyon. They also concluded that the name "San Jacinto fault" in Lytle Creek Canyon has been applied to an ancient fault zone that has witnessed multiple episodes of strike-slip faulting, only the latest of which can be attributed to the so-called "San Jacinto" that traverses the Peninsular Ranges Province to the southeast (Matti, *et al.*, 1992). Matti and Morton (1993) proposed that the "San Jacinto fault" in Lytle Creek Canyon was once part of the previously discussed middle-Miocene, left-lateral Malibu Coast-Raymond-Banning fault and the late-Miocene San Gabriel-Banning fault. Here these faults shared their sequential left- and right-slip histories, in addition to episodes of Quaternary right slip related to the San Jacinto fault farther south in the Peninsular Ranges.

The "San Jacinto fault zone," where it penetrates the southeastern corner of the San Gabriel Mountains near the mouth of Lytle Creek, consists of three near vertical faults (Matti and Morton, 1993). Soils offset by the Lytle Creek fault are reportedly in the 50,000 to 60,000 years old range (Metzger and Weldon, 1983).

A variety of slip rates have been estimated for the SJFZ. Morton and Matti (1993) inferred ~10 to 20 mm/yr for the Glen Helen and Claremont segments. The Southern California Earthquake Center (SCEC, 2006a) postulate a 7 to 17mm/yr slip rate, and Kendrick, *et al.* (2002) suggested slip may be greater than 20 mm/yr. According to Bennet, *et al.* (2004), San Jacinto fault slip alternates from about 0 to 26 ±4 mm/yr since its inception about 1.5 million years ago; and that the current slip is about 9 ±2 mm/yr. Bennet, *et al.* (2004) also concluded that the change in slip on the San Jacinto fault is matched by an equal and opposite change on the San Andreas fault. The WGCEP 2007 (2008), infers a slip rate of 3-10mm/yr, with a preferred slip rate of 6 mm/yr, for the SJFZ nearest the project.

SCEC (2006a) indicates that surface-rupture recurrence is between 100 and 300 years, per segment, for earthquake magnitudes between M6.5 and M7.5. Kendrick and Fumal (2005) reported recurrence of approximately 100 and 266 years, respectively, for the SJFZ near Colton and San Bernardino, California. The WGCEP 2007 (2008), indicates a recurrence interval ranging from 240 to 410 years, with a preferred return interval of about 325 years for a ±M6.7 earthquake; however, the San Bernardino Valley segment is thought to have an average interval between 132-187 years for earthquakes of such magnitude.

Matti and Morton (1993) point out that the San Andreas system between Cajon Pass and Coachella Valley is characterized by complex fault strand development, by strand switching, and by strand abandonment related to formation of a structural knot in San Gorgonio Pass. Two major structural features resulted from progressive development of the structural knot. For the SAFZ, this is manifested by an apparent lack of a through-going surface fault. The SJFZ is the most recent tectonic feature and simply has bypassed the San Gorgonio knot since its inception about 2.5 to 1.5 ma. In the convergence area between the San Andreas and San Jacinto faults, the Glen Helen fault is the northernmost characteristic of faulting within the SJFZ in the Peninsular Ranges (Matti and Morton, 1993). Contraction and uplift occurring in the eastern San Gabriel Mountains, between the

Cucamonga fault zone (CFZ) and the San Andreas fault, is interpreted as strain accumulation because of slip transfer between the San Jacinto and San Andreas fault zones.

Cucamonga Fault Zone

The Cucamonga fault is discussed for context only. Our review and prior work indicates that the Cucamonga fault is not expressed on the site at, or near, the surface. However, the trend of the Cucamonga fault, and its associated Alquist-Priolo Earthquake Fault Zone (APEFZ) project west to east toward Neighborhoods IV and I, and the ICBO (1998) indicates that portions of Neighborhood I, III, and IV lie with the Cucamonga fault "near-source zone."

The Cucamonga fault defines the southern margin of the eastern San Gabriel Mountains and marks the eastern end of the frontal fault system of the San Gabriel Mountains (Matti and Morton, 1993). The Cucamonga fault is a compressional zone of Quaternary reverse and thrust faults that separates crystalline rocks of the San Gabriel Mountains from alluviated lowlands of the upper Santa Ana River valley (Morton; 1975a, 1975b, 1976a, 1976b; Morton and Matti, 1987), as well as thrust faults entirely within alluvium (Morton and Matti, 1987). The Cucamonga fault zone (CFZ) consists of several anastomosing east-striking and north-dipping thrust faults. Matti and Morton (1993) projected the CFZ down-dip 13 km to merge with the San Andreas fault. They also conclude that the CFZ has been displaced 5 km farther north than the San Gabriel mountain front to the west of San Antonio Canyon.

Geologic investigations and mapping by Morton (1976a and 1976b) show the Cucamonga as a system of fault scarps between Lytle Creek and San Antonio Canyons. Holocene surface rupture has only been established west of Lytle Creek Canyon (Morton and Matti, 1987). Epicenters of microseismic activity do fall near the surface trace of the Cucamonga fault, but their focal depths (6 to 12 km) are too deep for this activity to be on the Cucamonga fault (Cramer and Harrington, 1987). Cramer and Harrington (1987) further conclude that internal deformation is occurring within the Cucamonga block. In the western part, deformation is largely vertical, while in the eastern part, it is largely horizontal shearing under the influence of the San Jacinto fault system. Morton and Matti (1987) suggest that faulting within the CFZ may have migrated southward during late Pleistocene and Holocene time. The average north-south convergence across the CFZ is an estimated 3 mm (Weldon, 1986) to 6 mm/yr (Matti, *et al.*, 1985; Morton and Matti, 1987). The WGCEP 2007 (2008), indicates a slip rate of 5 mm/yr. The Latest episodes of strain release may have occurred mainly in the eastern 15 km of the fault zone and not throughout its entire 25-km length (Matti, *et al.*, 1992).

The intervals between major ruptures are about 600 to 700 years (SCEC, 2006b). Matti, *et al.* (1992) concluded that major earthquakes with vertical displacement of about 2 meters had an average recurrence of about 625 years. Minor or ambiguous evidence of present day seismicity is documented (Morton and Yerkes, 1987).

SUMMARY OF GEOLOGIC AND GEOTECHNICAL INVESTIGATIONS

1. State of California

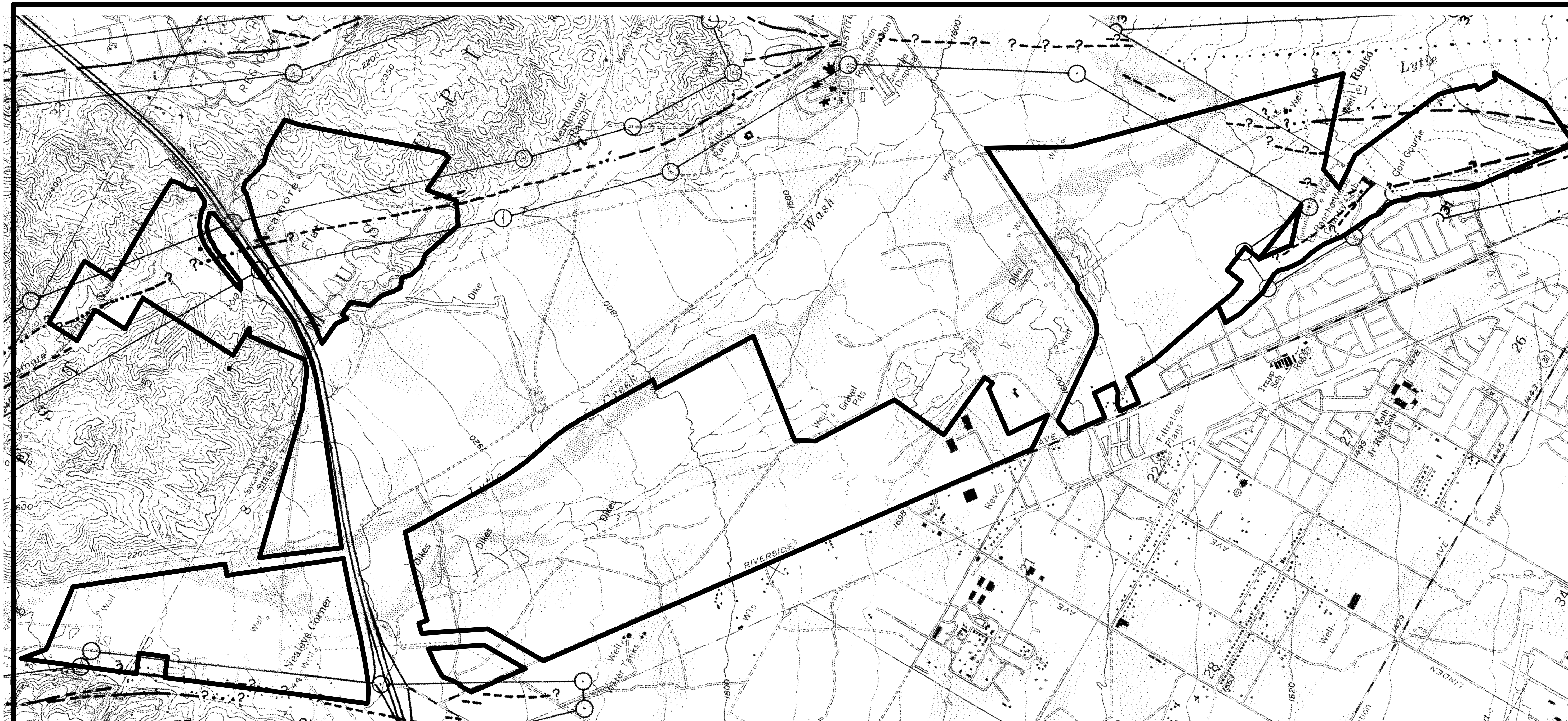
Much of the current project area was previously encompassed by Alquist-Priolo Earthquake Fault Zones (APEFZ), established by the State of California (1974a and 1974b) as shown on the Devore and San Bernardino North 7.5 minute Quadrangles. This included postulated traces of active faults associated with the San Jacinto and Cucamonga fault zones. The Devore 7.5 minute quadrangle was revised in 1995 (State of California, 1995), based in part on fault investigations by Gary S. Rasmussen and Associates, Inc., GeoSoils, Inc. and LOR Geotechnical Group, Inc. (LOR). Figure 3 shows the current APEFZ within the site.

2. Mineral Resource Studies (Cole [1987] and Miller [1987])

As indicated by Cole (1987), and Miller (1987), the site is primarily located within a MRZ-2 zone in the alluvial/alluvial fan areas, and a MRZ-3 zone in the offsite bedrock/highlands area to the north of the site. A MRZ-2 zone is defined as "Areas where adequate information indicates that significant mineral deposits are present or where it is judged that a high likelihood exists for their presence." An MRZ-3 zone is defined as "Areas containing mineral deposits the significance of which cannot be evaluated from available data." In the alluvial/alluvial fan areas of the site, such deposits may be on the order of 80 feet thick (Miller, 1987). MRZ-2 areas are widespread throughout the region.

3. Gary S. Rasmussen and Associates, Inc.

Since 1980, several investigations at the site and adjacent areas have been performed by Gary S. Rasmussen and Associates, Inc. (GSRA). In 1980, 1982, 1993, and 1994, GSRA conducted fault investigations on the El Rancho Verde Golf Course area of Neighborhood II where active splays of the SJFZ were identified in trench exposures. With collective data from GSRA (1980, 1982a, 1982b, 1993, 1994a, and 1994b), setbacks for structures for human occupancy were recommended. GSRA (1994b) concluded that the San Jacinto fault steps west in this area of the site and is "characterized by a complex series of left-stepping en echelon faults and splays accompanied by a wide zone of faulting" with an overall trend of about N30°W. GSRA (1994b) also indicates that the San Jacinto fault may be dying out on the site or its activity rate may be decreasing. The potential for severe seismic shaking, liquefaction, ground lurching (mitigated by recommended setbacks), seismically-induced flooding (should catastrophic failure of the up-gradient, Metropolitan Water District aqueduct occur during an earthquake), seiching, and temporary artesian conditions to occur at the site were also noted in GSRA (1994b). In addition, GSRA (1994b) pointed out that several utilities crossing the San Jacinto fault are vulnerable to breakage and/or deformation owing to surface rupture during a large earthquake on the San Jacinto fault. The report also



Base Map from State of California, 1995; State of California, 1974

LEGEND

Approximate limits of site area

5000 0 5000

Scale Feet

GeoSoils, Inc.

RIVERSIDE CO.
ORANGE CO.
SAN DIEGO CO.

EARTHQUAKE FAULT ZONE MAP

Figure 3

W.O. 5049-A3-SC	DATE 05/08	SCALE 1"=2000'

recommended that utilities should cross fault traces at a high angle in order to minimize the amount of damage, should movement occur.

A preliminary engineering geology investigation for the entire Lytle Creek Ranch project area, including Tract 15900, was previously performed by GSRA in 1988. That study concluded that a large portion of the overall project could be developed if appropriate mitigation were implemented for possible faulting and floods, severe seismic shaking and surface ground rupture. GSRA (1988) also concluded that the potential for liquefaction was low, owing to the coarseness of onsite sediments and depth to groundwater. Additionally, GSRA (1988) recommended subsurface geologic investigations, including trenching of aerial-photographic lineaments.

4. Soil and Testing Engineers, Inc., "Alquist-Priolo Geologic Investigation of Portions of Section 4 and 5, T1N, R5W, Sycamore Flat[s], San Bernardino, California"

Soil and Testing Engineers, Inc. (STE, 1988) studied the geology of the Sycamore Canyon and Sycamore Flat areas of Neighborhood I (STE, 1988). STE excavated 19 exploratory trenches (totaling 4,850 feet in length) to a maximum depth of ±16 feet below existing grades. STE also conducted six seismic traverses within Sycamore Canyon and Sycamore Flat to evaluate possible extensions of the San Jacinto fault identified by the Southern California Gas Company. Although unequivocal evidence of Holocene faulting was apparent in only one of their trenches (T-6), as indicated on graphic logs, STE recommended a "No Human Occupancy Structures" zone based on "sand boil or shear alignment in alluvium being on the main fault trace." According to STE (1988), "exposures in Trench No. 7 were the most definitive with respect to determining the main trace of the fault and secondary-shear features, and permitted determining the width of the San Jacinto Fault Zone on-site." We understand that the County reviewed and rejected the STE (1988) report for it apparently was inadequate to satisfy the APEFZ Act (then referred as the Special Studies Act) and the County guidelines for fault rupture-hazard investigations. Because the STE (1988) report was rejected, GSI did not rely on the data for this review.

5. Eberhart and Stone, Inc., Unpublished Geologic Investigation

As summarized by LOR (1994b), in the spring of 1990, Eberhart and Stone (E&S) investigated faulting on the Sycamore Canyon and Sycamore Flat areas of Neighborhood I by excavating 26 exploratory trenches (totaling approximately 7,700 linear feet), by geologic site mapping, by soil stratigraphy and age-dating analysis, and by a seismic-refraction study. However, owing to a lack of funding, the investigation was halted and abandoned in 1993. Excepting the graphic trench logs for 7 trenches located south of Sycamore Flat that were provided to GSI and published in GSI (1994), E&S's preliminary data were never made available.

6. LOR Geotechnical Group, Inc., "Geologic Fault Investigation, Sycamore Flat[s] Area, San Bernardino County, California"

LOR Geotechnical Group, Inc. (LOR) undertook a third fault investigation of Sycamore Canyon and the adjacent Sycamore Flat area (now included in Neighborhood I) between April and September 1994 in order to satisfy requirements of the Alquist-Priolo Earthquake Fault Zoning Act. LOR was the lead consultant with further technical expertise provided by Terra Geosciences, and Dr. Tom Rockwell (California State University, San Diego; now referred to as San Diego State University). LOR reviewed pertinent publications, reports, and maps; analyzed aerial photographs and lineaments; excavated and logged 18 exploratory trenches up to 31 feet in depth and totaling 8,200 linear feet in length (nine of which are located within Sycamore Canyon); dated soils using soil stratigraphic and radiocarbon age-dating techniques; mapped the site geologically; surveyed trench and fault locations; and prepared a final report (LOR, 1994b). LOR (1994b) identified Holocene faulting within Sycamore Canyon in exploratory trenches T-1, T-2, T-7, and T-8 where "the active trace of the [San Jacinto] fault exists as numerous individual fractures constrained within a well defined zone ranging from 30 to 100 feet in width. The trend of this portion of the fault ranges from N50°W to N55°W." Based on radiocarbon dating analysis of charred wood fragments in the oldest unfaulted and youngest faulted units in Trench T-2, LOR determined that the last seismic event for the zone was bracketed to a 95 percent probability, to have occurred between "AD 1380" and "AD 1810." LOR (1994b) stated that "the surficial extent of the active fault trace is less distinct" on the southeastern portion of the property, southeast of Interstate 15 (Sycamore Flat). Within Sycamore Flat, LOR identified disrupted and sheared alluvial deposits in exploratory trench T-14 and T-16 "in line with the fault on the northwestern portion of the site [Sycamore Canyon]. This would indicate that the active trace crosses the southeastern portion of the site at roughly the same trend as in Sycamore Canyon, N50°-60°W." However, LOR also pointed out that fault activity on the [southeast] portion of the site within this narrow zone was difficult to assess because of less relative fault movement than observed in Sycamore Canyon; because of the absence of datable sediments above disrupted, older alluvial units with no distinct fault zones; and because of shallow groundwater in exploratory trenches that precluded identifying the origin of a lineament. LOR therefore concluded that Holocene faulting occurs at the site and provided setbacks for structures for human occupancy. LOR's setback zone transected portions of what is now Neighborhood I (Sycamore Canyon and Sycamore Flat) from the northwest to the southeast.

The County of San Bernardino (1994b), reviewed LOR (1994b) and required LOR to address four issues for possible County approval. The County also noted that because development was not yet proposed, LOR may have to update their report when development plans became available. Additionally, the County of San Bernardino (1994b) pointed out that not all LOR trenches exposed pre-Holocene sediments nor were likely to do so given the thickness of alluvium in the area. The

County thus suggested that a risk analysis may be necessary for the proposed development.

Subsequent to the County's initial review, LOR (1994a) acknowledged and addressed the County's comments. LOR (1994b) was then granted approval from the County as indicated in County of San Bernardino (1994a). The County then forwarded LOR (1994a and 1994b) and County of San Bernardino (1994a and 1994b) to the California Division of Mines and Geology (CDMG). In a letter to the County, the CDMG states that LOR (1994a and 1994b) has been placed in an open file and substantiates CDMG zoning recommendations dated December 1, 1994.

7. GeoSoils, Inc., Preliminary Geologic Investigation, "The Villages"

In addition to the GSRA and LOR investigations, GSI (1994) preliminarily evaluated a previous proposed master plan development for "The Villages at Lytle Creek" (PBR, 1994). GSI (1994) included almost all the currently proposed development areas, excepting all of Sycamore Canyon (PA's 1 through 5), the northern and western parts of the Sycamore Flat area of Neighborhood I (PA's 6, 7, 9, and 10), and the El Rancho Verde Golf Course area of Neighborhood II (a portion of PA 95 and entire PA's 96, 97, 98, 99, 100, 101, 102, and 103), which are now a part of the current Lytle Creek Land Use Plan (dated April 29, 2008). However, Tract 15900 and other open space areas are now not a part of the current development plan. GSI (1994) subsurface investigations included geologic logging of approximately 19,840 linear feet of exposures in open-pit mines, eight exploratory trenches totaling approximately 3,855 linear feet, and one calibration test pit. In addition, unpublished trenches (approximately 2,775 linear feet) previously excavated on the site by Eberhart & Stone (E&S), were reviewed and evaluated by emplacing another 785 linear feet of trenches.

GSI (1994) concluded that, in general, project development was feasible from a geologic and geotechnical viewpoint. That study also indicated that faulting along the northeast margin of the original project site is active (i.e., movement within the Holocene epoch, or last ±11,000 years) and that structural setbacks are warranted. However, some of this area is either deemed open-space or no longer part of the current development plan and such setbacks are therefore considered irrelevant to the currently proposed development.

GSI (1994) did not observe strong aerial-photographic lineaments and/or geomorphic or geologic features, indicative of active faulting, except for the extreme northeast corner of the site (i.e., near the east/southeast side of PA 8 [Sycamore Flat]). The GSI data therefore supported the model for slip transfer between the San Jacinto and San Andreas fault zones proposed by Matti, *et al.* (1992), and Matti and Morton (1993).

No evidence of active faulting was encountered in the explorations for remainder of the project. Neither observed in the field or on the aerial photographs were on-site groundwater barriers. Based on that data, GSI (1994) concluded that active faults likely do not exist within the remainder of the property, and that the then-current State APEFZ were therefore largely unwarranted and probably should be removed.

GSI (1994) indicated that severe seismic shaking and possible ground lurching may occur throughout the site should an earthquake occur on one of the nearby active faults. Mitigation in accordance with the recommendations of the project geotechnical engineer were therefore needed. Also requiring evaluation was flooding potential during periods of heavy precipitation. Similarly, hydrocollapse and liquefaction needed site-specific evaluation by the project geotechnical engineer, should groundwater levels rise as a result of urbanization or other natural means. Any subsidence in the study area, would likely be associated with active faults within the APEFZ northeast of the site and would be mitigated via recommended setbacks. GSI also concluded that it was imperative that utilities crossing the fault zone be constructed at high angles to the fault trace in order to minimize damage. Appropriately, up- and down-gradient cut-off valves for utilities, to facilitate repair, would need to be considered. Any proposed slopes greater than 30 feet high and constructed at 2:1 h:v gradients, would need evaluation by the project geotechnical engineer and engineering geologist.

Subsequent to GSI (1994), California Division of Mines and Geology (CDMG) published revised earthquake fault zones for the Devore Quadrangle (State of California, 1995), and commented on GSI's corroborating data in Fault Evaluation Report No. 240 and its supplements (CDMG, 1994, 1995a, and 1995c). Supplement No. 1 (CDMG, 1995c) specifically reviewed and commented on the GSI (1994) data and conclusions. The revised APEFZ mapping significantly reduced fault zones across the project area.

8. San Bernardino County Review and Response Report by GSI

The County of San Bernardino Reviewing Geologist, Mr. Wessly A. Reeder (County of San Bernardino, 1995b) raised several issues that were later clarified by GSI (1995). Mr. Reeder subsequently indicated that, "the response report and initial report appear to be adequate as a general feasibility investigation" (County of San Bernardino, 1995a). Mr. Reeder and GSI recognized the need for additional site-specific geotechnical studies, including slope stability and liquefaction evaluations, and supplemental fault investigations for portions of the site remaining within APEFZ's. The County of San Bernardino (1995b), is included in GSI (1995).

9. GSI's Geotechnical Investigation, 50-Acre School Site

GSI (1997) prepared a geotechnical investigation and liquefaction evaluation for a proposed 50-acre school site within Neighborhood III, along Riverside Avenue. This investigation included subsurface exploration consisting of the excavation and sampling of five hand-dug test pits. Also sampled were similar alluvial fan deposits at various depths in the geologically similar environment of the nearby open-pit mines. GSI (1997) documented that the proposed school site is underlain by alluvial fan deposits consisting of sandy gravel and gravelly sand typical of this geologic environment. These materials were locally overlain by undocumented fill.

A liquefaction analysis at that time concluded that liquefaction potential was low at that site and did not constitute an unacceptable risk even if the regional groundwater table should rise as a result of urbanization (irrigation) or perched groundwater. On a preliminary basis, GSI also indicated that dynamic settlements caused by the "design earthquake," were about 1 inch, with differential settlement of about ½-inch. GSI ultimately concluded that the proposed school site appeared suitable for its intended use provided the conclusions and recommendations presented were properly implemented.

10. GeoSoils, Inc., Supplemental Alquist-Priolo Earthquake Fault Zone Investigation, Sycamore Flat

In 1999, GSI performed a supplemental APEFZ investigation within Sycamore Flat in order to re-evaluate and correlate the existing, approved Alquist-Priolo report for that area (LOR, 1994b); to reconcile apparently equivocal data from that study with well documented soil-stratigraphy and age-dating obtained during GSI (1994) on the adjoining property; and to integrate all of the previous investigations into a regional, local and site geomorphic/geologic context. The GSI (1999b) scope did not include the Sycamore Canyon area of Neighborhood I.

According to CDMG (1995b), "Evidence of Holocene faulting in the southeastern part of Sycamore Flat is more equivocal in the LOR trenches as the area has a higher water table, thinner Holocene units, and has been extensively graded." Based on the State's and our review of LOR's data, there was reasonable doubt that the LOR fault was through-going. To verify this, GSI emplaced five trenches (T-101 through T-105) within Sycamore Flat. Trenches T-101 and T-102 were excavated perpendicularly across the LOR zone. In those particular trenches, GSI identified unbroken, Holocene stratigraphy and/or unbroken pre-Holocene paleosols. GSI also placed two trenches across a strong, aerial-photographic lineament (T-103 and T-105) and another outside of the lineament where the undifferentiated slopewash, colluvium, and fill had been stripped (T-104). These soils were also absent from T-105. The photolineament generally coincided with apparently right-lateral offset drainage and alluvial fans on the site, topographic saddles to the southwest, a break-in-slope, and a recently incised drainage swale that was cut-off from a source area (GSI, 1994).

Active faulting appears to be reflected by a tectonic graben with the down-dropped and vertical displacement of the youngest alluvial units in the Trench T-103. In Trench T-105, the development of the graben was less defined, suggesting that the fault may be dying out, or right-stepping to the Glen Helen fault. According to GSI (1999b), "The appearance and width of the grabens noted in GSI's trenches on the offsite Lytle Creek property, T-7 and T-8 (GSI, 1994), and in T-103, this study, and closely associated topographic break and lineament, also strongly suggest that the fault is active."

Based on site-specific observations, regional geologic setting, and temporal step-over of the San Jacinto fault to the Glen Helen fault and in turn to the San Andreas fault, GSI (1999b) concluded that the LOR, Holocene-faults in Sycamore Flat, were paleoliquefaction features. Additionally, other factors suggest their equivocal data are better attributed to an older, non-seismogenic fault which may exist on the Sycamore Canyon site and possibly has experienced sympathetic movement as a result of nearby seismic activity. GSI (1999b) reported that the LOR fault was <u>not</u> through-going, and the projected fault trend was incorrect. GSI (1999b) also pointed out that a graben structure, presence of a strong aerial-photographic lineament, and topographic break-in-slope all indicated an active fault along the eastern part of the property. GSI's in-progress investigation further substantiates the association of faulting with the topographic break-in-slope between Lower Lytle Creek Ridge-Verdemont Hills and Sycamore Flat where short, discontinuous reverse faults with general northeasterly trends represent slip distribution as faults step over to the more active Glen Helen fault. As indicated on Active faulting enters PA 8 from the southeast and is coincident with the topographic break-in-slope along its eastern margin. Faulting then continues northeast into PA 7 (Open Space).

11. GeoSoils, Inc., Fault/Seismic Investigation, Lytle Creek Ranch, Neighborhoods II and III (Portions of Planning Areas 24, 54, 55, 56, 58, and 59 and All of Planning Areas 60, 61, and 62)

Beginning in late May 2006, GSI conducted a fault/seismic investigation for parts of Neighborhoods II and III located within an APEFZ. This investigation was performed for a previous land use plan prepared by EDAW/AECOM (2006). However, based on our review of the current land use plan prepared by KTGY (2008), we note that the subject Planning Areas are now referred to as portions of Planning Areas 33, 81, 83, 84, 94, and 95. For this investigation, GSI performed a geologic and geomorphic site reconnaissance, reviewed pertinent literature, analyzed aerial-photographic lineaments, geologically logged seven fault-finding/age-dating trenches, totaling approximately 4,322 linear feet, observed the north and south channel banks of Lytle Creek Wash with 15 feet or more exposure, and published a report that summarized our findings, conclusions, and recommendations (GSI, 2006a).

GSI identified Holocene faults associated with the SJFZ in Fault Trenches (FT-1, FT-2, FT-3, FT-4, and FT-5 [Plate 1]) located within parts of Neighborhood II. Faulting consisted of two distinct zones (Fault Zones 1 and 2). Fault Zone 1 exhibited several short, discontinuous fault splays trending N 4°- 51°W that were determined to die to the northwest for apparent vertical displacements decreased from the southeast to the northwest and faulting was not identified in FT-6 and T-6 (GSI, 1994). Fault Zone 2 was composed of a discrete fault, identified in FT-3 and FT-5 that generally trended N 27°W. Apparent vertical displacement significantly decreased from the northwest to the southeast suggesting that Fault Zone 2 is dying to the southeast. Based upon the field data, GSI concluded that a divergent step-over from Fault Zone 1 to Fault Zone 2 occurs at the site. However, no cross-faulting associated with this right step was observed in any of our trench exposures. Using soil-stratigraphic markers, GSI determined the recurrence intervals for fault rupture were on the order of 1,000 to 2,000 years for Fault Zone 1, and 1,000 to 1,500 years for Fault Zone 2. Thus, recurrence for Fault Zones 1 and 2 is much greater than reported by SCEC (2006a), or WGCEP 2007. In accordance with current standards, GSI recommended 50-foot setbacks for structures for human occupancy from active faults. Faulting was not identified in the trench exposure emplaced within Neighborhood III. However, in accordance with County of San Bernardino (1984), a setback for structures for human occupancy is recommended 50 feet northeast of the southwest end of FT-7 because it cannot be entirely precluded that active faulting does not occur southwest of FT-7. This setback zone parallels the northern APEFZ boundary. GSI noted that Fault Zones 1 and 2 project toward a portion of PA 59 (now referred to as a portion of PA 95) and a portion of PA 63 (now referred to as portions of PA's 97 and 98). Portions of PA 59 (now referred to as portions of PA's 95 and 99, and ending PA 101) and all of PA 63 (now referred to as PA's 97 and 98) were previously investigated by GSRA and it was not in GSI's scope to reinvestigate these areas. Further, the distance between the GSI and GSRA trenches exceeds the maximum trench-spacing distance currently accepted by the industry. Thus, in accordance with current standards of practice, GSI recommended additional subsurface investigations to determine if the faulting identified by GSI occurs within these PA's. Otherwise, additional setbacks for human-occupied structures (where proposed) may be required.

12. **GeoSoils, Inc., Supplemental Fault/Seismic Investigation, Lytle Creek Ranch, Neighborhood I, Sycamore Canyon Area**

Between September and November 2006, GSI performed a supplemental fault/seismic investigation for PA 2 (now referred to as PA 3) within the Sycamore Canyon area of Neighborhood I (GSI, 2007a). The purpose of this supplemental investigation was to evaluate the fault zone identified by LOR (1994b) within Sycamore Canyon because GSI exploratory trenches emplaced to intercept and evaluate the LOR fault zone, within Sycamore Flat, indicated that the LOR fault zone was not through-going in that area (GSI, 1999b) and provided reasonable doubt as to the accuracy of the LOR fault zone within Sycamore Canyon.

For this investigation, GSI performed a geologic and geomorphic site reconnaissance, reviewed pertinent literature, analyzed aerial-photographic lineaments, and geologically logged, seven fault-finding/age-dating trenches, totaling approximately 1,780 linear feet. The trenches were emplaced perpendicularly across the LOR fault zone. In Fault Trenches FT-203,203A, and 204, GSI identified Holocene faults related to the SJFZ. However, faulting was not identified in Fault Trenches 200, 201, and 202. Based upon the field data, GSI concluded that the LOR fault zone is not through-going within Sycamore Canyon and provided an amended setback zone from active faults (Plate 1). Additionally, the field data suggested that the faults within Sycamore Canyon are non-seismogenic and maybe associated with a right step-over to the Glen Helen fault or are related to slip partitioning along en echelon tears in response to major events on the Glen Helen fault. Using soil stratigraphic markers and radiocarbon age-dating techniques, GSI concluded the recurrence interval for faulting within Sycamore Canyon is between ~2,000 and ~4,420 years. Paleoliquefaction features were also identified in FT-200, 201, 202, and 203 providing evidence that liquefaction and possible ground deformation has previously occurred onsite.

13. **GeoSoils, Inc., Additional Fault/Seismic Investigation, Lytle Creek Ranch, Neighborhood I, Planning Area 8, Sycamore Flat Area**

During the last day of March, through April of 2008, GSI excavated an additional 1,361 feet of fault finding and dating trenches in the Sycamore Flat area of Neighborhood I. The purpose of this additional investigation was to refine the previously recommended setbacks within current Planning Area 8 (PA 8) of Neighborhood I, field check GSI's postulated east-curving of the onsite splay of the SJFZ, and respond to reviewers comments, as well as further evaluate the questionable fault zone provided by LOR (1994b), as it extended into Sycamore Flat.

For our most recent investigation, GSI performed a geologic and geomorphic site reconnaissance, reviewed pertinent literature, analyzed aerial-photographic lineaments, and geologically logged, 12 additional fault-finding/age-dating trenches. The trenches were emplaced perpendicularly across the photolineaments, and GSI's previously mapped fault zone (GSI; 1994, 1999b, 2007a, and 2007b). In the western portion of Fault Trenches FT-300 and 306, as well as FT-300A, 302, and 303, GSI identified pre-Holocene faults likely related to the ancient SJFZ. However, at the sinuous geomorphic break-in-slope of the Lower Lytle Creek Ridge-Verdemont Hills ridgeline, generally coeval with GSI's previous mapped fault zone, active faulting was indeed observed in Fault Trenches 300, 305, 306, 307, and 308. The active faults were characterized primarily as reverse faults, forming an escarpment which was coincident with the break-in-slope discussed above, and generally followed the topography to the northeast-east, outside of the limits of PA 8, into PA 7 (proposed as Open Space).

A synthesis of the data from GSI (1994, 1999, 2007a, and 2007b) indicates that the active splay of the SJFZ enters the project from the southeast in PA 8, where local transtension is primarily occurring, typically generating rift and graben features, a characteristic of pull-apart regions. Heading toward the northwest, north of FT-103, the style of faulting begins changing from transtension, to transpression, generally exhibiting reverse faults, a characteristic of restraining bends in the fault trend. These reverse faults are usually imbricated, with a series of topographically up-gradient, over-riding reverse faults that tend to exhibit contractional horsetail splays where they bend, and are areas of regional topographic uplift of crystalline bedrock, such as at PA 8 and along the Lower Lytle Creek Ridge-Verdemont Hills ridgeline. The horsetail splays also characteristically exhibit flowering upward features, where fault slip is distributed as faults step over to more active splays (such as the Glen Helen fault), or die out. There was no evidence of a continuous, sufficiently-active or well-defined, through-going fault from Sycamore Flat, trending northwest into Sycamore Canyon. Since fault scarps degrade during fault dormancy, and are well preserved when the earthquake recurrence interval is short enough, GSI concludes that the recurrence interval for the active strand of the SJFZ in Sycamore Flat is probably on the order of a several hundred to as much as two thousand years, per major fault event.

GENERAL SITE GEOLOGY AND GEOMORPHOLOGY

Excepting the Sycamore Canyon and Sycamore Flat areas of Neighborhood I, most of the project area is underlain by fluvial sediments emanating from Lytle Creek, and to a lesser extent, from Sycamore Canyon. These sediments may reach depths of 120 to 950 feet before basement rock is encountered (Geoscience, 1992). The heads of Lytle Creek and Sycamore Canyon are located within the San Gabriel Mountains. Coalescing sediments deposited primarily from Lytle Creek have created a large alluvial fan that reaches from

Ontario on the southwest, east to Colton, and north to the base of the San Gabriel Mountains. Some onsite sediments may also have been deposited by Cajon Wash. As pointed out by GSRA (1994b), the distal edges of the Lytle Creek and Cajon Wash fans overlapped and interfingered during the Pleistocene and early Holocene. Alluvium was entirely deposited by Lytle Creek, and to a lesser extent by Sycamore Canyon, after drainage shifted eastward and the fan beheaded owing to continued incision and uplift along the San Jacinto fault during the mid-Holocene. Geomorphically, the alluvial fan deposits exhibit characteristics associated with young to intermediate development, likely corresponding to sediments of Holocene- to Pleistocene-age (Shlemon, 1978).

In the Sycamore Canyon and Sycamore Flat areas of Neighborhood I, alluvial fan deposits overlie Tertiary and older basement rocks, consisting of schistose, mylonitic, and granitic rocks of the Peninsular Ranges terrane. As indicated previously, these schistose, mylonitic, and granitic rocks, have been telescoped or displaced along faults associated with the SJFZ. Terraces developed on older, alluvial fan deposits westerly to easterly of the site, including the elevated Sycamore Flat area of Neighborhood I (now partially graded), exhibit geomorphic characteristics associated with the development of older, alluvial fans and may be older than 500,000 years (Christenson and Purcell, 1985), assuming no uplift on bounding faults. Alternatively, these terraces may have also been uplifted on the bounding faults, suggesting geomorphic characteristics indicative of the development of intermediate-age alluvial fans, and are likely pre-Holocene in age (Shlemon, 1978). The younger alluvial sediments are Holocene to recent in age.

Dibblee (2003 and 2004) indicate that site geologic units consist of Quaternary alluvial deposits and crystalline basement rocks consisting of granodiorite, quartz monzonite, cataclastic granitic rock, and mica schists to gneiss. Morton and Matti (2001) and Miller, *et al.* (2001) have mapped (from youngest to oldest) Quaternary, very young or modern wash deposits and modern alluvial fan deposits (age-equivalent), young alluvial fan and alluvial valley deposits (age-equivalent), old alluvial fan deposits, very old alluvial fan deposits, Tertiary "Granodiorite of Telegraph Peak" with olivine diabase and gabbro inclusions, Mesozoic greenstone, Cretaceous leucocratic muscovite monzogranite and mylonitic leucogranite (age-equivalent), and Paleozoic schist and gneiss at the site. Morton and Miller (2006) demonstrate that site geologic units (from youngest to oldest) include Quaternary, very young wash and alluvial fan deposits (age-equivalent), young axial-channel and alluvial fan deposits (age-equivalent), old alluvial fan and eolian deposits (age-equivalent), Tertiary "Granodiorite of Telegraph Peak" with olivine diabase and gabbro inclusions, Cretaceous, mylonitized leucogranite and leucocratic-muscovite monzogranite (age-equivalent), and Paleozoic, metasedimentary schist and gneiss. Dutcher and Garrett (1963) mapped most of the site as consisting of Quaternary, river-channel deposits, younger and older alluvium, and an igneous and metamorphic basement complex. A regional geologic map, adopted from Morton and Matti (2001) and Miller, *et al.* (2001) has been included previously as Figure 2. GSI presents the site geologic units on Plates 1 through 4.

Lineament Analysis

In order to identify possible unmapped faults and to evaluate topographic expressions of published fault traces, a lineament analysis was performed. Stereoscopic "false-color," infrared aerial photographs at a scale of approximately 1:40,000 (United States Department of Agriculture [USDA], 1980 and 1982) and stereoscopic black-and-white aerial photographs at a scale ranging from approximately 1:12,000 to 1:24,000 (San Bernardino County Flood Control, 1938, 1955, 1965, and 1978), and 1:1,600 (Fairchild Aerial Photography Collection, 1932), were utilized for the analysis.

A number of photo-lineaments have been noted in the vicinity of the site and have been intercepted by exploratory trenches (GSI [1994, 1999a, 2006a, and 2007a]; LOR, [1994b]; and GSRA [1980, 1982a, 1982b, and 1994b]). A strongly developed northwest trending lineament was noted to lie along the southeast margin of Sycamore Flat (GSI, 1994). The lineament was intercepted by trenching as indicated in GSI (1994), and during our in-progress investigation. This strong lineament coincides with offset alluvial fans, topographic saddles, a break in slope, and a recently incised and filled drainage swale without a source area (now removed by the aforementioned grading), and thus strongly suggested the presence of an active fault. Numerous other weak and moderate photo-lineaments had been associated with queried and inferred traces of the San Jacinto, Cucamonga, and/or Lytle Creek faults. These lineaments were investigated in GSI (1994, 2006a, and 2007a) and found not to be associated with any active faulting. Rather, unbroken sediments were documented. Owing to the young, low-lying near-surface alluvial sediments that mantle most of the site, the lineaments in this terrain most likely reflect Holocene and historic flooding channels, and thus are not inherent indicators of active faults.

SITE GEOLOGY

Several geologic units have been identified at the site by GSI and other investigators. Site geologic units include roadway fill, compacted artificial fill, undocumented artificial fill, colluvium, young alluvial fan deposits, alluvial fan deposits, older alluvial fan deposits, and a bedrock complex consisting of granitic, mylonitic, and schistose rocks. The limits of mappable units are shown on Plates 1 through 4 Additional descriptions for units encountered in the subsurface explorations are provided in GSI (1994, 1999b, 2006a, and 2007a). Based on the available data to date, the major geologic units are generally described as follows, from youngest to oldest:

Artificial Fill - Compacted (Map Symbol - Afc)

Compacted artificial fill is associated with the fault trench backfill described in GSI (2006b and 2007b) and predominately consists of fine- to coarse-grained sand and silty sand with trace to locally abundant subrounded to subangular pebble- to cobble-sized clasts and trace subrounded to subangular boulder-sized clasts. GSRA (1994a and 1994b) indicate compacted artificial fill in the El Rancho Verde Golf Course area of Neighborhood II. However, the engineering properties of the fill are unknown since no documentation regarding its suitability has been provided to GSI for review. Accordingly, GSI considers this fill unsuitable for the support of engineered fill and/or settlement-sensitive improvements. The compacted artificial fill documented in GSI (2006b and 2007b) is suitable for support of engineered fill and/or settlement-sensitive improvements, provided our recommendations are properly implemented. Minimally, however, the upper 1 foot of these materials should be scarified, moisture conditioned to at least the soil's optimum moisture content, and recompacted to at least 90 percent of the laboratory maximum (ASTM D 1557) prior to placement of additional fill or settlement-sensitive improvements.

Roadway Fill (Map Symbol - Afr)

Roadway fill is associated with the construction of various roadways and Interstate 15. Roadway fill was not exposed in our subsurface explorations. Unless, documentation regarding its engineering suitability can be provided for geotechnical review, the roadway fill is considered unsuitable for the support of engineered fill and/or settlement-sensitive improvements.

Artificial Fill - Undocumented (Map Symbol - Afu)

Undocumented artificial fill is associated with roads, levees, berms, underground utilities, golf course construction, and previous subsurface explorations (STE [1988]; E&S [unpublished]; GSI [1994 and 1999b]; LOR [1994b]; and GSRA [1980, 1982a, 1982b, 1994a, and 1994b]). As previously stated, GSRA (1994a and 1994b) indicate compacted artificial fill in the El Rancho Verde Golf Course area of Neighborhood II. However, the engineering properties of the fill is unknown since no documentation regarding its suitability has been available to GSI for review. Accordingly, GSI considers this fill unsuitable for the support of engineered fill and/or settlement-sensitive improvements. End dumped fill and/or debris also occur scattered around the low-lying areas of the project. It should be noted that additional areas of undocumented fill that are not indicated on Plates 1 through 4 may occur within the site. These areas may be further delineated during a 40- or 100-scale grading plan review. Typically, undocumented fill consists of gravelly, fine- to coarse-grained sands and silt to silty fine- to coarse-grained sand with trace to locally abundant subrounded to subangular pebble- to cobble-sized clasts. The thickness of these soils ranges between less than 1 foot to about 31 feet. The fill materials are anticipated to have a low to possibly medium expansion potential based on visual classification; however, a high expansion potential may exist if the fill was derived from clayey, parent soils. All undocumented fill is potentially compressible in its existing state and may settle appreciably under additional fill or foundation and improvement loadings. It should be noted that some of the undocumented fill associated with exploratory trenches within PA 8 of Neighborhood I have been removed as a result of the aforementioned grading (excavation).

Quaternary Colluvium (Not Mapped)

Colluvium was observed to discontinuously mantle portions of the site. Some of these sediments may be alluvial overbank deposits in the low-lying areas of the site; however, for this report are not differentiated. As observed during our subsurface explorations, the colluvium ranges in thickness from about 1 to as much as 10 feet. The colluvium is generally silty, fine- to coarse-grained sands with traces of angular to subangular pebble- to cobble-sized clasts. Typically, colluvium has a low to medium expansion potential; however, a high expansion potential may exist in clayey sediments. All colluvium is potentially compressible and may settle appreciably under loading. Removal and recompaction is recommended if colluvium occurs within the influence of proposed settlement-sensitive improvements and/or proposed fill. The colluvium is late Holocene in age.

Quaternary Alluvial Fan Deposits - Young (Map Symbol - Qafy)

Young alluvial fan deposits were encountered in drainage meanders and the low-lying areas of PA 8. These earth materials generally consist of poorly graded, fine- to medium-grained sands, silty sands, and local silt with rare subangular to subrounded pebble-to cobble-sized clasts. Where encountered, the young alluvial fan deposits were observed to be dry to saturated and loose/soft. These deposits were generally thickly bedded with localized low-angle cross bedding. The young alluvial fan deposits are considered unsuitable for the support of settlement-sensitive improvements in their existing state. Based upon the presence of barbed wire, ceramic plates, and glass bottles, transported by debris flows, the young alluvial fan deposits are estimated to be late Holocene in age.

Quaternary Alluvium (Map Symbol - Qal)

Quaternary alluvium was observed to underlie the floor of Sycamore Canyon (PA 3). These sediments are generally grayish brown, dark olive brown, light gray, and pale yellow fine-to medium-grained sand and grayish brown, dark olive brown, light gray, pale yellow, light brownish gray, and light yellowish brown fine- to coarse-grained sand and silty sand with traces of sub-rounded to sub-angular pebble- to cobble-sized clasts. The sediments are dry and poorly indurated and become moist to occasionally wet and moderately indurated with depth. The alluvium is typically massive to thickly bedded with a trace of thin bedding and localized cross-bedding. These sediments regionally dip to the south. However, local topset, foreset, and bottomset beds dip to the north. These sediments typically have a very low to low, and possibly medium expansion potential; however, a high expansion potential may exist in clayey sediments. Based on radio-carbon dating and paleosol development, these deposits are estimated to be no older than mid-Holocene in age.

Quaternary Alluvial Fan Deposits (Map Symbol - Qaf)

Intermediate-age Quaternary alluvial fan deposits were locally encountered along the northern and southern flanks of the Sycamore Canyon area of Neighborhood I as well as, Neighborhood I's southern extent. They were also widespread throughout Neighborhoods II, III, and IV. These sediments generally consist of dry to damp, silty, fine- to coarse-grained sands, fine- to coarse-grained sands, and sands and gravels with pebble- to boulder-sized clasts. In the near-surface, the alluvial fan deposits are generally weathered and loose, and become medium dense with depth. These deposits are either massive to thickly bedded, or thin- to medium- bedded. Typically, alluvial fan deposits have a very low to perhaps medium expansion potential; however, a high expansion potential may exist in clayey sediments. The near-surface, weathered alluvial fan deposits are generally unsuitable for the support of engineered fill and/or settlement-sensitive improvements in their existing state. Based upon paleosol development and their degree of incision, the alluvial fan deposits are estimated to be mid- to early Holocene in age.

Older Alluvial Fan Deposits (Map Symbol - Qaf_o)

Separated by an erosional unconformity, older alluvium and fluvial-fan sediments are exposed at the surface or discontinuously underlie the younger alluvial sediments in some locales within Neighborhoods I, II, and IV. Within the Sycamore Flat area of Neighborhood I, older alluvial sediments are generally yellow brown, to brown, to yellowish red, silty sands with occasional gravels and cobbles, and clay. The proximal fans tend to contain more gravels and cobbles, while the distal fans are sandier. These sediments were generally flat lying and massive to thickly bedded and typically exhibit moderately to well developed paleosols, dated as being Pleistocene in age (Shlemon, 1994 and 1999). Older alluvial sediments were encountered, within the southern part of Neighborhood II, during field work in preparation of GSI (2006a) and GSRA (1994b). As indicated in GSI (2006a), the older alluvial fan deposits and alluvium consisted of moderately to well indurated silty, fine- to coarse-grained sands with rare pebble-sized clasts and slightly plastic silty clays to clayey silts. These deposits are pre-Holocene in age. Morton and Matti (2001) indicate that older alluvium also locally exists along a part of the northern boundary of Neighborhood IV. Excepting weathered portions, the older alluvial deposits are generally considered suitable for the support of engineered fill or settlement-sensitive improvements and typically exhibit low to medium expansion potentials. However, high expansion potentials cannot be precluded, depending on the clay content.

Tertiary Granodiorite of Telegraph Peak (Map Symbol - Ttp)

The northern wall of Sycamore Canyon and the northern highland area of Sycamore Flat (Neighborhood I) exposes Oligocene biotite granodiorite that ranges to biotite monzogranite and is termed the "Granodiorite of Telegraph Peak" (Morton and Matti [2001]). This bedrock unit is medium- to coarse-grained, predominately massive, and highly fractured/sheared. Miocene-age olivine diabase and gabbro plutons, as well as andesitic dikes, are commonly associated with this unit.

Cretaceous Leucocratic Muscovite Monzogranite (Map Symbol - Kgm)

According to Morton and Matti (2001), medium- to coarse-grained, massive to semi-foliated, highly fractured, muscovite monzogranite is exposed on a knob in the southern Sycamore Flat area of Neighborhood I. The bedrock in this area was described as a well-banded gneiss in GSI (1994). However, it is now our opinion that the description provided by Morton and Matti (2001) is technically correct because it is likely that the rock composition was substantiated by laboratory and microscopic testing. This nomenclature correction does not alter any of our fundamental conclusions.

Cretaceous Mylonitic Leucogranite (Map Symbol - Kgc)

Morton and Matti (2001) mapped the southern wall of Sycamore Canyon (Neighborhood I) as leucocratic mylonitic monzogranite, which is "characterized by distinct mylonitic layering defined by deformed quartz and feldspar." It is thoroughly fractured and decomposed, where observed.

Paleozoic Pelona Schist (Map Symbol - Pps)

Pelona Schist was encountered during field mapping and subsurface explorations in preparation of LOR (1994b) and GSI (1999b). According to LOR (1994b), Pelona Schist was encountered along the southern portions of the Sycamore Flat area of Neighborhood I, east and southeast of Interstate 15, on two of the small northwest trending ridges. Within the formation, LOR identified silica-rich and greenstone units. The greenstone unit was reported to be composed of indistinct layers of chlorite-epidote-albite, and hornblende. It is dark green in color and foliated. The greenstone units weather to a dark reddish brown silty clay. The silica-rich units were described as consisting of a fractured and foliated muscovite schist that is brown to greenish gray in color and weathers to a brown, silty gravel. The Pelona Schist is considered suitable bearing bedrock where unweathered. Fill generated from excavations into the Pelona Schist may be expansive, especially in weathered portions.

SEISMICITY AND SEISMIC HISTORY

Locating earthquake epicenters is often inaccurate. Estimates of magnitude and epicenter locations for earthquakes prior to recording instruments were usually based on description of the earthquakes by individuals in different areas. Seismic instrumentation did not become available until about 1932, and these earlier instruments were imprecise. Historic-earthquake epicenters of earthquakes within ~100 kilometers of the site, as well as their estimated magnitudes and coordinates, are included in Appendix B.

The San Jacinto fault has been the most seismically active fault in southern California (Sharp, 1975). Between 1899 and 1992, eight earthquakes of M6.0, or greater, have occurred somewhere along the San Jacinto fault between the San Gabriel Mountains and Mexico.

Since 1899, earthquakes on the San Jacinto fault of Richter magnitude 6.0, or greater, have tended to occur about every 5 to 19 years. The earthquakes in 1899, 1918, and 1923 apparently occurred along the northern portion of the San Jacinto fault; an earthquake in 1937 apparently occurred near the middle of the San Jacinto fault; and earthquakes in 1942, 1954, 1968, and 1987 are believed to have occurred along the southern portion of the San Jacinto fault.

Documented evidence for large earthquakes along the Cucamonga fault has only recently been found. This fault is part of the Sierra Madre-Cucamonga fault system which ruptured during the M6.4 San Fernando earthquake in 1971 and was also responsible for the M5.8 Sierra Madre earthquake which occurred on June 28, 1991. Subsurface investigations have documented evidence of Holocene activity along the Cucamonga fault west of Lytle Creek (GSRA, 1989 and 1990).

No significant earthquake epicenter can be specifically attributed to the Glen Helen fault. Similarly, no significant earthquakes generating surface rupture are known to have occurred during historic time along the Glen Helen fault, or along groundwater barriers.

SEISMIC DISCUSSION

Significant earthquakes affecting the site may occur on the San Jacinto, San Andreas, Cucamonga, and/or other fault zones during the life of the proposed residential and mixed-use structures. However, the San Jacinto, Cucamonga, and San Andreas fault zones are considered to be the most important faults to the site from a seismic shaking standpoint, based on the site's location relative to these faults.

Recurrence intervals for maximum probable earthquakes cannot yet be precisely determined from a statistical standpoint, because recorded information on seismic activity does not encompass a sufficient span of time. However, based on available information, it is GSI's opinion that for design purposes, an earthquake of ±M6.7-7.0 may occur along the San Jacinto, Cucamonga, or San Andreas fault zones. Large earthquakes could occur on other faults in the general area.

The 1992 Landers earthquake sequence was thought to have resulted in a statistical increase in the probability of a large earthquake on the San Andreas and San Jacinto faults. The June 28, 1992 earthquakes were also thought to increase the stress toward the failure limit for the San Bernardino Mountain and Coachella Valley segments of the San Andreas fault and for the San Bernardino Valley and San Jacinto Valley segments of the San Jacinto fault, thereby advancing the time to failure for both faults. The Working Group on California Earthquake Probabilities (1992) concluded that regional earthquake activity has increased since 1985, and the Landers-Big Bear earthquakes have increased the stress towards the failure limit for parts of both the San Andreas and San Jacinto faults.

The January 17, 1994, M6.7 Northridge earthquake likewise was thought to increase the static stress on a 12- to 25-mile (20- to 40-kilometer) section of the San Andreas fault near Palmdale (Simpson, *et al.*, 1994). This was surmised to result in an increase of about one to three years of tectonic loading by long-term deep slip on the San Andreas fault (Simpson, *et al.*, 1994). The largest changes in static stress resulting from the Northridge earthquake occurred on faults in the thrust belts which lie east and west of Northridge (Simpson, *et al.*, 1994). This may include the Sierra Madre-Cucamonga fault zone, which produced the 1971 M6.4 San Fernando earthquake.

More recently, the 2007 WGCEP (2008), significantly revised their conclusions regarding mean 30-year probabilities for M≥6.7 events. This is based on new paleoseismic data, new geodetic data, and an earthquake rate model that allows a greater variety of rupture sizes on faults. While the probability for a M≥6.7 earthquake to occur on the SAFZ has actually increased from 53 to 59 percent, this potential has almost halved for the SJFZ, from 61 to 31 percent. Thus, from a regional perspective, the most dangerous faut is the southern San Andreas, and notably, the San Bernardino segment (which continues to Cajon Pass), and lies in relatively close proximity to the project.

SEISMICITY

General

GSI analyzed site seismicity using the EQFAULT, EQSEARCH, and FRISKSP computer programs developed by Thomas F. Blake (Blake; 2000a, 2000b, and 2000c). For the purpose of this report, GSI performed these analyses for the approximate geographic center of the master planned community (KTGY, 2008). Based upon the size of the Lytle Creek Ranch project and the dispersed configuration of the "Neighborhoods," the anticipated ground-acceleration values, reported herein, may vary based upon the selected location within the site and the particular soil profile underlying the selected location. These analyses should be re-evaluated during "Neighborhood" and/or PA specific geotechnical investigations.

EQFAULT

The acceleration-attenuation relations of Bozorgnia, Campbell, and Niazi (1999), Campbell and Bozorgnia (1997 Revised), and Sadigh, *et al.* (1997), have been incorporated into EQFAULT (Blake, 2000a). EQFAULT is a computer program which performs deterministic seismic hazard analyses using digitized California faults as earthquake sources. For this study, peak horizontal ground accelerations anticipated at the site were determined based on the mean and mean plus 1 - sigma attenuation curves developed by those investigators. The program estimates the closest distance between each fault and a given site. If a fault is found to be within a user-selected radius, the program estimates peak horizontal ground acceleration that may occur at the site from the "upper bound" or "maximum credible" earthquakes on that fault. Site acceleration (g) is evaluated by any of a number of user-selected acceleration-attenuation relations that are contained in EQFAULT. Based on the EQFAULT program, peak horizontal ground accelerations at the approximate geographic center of the site from an upper bound event may be on the order of 0.62g to 0.98g. The computer printouts of the EQFAULT program are included within Appendix B.

The possibility of ground shaking at the site may be considered similar to the southern California region as a whole. The relationship of the site location to these major mapped faults is indicated in Appendix B. It should be noted that in the event of a "maximum probable" or upper bound ("maximum credible") earthquake occurring on any of the nearby major faults, strong ground shaking would occur in the subject site's general area. Potential damage to any structure(s) would likely be greatest from the vibrations and impelling force caused by the inertia of a structure's mass, than from those induced by the hazards considered above. This potential would be no greater than that for other existing structures and improvements in the immediate vicinity.

EQSEARCH

Historical site seismicity was additionally evaluated utilizing the computer program EQSEARCH (Blake, 2000b). This program was utilized to perform a search of historical earthquake records for magnitude 5.0 to 9.0 seismic events within a 100-kilometer radius from the approximate geographic center of the site, between the years 1800 through December 2007. Based on the selected acceleration-attenuation relation, a peak horizontal ground acceleration is estimated, which may have affected the site during the specific seismic events in the past. Based on the available data and attenuation relationship used, the estimated maximum (peak) site acceleration during the period 1800 through December 2007, was 0.4g (mean plus 1 sigma). In addition, a seismic recurrence curve and earthquake epicenter map was also estimated/generated from the historical data (see Appendix B).

FRISKSP

A probabilistic seismic hazards analyses for the approximate geographic center of the site was performed using FRISKSP (Blake, 2000c) which models earthquake sources as 3-D planes and evaluates the probabilities of exceedance for given peak acceleration levels or pseudo-relative velocity levels. Based on a review of these data, and considering the relative seismic activity of the southern California region, a peak horizontal site acceleration (PHSA) of 0.9g was calculated. This value was chosen as it corresponds to a 10 percent probability of exceedance in 50 years (or a 475-year return period). Computer printouts of pertinent portions of the FRISKSP program are included in Appendix B. It should be noted that the California Geologic Survey (CGS) probabilistic seismic hazard mapping web site (CGS, 2002) indicated a general ground acceleration of 0.96g for the 10 percent probability of exceedance in 50 years.

SEISMIC SHAKING PARAMETERS

Portions of the site are located within the SJFZ (San Bernardino Segment) and now have documented Holocene displacements (see Plates 1 through 4). Fault splays or segments associated with the Cucamonga Fault Zone (CFZ) were not observed during this or previous investigations. However, the ICBO (1998), which indicates Active Fault Near-Source Zones to be used to determine near-source factors for seismic design, such as directivity and fling (Abrahamson, 2005), has designated that portions of the site lie within the Cucamonga Fault Near-Source Zone as well as the San Jacinto/San Bernardino Fault Near-Source zone. Therefore, according to code, we provide the following minimal seismic design parameters for both the Cucamonga Fault and San Jacinto/San Bernardino Fault Near-Source Zones for preliminary planning. This inherently excludes the effects of earthquake induced liquefaction. Based on site conditions, Chapter 16 of the Uniform Building Code/California Building Code ([UBC/CBC], International Conference of Building Officials [ICBO], 1997); and California Building Standards Commission (CBSC, 2007), minimal seismic parameters are provided in the following tables:

PRELIMINARY FAULT NEAR-SOURCE DATA		
Seismic Zone (per Figure 16-2*)	4	4
Seismic Zone Factor Z(per Table 16-I*)	0.40	0.40
Soil Profile Types (per Table 16-J*)	S_c (Bedrock [map symbols - Ttp, Kgm, Kgc, and Pps]), S_D (Older Alluvial Fan Deposits and Alluvial Fan Deposits [map symbols - Qafo and Qaf]), and S_E (Young Alluviual Fan Deposits and Alluvium [map symbols - Qafy and Qal])	S_c (Bedrock [map symbols - Ttp, Kgm, Kgc, and Pps]), S_D (Older Alluvial Fan Deposits and Alluviual Fan Deposits [map symbols - Qafo and Qaf]), and S_E (Young Alluvial Fan Deposits and Alluvium [map symbols - Qafy and Qal])
Seismic Coefficient C_a (per Table 16-Q*)	0.40 N_a (Bedrock [map symbols - Ttp, Kgm, Kgc, and Pps]), 0.44 N_a (Older Alluvial Fan Deposits and Alluvial Fan Deposits [map symbols - Qafo and Qaf]), 0.36 N_a (Young Alluvial Fan Deposits and Alluvium [map symbols - Qafy and Qal])	0.40 N_a (Bedrock [map symbols - Ttp, Kgm, Kgc, and Pps]), 0.44 N_a (Older Alluvial Fan Deposits and Alluvial Fan Deposits [map symbols - Qafo and Qaf]), 0.36 N_a (Young Alluvial Fan Deposits and Alluvium [map symbols - Qafy and Qal])

PRELIMINARY FAULT NEAR-SOURCE DATA		
Seismic Coefficient C_v (per Table 16-R*)	0.56 N_v (Bedrock [map symbols - Ttp, Kgm, Kgc, and Pps]), 0.64 N_v (Older Alluvial Fan Deposits and Alluvial Fan Deposits [map symbols - Qafo and Qaf]), 0.96 N_v (Young Alluvial Fan Deposits and Alluvium [map symbols - Qafy and Qal])	0.56 N_v (Bedrock [map symbols - Ttp, Kgm, Kgc, and Pps]), 0.64 N_v (Older Alluvial Fan Deposits and Alluvial Fan Deposits [map symbols - Qafo and Qaf]), 0.96 N_v (Young Alluvial Fan Deposits and Alluvium [map symbols - Qafy and Qal])
Near Source Factor N_a (per Table 16-S*)	1.3	1.18
Near Source Factor N_v (per Table 16-T*)	1.6	1.51
Seismic Source Type (per Table 16-U*)	B	A
Distance to Seismic Source	0.0 km	5.9 km
Upper Bound Earthquake	San Jacinto fault $M_w = 6.7$**	Cucamonga fault $M_w = 7.0$**
Probabilistic Horizontal Site Acceleration (PHSA) 10% in 50 years	~1g	
*Figure and table references from Chapter 16 of ICBO (1997) ** ICBO (1998)		

The table below summarizes the site-specific design criteria obtained from the 2007 CBC (based on the International Building Code [IBC], International Code Council, Inc. [ICCI], 2006), Chapter 16 Structural Design, Section 1613, Earthquake Loads, and may supercede the information presented previously, once the code is adopted. Our analysis inherently excludes the effects of earthquake induced liquefaction. We used the computer program Seismic Hazard Curves and Uniform Hazard Response Spectra, provided by the U.S.G.S. The short spectral response uses a period of 0.2 seconds.

IBC SEISMIC DESIGN PARAMETERS				
PARAMETER	**VALUE**	**VALUE**	**VALUE**	**IBC-06 REFERENCE**
Site Class	C (Bedrock only)	D (Older Alluvial Fan Deposits and Alluvial Fan Deposits)	E (Young Alluvial Fan Deposits and Alluvium)	Table 1613.5.2
Spectral Response - (0.2 sec), S_s	1.94g	1.94g	1.94g	Figure 1613.5(3)
Spectral Response - (1 sec), S_1	0.7g	0.7g	0.7g	Figure 1613.5(4)
Site Coefficient, F_a	1.0	1.0	0.9	Table 1613.5.3(1)
Site Coefficient, F_v	1.3	1.5	2.4	Table 1613.5.3(2)
Maximum Considered Earthquake Spectral Response Acceleration (0.2 sec), S_{MS}	1.94g	1.94g	1.74g	Section 1613.5.3 (Eqn 16-37)

IBC SEISMIC DESIGN PARAMETERS				
PARAMETER	VALUE	VALUE	VALUE	IBC-06 REFERENCE
Maximum Considered Earthquake Spectral Response Acceleration (1 sec), S_{M1}	0.91g	1.05g	1.68g	Section 1613.5.3 (Eqn 16-38)
5% Damped Design Spectral Response Acceleration (0.2 sec), S_{DS}	1.3g	1.3g	1.16g	Section 1613.5.4 (Eqn 16-39)
5% Damped Design Spectral Response Acceleration (1 sec), S_{D1}	0.61g	0.70g	1.12g	Section 1613.5.4 (Eqn 16-40)

Conformance to the criteria above for seismic design does not constitute any kind of guarantee or assurance that significant structural damage or ground failure will not occur in the event of a large earthquake. The primary goal of seismic design is to protect life, not to eliminate all damage, since such design may be economically prohibitive. Cumulative effects of seismic events are not included in the code and regular maintenance and repair following significant seismic events (i.e., M_w4.5) will be necessary.

In case of conflict, the most conservative values in the above tables should likely govern design. These seismic design parameters are considered valid for the approximate geographic center of the Ranch and will vary depending upon the selected location within the project boundaries, and the soil profile at the selected location. Thus, seismic design should be re-evaluated during the 40- or 100-scale grading plan review and at the conclusion of grading.

GROUNDWATER

Historical well water data for wells near the site indicate that groundwater levels have significantly fluctuated in the past depending upon the amount of up-gradient precipitation. High groundwater stands and artesian conditions have been recorded within parts of the El Rancho Verde Golf Course area of Neighborhood II (GSRA, 1994b). Historic groundwater levels reported by CDWR (2006) in a well near Neighborhood II, ranged from 25 and 171 feet deep between the years 1928 and 2000. CDWR (2006) also reports that historic groundwater depths in a well near Neighborhood III between January and July 1992 fluctuated between 237 and 267 feet. Historic groundwater records in a well near Neighborhoods I and IV indicated that groundwater levels alternated between ±19 and ±108 feet between 1919 and 2000 (CDWR, 2006). Seeps and standing water, likely perched groundwater, were encountered in previous subsurface explorations at the site by GSRA (1994b), LOR (1994b), and STE (1988). During GSI's most recent fault investigation, within younger alluvial areas in PA 8 (Sycamore Flat) of Neighborhood I, localized perched groundwater was encountered at depths as shallow as about 8½ feet. Elsewhere within PA 8, perched groundwater was encountered along discontinuities in the bedrock and older alluvial fan deposits, or along unconformable contacts with permeability contrasts (i.e., relatively permeable sediments underlain by aquitards). Groundwater was not encountered during GSI (2006a and 2007a) in Neighborhoods II and III. GSI (1994) indicated that groundwater in the vicinity of Neighborhoods II and III appeared to be deeper than 75 to 100 feet based upon the levels of the nearby open-pit mines. These observations reflect site conditions at the time of our investigations and do not preclude changes in local groundwater conditions in the future from heavy irrigation, precipitation, or other factors not obvious at the time of our field work. Perched groundwater may occur in the future owing to increased precipitation or increased irrigation and runoff from urbanization, or along zones of contrasting permeabilities (i.e., younger and older alluvial fan deposit/bedrock contacts or discontinuities). It is also possible that following periods of high precipitation, artesian/spring conditions may occur; however, in view of the general permeability of the site alluvial materials, this is considered unlikely, but may not be precluded.

According to (Fife, *et al.*, 1976), several groundwater barriers transect the project area. None of these possible groundwater barriers appear to be effective at shallow depths (depths less than 50 to 75 feet). According to GSRA (1994b), the groundwater barriers are evidently not fault associated based on field data or reviewed aerial photographs, and may be the result of older, inactive faults, or may be a result of the subsurface stratigraphy. However, it should be noted that the possible groundwater barriers indicated by (Fife, *et al.*, 1976), within Neighborhood II, are located in close proximity to Holocene faults identified in GSRA (1994a and 1994b) and GSI (2006a).

OTHER GEOLOGIC HAZARDS

Exhibit 1 is an Index Map for the various neighborhoods. Plates 1 though 4 follow and show project geologic hazards discussed previously, as well as below.

Liquefaction Potential

Seismically induced liquefaction is a phenomenon in which cyclic stresses, produced by earthquake-induced ground motion, create excess pore pressures in soils. The soils may thereby acquire a high degree of mobility and lead to lateral movement, sliding, sand boils, consolidation and settlement of loose sediments, and other damaging deformation. This phenomenon occurs only below the water table; but after liquefaction has developed, it can propagate upward into overlying, non-saturated soil as excess pore water dissipates. Typically, liquefaction has a relatively low potential at depths greater than 50 feet and is unlikely and/or will produce vertical strains well below 1 percent for depths below 60 feet when relative densities are 40 to 60 percent and effective overburden pressures are two or more atmospheres (i.e., 4,000 psf [Seed, 2005]).

LEGEND FOR PLATES 1-4

Afr	Artificial fill - roadway
Afu	Artificial fill - undocumented
Qafy	Quaternary alluvial fan deposits - young
Qal	Quaternary alluvium
Qaf	Quaternary alluvial fan deposits
Qafo	Quaternary alluvial fan deposits - older
Ttp	Tertiary Granodioorite of Telegraph Peak
Kgm	Cretaceous leucocratic muscovite monzogranite
Kgc	Cretaceous mylonitic leucogranite
Pps	Paleozoic Pelona schist

Approximate location of geologic contact

Approximate area of geologic hazard - active fault zone

Approximate area of geologic hazard - high liquefaction

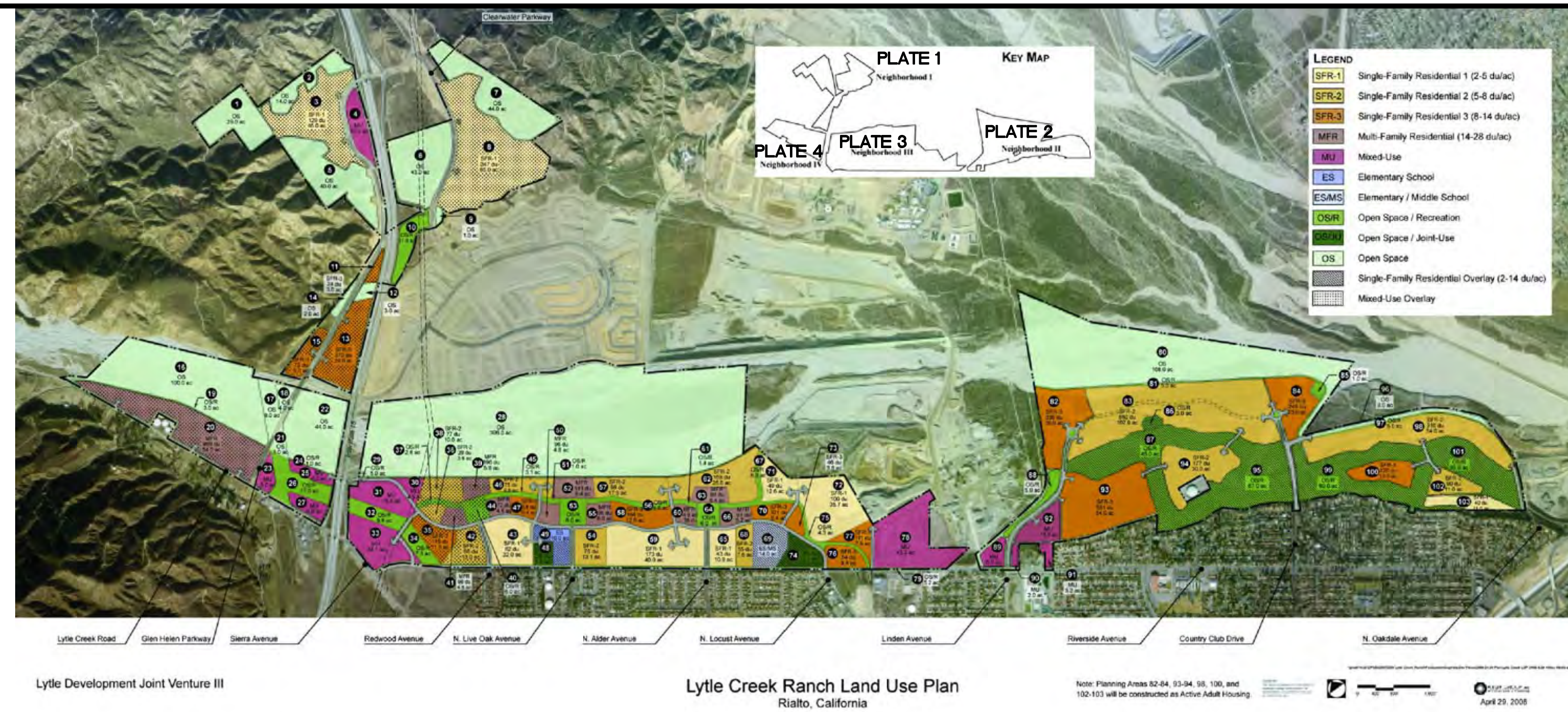
Approximate area of geologic hazard - low liquefaction

Approximate area of geologic hazard - debris flow

Approximate area of geologic hazard - slope instability

Approximate area of geologic hazard - rock fall

Approximate area of geologic hazard - ridgetop shattering



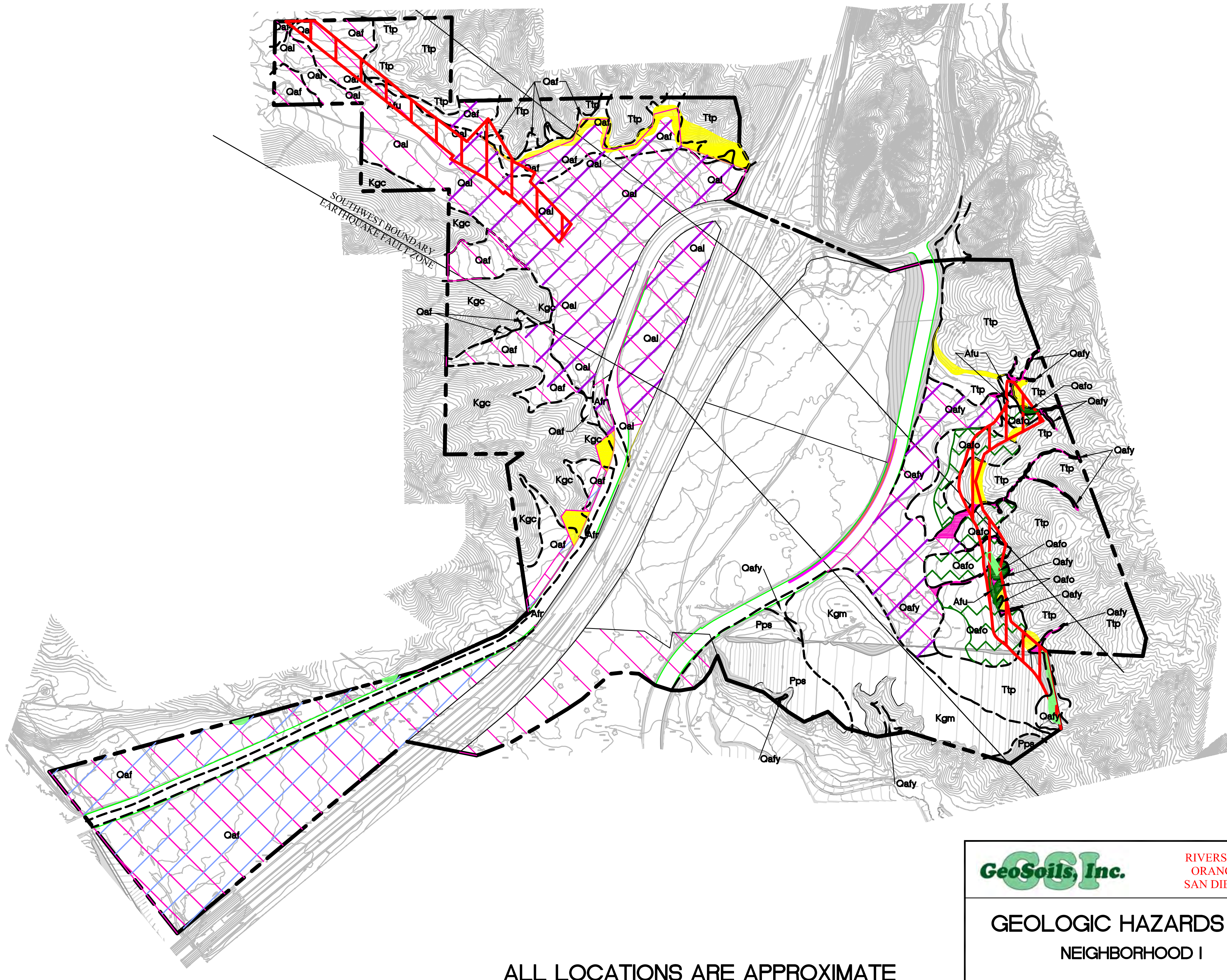
GeoSoils, Inc.

RIVERSIDE CO.
ORANGE CO.
SAN DIEGO CO.

INDEX MAP

Exhibit 1

W.O. 5409-A3-SC	DATE 05/08	SCALE Bar Scale



SEE EXHIBIT 1 FOR LEGEND

ALL LOCATIONS ARE APPROXIMATE

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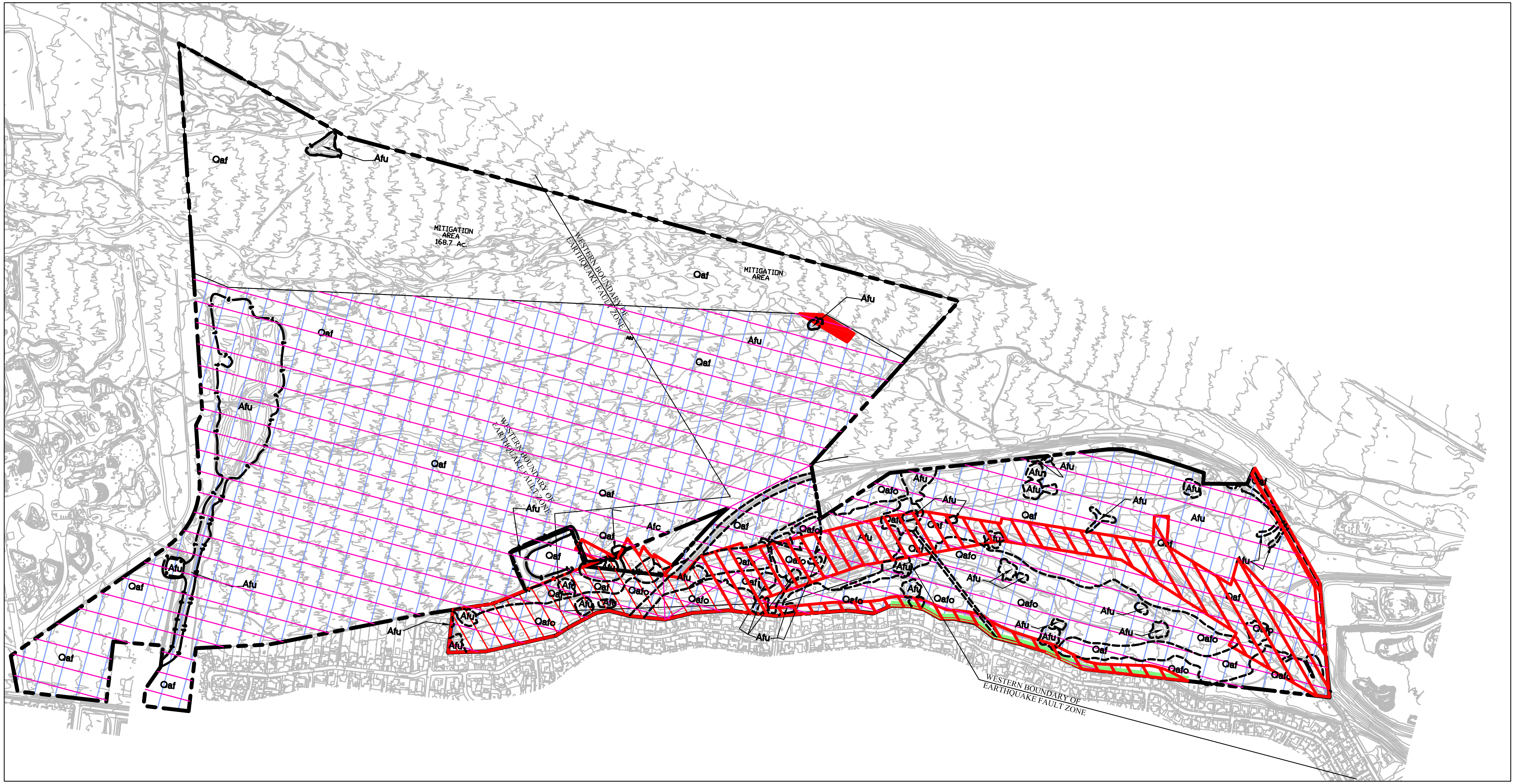
RIVERSIDE CO.
ORANGE CO.
SAN DIEGO CO.

GEOLOGIC HAZARDS MAP

NEIGHBORHOOD I

Plate 1

W.O. 5409-A3-SC	DATE 05/08	SCALE 1"=800'



SEE EXHIBIT 1 FOR LEGEND

ALL LOCATIONS ARE APPROXIMATE

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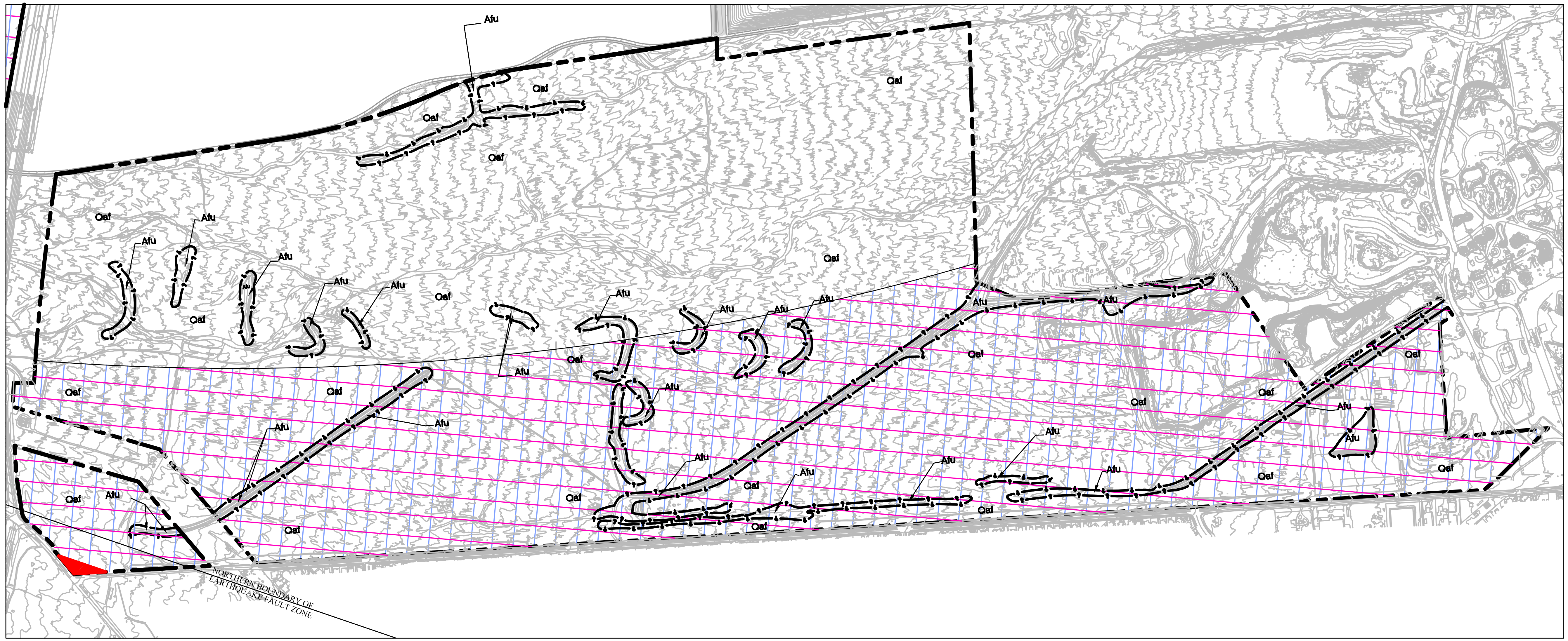
GEOLOGIC HAZARDS MAP

NEIGHBORHOOD II

Plate 2

W.O. 5409-A3-SC	DATE 05/08	SCALE 1"=1000'



SEE EXHIBIT 1 FOR LEGEND

ALL LOCATIONS ARE APPROXIMATE

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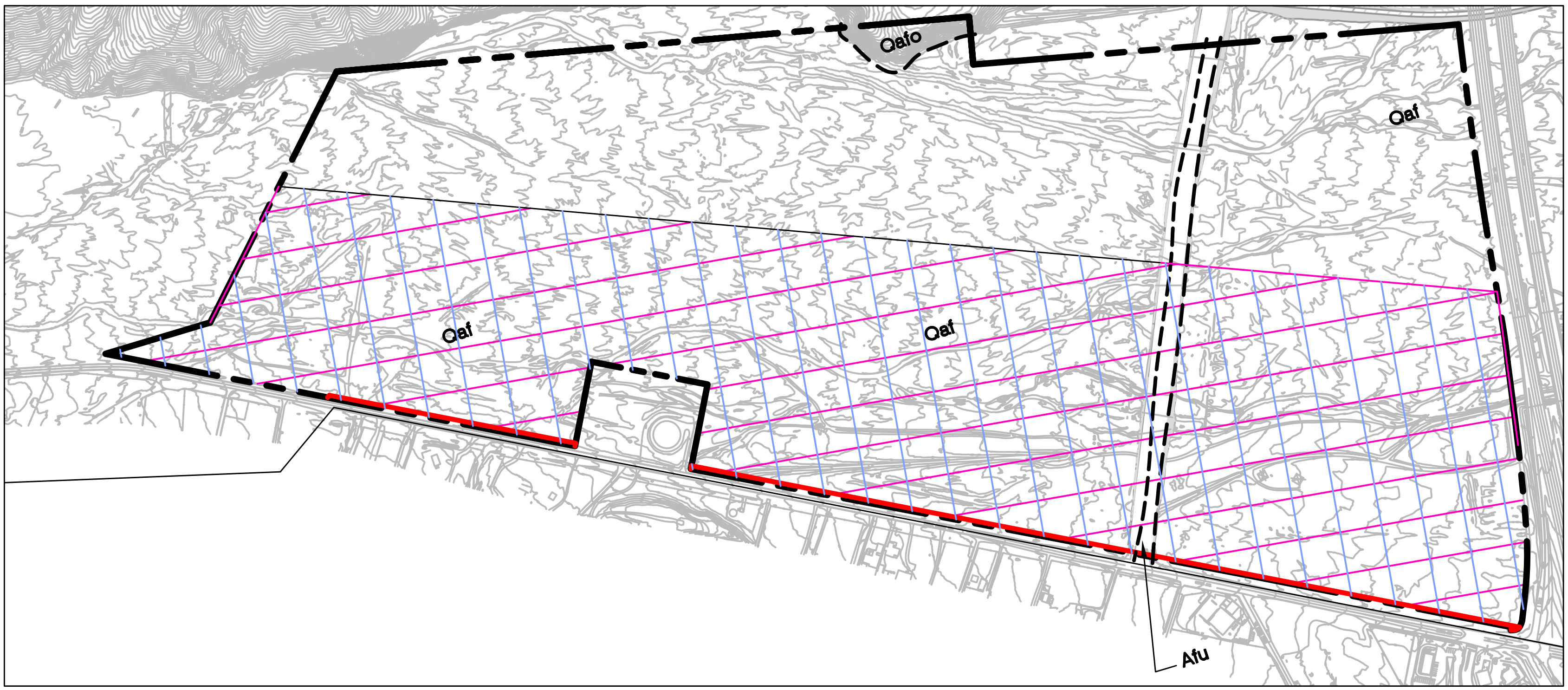
GEOLOGIC HAZARDS MAP

NEIGHBORHOOD III

Plate 3

W.O. 5409-A3-SC	DATE 05/08	SCALE 1"=1000'



ALL LOCATIONS ARE APPROXIMATE

SEE EXHIBIT 1 FOR LEGEND

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GEOLOGIC HAZARDS MAP

NEIGHBORHOOD IV

Plate 4

W.O. 5049-A3-SC	DATE 05/08	SCALE 1"=800'

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Liquefaction has two principal effects. One is the consolidation of loose sediments with resultant settlement of the ground surface. The other is lateral sliding. Significant, permanent lateral movement generally occurs only when there is considerable differential loading on susceptible soils, such as fill or natural ground slopes on alluvium.

Liquefaction susceptibility is related to many factors and the following conditions should be present for liquefaction to occur: 1) sediments must be relatively young in age and not be strongly cemented; 2) sediments generally consist of medium- to fine-grained, relatively cohesionless sands; 3) the sediments must have low relative density; 4) free groundwater must be present in the sediment, and; 5) the site must experience a seismic event of a sufficient duration and magnitude to induce straining of soil particles.

GSI (1997) previously evaluated the potential for liquefaction to occur at a proposed school site in Neighborhood III. Based upon the absence of paleoliquefaction features in open-pit mines and trenches during field work in preparation of GSI (1994), our experience with similar sites, laboratory testing, and engineering analysis, GSI concluded that liquefaction has a low potential to occur at the proposed school site, and that it did not constitute an unacceptable risk to development, from a geotechnical viewpoint, even if the regional water table should rise as a result of urbanization (irrigation), or perched groundwater conditions develop. However, this investigation currently does not meet the standards of practice as specified in Special Publication 117 (CDMG, 1997), which provides more onerous guidelines for evaluating liquefaction potential. Additionally, GSI observed a gravel dike in older, alluvial sediments during field work in preparation of GSI (2006a) and local paleoliquefaction features in mid-Holocene and younger alluvium within the Sycamore Canyon area of Neighborhood I (GSI, 2007a), and GSI (1999b) further concluded that paleoliquefaction features were mis-identified as faults in LOR (1994b) within the Sycamore Flat area of Neighborhood I. Thus, site-specific liquefaction evaluations should be performed since future performance of the site with respect to liquefaction should be similar to the past. Depending upon the magnitude of liquefaction-induced settlement, engineered foundation design and/or ground-improvement techniques are considered acceptable mitigation measures of this potential condition.

Settlement

The low-lying alluvial areas of the site have local potential for dry sand settlement, and differential settlement (both static and seismic). This will need evaluation with respect to settlement-sensitive improvements, buildings, and critical infrastructure and would be best performed at the 40- or 100-scale grading plan review stage.

Subsidence

Our experience in the site vicinity and review of readily available data indicate that the project area is not subsiding. Lu and Danskin (2001) suggest that, in fact, the site area may actually be uplifting, based on rising groundwater levels. Subsidence typically occurs due to down-faulting along bordering fault zones and although unlikely, to regional groundwater withdrawal.

The effects of areal subsidence generally occurs at the transition between sediments with substantially different engineering properties. Based on available data, bedrock underlies all alluvial deposits throughout the site; therefore, this potential is considered low. The stereoscopic aerial photographs (Appendix A) also show no features generally associated with areal subsidence (i.e., radially-directed drainages flowing into a depression(s), linearity of depressions associated with mountain fronts).

Ground fissures are generally associated with rapid groundwater withdrawal and associated subsidence, or active faults. Our review did not indicate that rapid groundwater withdrawal is occurring at this time. In the site, should fault-induced subsidence (or uplift) occur, it would be inherently mitigated by the recommended setback zones.

Mass Wasting and Slope Stability

Mass wasting refers to the various processes by which earth materials are moved down slope in response to the force of gravity. Indications of seismically induced or deep-seated landsliding, slope creep, or significant surficial failures on the site were not observed during field work in preparation of GSI (1994, 2006a, and 2007a). However, slope failures have been recorded by LOR (1994b) in the Sycamore Canyon area of Neighborhood I, bordering the west side of PA 3. According to Morton and Matti (2001), the greenstone facies of the Pelona Schist is landslide prone. Cohesionless natural sediments, and proposed fills within the Ranch should be considered erosive.

GSI (1999a and 2003) included slope stability evaluations for the nearby Tract 15900, which was once part of the overall conceptual plan. The data and conclusions, regarding fill slope stability, discussed in these reports could generally be applied when evaluating fill slope stability for most of the project because of the similarity of the parent, alluvial sediments across a majority of the project area. However, the variable orientation of natural and proposed cut slopes, and geologic structure does not allow the same application for areas outside of Tract 15900. According to GSI (1999a and 2003), calculated factors-of-safety greater than 1.5 or 1.15 were previously obtained for assumed maximum anticipated fill slopes, when analyzed from a static or pseudo-static (seismic) viewpoint, respectively. Previous surficial stability calculations also indicated a surficial safety factor greater than 1.5 for proposed fill slopes, under normal conditions of care, maintenance, and rainfall. GSI recommends that site-specific, geotechnical studies and slope stability evaluations be performed on significant fill, cut, and natural slopes, once actual grading plans have been prepared.

Due to the non-cohesive materials that exist within most of the site, caving and sloughing should be anticipated in all subsurface excavations and trenching. Appropriate safety considerations for potential caving and sloughing, such as shoring or layback cuts, should be incorporated into the construction design details. All excavations should be observed by an engineering geologist or soil engineer, prior to workers entering the excavation or trench, and minimally conform to Cal-OSHA, state, and local safety codes.

Rockfalls

Although our previous investigations generally did not indicate significant rockfalls within the areas of proposed development, many highly fractured outcrops occur in the highland areas of Neighborhood I. Large rocks may become dislodged due to erosion or significant seismic events and could potentially impact the proposed development. Therefore, this potential hazard should be evaluated by appropriate geotechnical studies.

Ridge-top Shattering

The project was also evaluated for the presence of "shattered ridges." Research from the San Fernando earthquake (Evans, 1975) indicates shattered ridges are the manifestation of locally intense ground motion from an earthquake. Factors that contribute to ridge-top shattering generally include earthquake magnitude and proximity, topography, rock type, and structure. According to the California Geological Survey (CGS, 2004), the most extensive ridge-top cracking occurred as a result of M6.7, or greater, earthquakes. Amplification of seismic waves on ridge-tops are apparently due to a topographic focusing effect. CGS (2004) states that a majority of the sites that have exhibited ridge-top shattering are underlain by firm to weak sedimentary rocks of Late Cretaceous- and Cenozoic-ages. Typically, the beds of the formational sediments in shattered ridges are generally oriented parallel or sub-parallel to the trend of the ridgeline.

Based on observations and logging during our investigations, all the factors mentioned above probably exist in Neighborhood I, or have the potential to occur, as the SJFZ is capable of a M6.7 seismic event; ridgelines, primarily Lower Lytle Creek Ridge-Verdemont Hills, and to a lessor extent Penstock Ridge, are located within Neighborhood I; formational sediments appear to vary in levels of induration (i.e., weakly to well indurated); and, the recorded strikes of bedding are generally sub-parallel to the trend of the ridgeline, at least locally.

Debris Flows/Flooding/Inundation

Evidence for major active debris flows that may impact the subject development was generally not specifically noted on the property and on aerial photographs. However, the potential for large debris flows within drainages and tributary canyons is moderate to high under present soil cover, vegetation, and excessive precipitation conditions and may be further exacerbated in burn areas. Further, low-lying areas of the project are underlain by alluvial deposits that owe their origin, at least in part, to irregular flooding. In consideration of the potential for prolonged rainfall, possible brush fires, and vegetation denudation, we recommend that the project civil engineer consider using debris/desilting/detention basins and/or debris impact walls with sufficient freeboard where swales or their watershed intersect the proposed development. Further, we recommend that the project civil engineer evaluate the site for flooding associated with catastrophic failure of flood control devices, and up-gradient water-storage tanks and aqueduct during an earthquake.

Seiches

Seiching refers to the periodic oscillation of a enclosed or semi-enclosed body of water which often occurs during, and following an earthquake. Considering that the site is located within, and in close proximity to, significant seismic zones and proposed development likely includes the construction of lakes for at least one golf course and landscape aesthetics, there is high potential for seiching and associated down-gradient flooding within Neighborhood II. This potential should be evaluated when the location, and side and bottom configuration of any proposed lake(s), become available. Seiche potential for any up-gradient or adjacent existing lakes should also be evaluated.

LABORATORY TESTING

A variety of laboratory testing procedures have been utilized during previous studies by GSI and others during earlier investigations (GSI,1997 and 1999a). These tests served to generally classify and evaluate soil parameters for earth materials exposed throughout the overall site area. Typical testing included moisture-density, laboratory maximum densities, consolidation testing, shear testing, expansion index testing, corrosion, etc.

In general, site soils are typically very low to low in expansive potential, although soils with medium to high or very high expansion characteristics may exist locally within portions of the site (e.g., primarily PA 8 in Sycamore Flat). Variations may occur and additional expansion index testing should be performed during future development to further evaluate conditions subsequent to grading.

Site soils typically have negligible sulfate contents and are slightly to medium acidic with respect to soil pH. Such soils are not generally problematic with respect to concrete and ferrous metals, where in contact. Similar to above, additional testing of site materials and evaluation by a corrosion engineer is recommended during future geotechnical studies and when proposed grading is complete, to further evaluate these findings.

PRELIMINARY SETTLEMENT ANALYSES

Preliminary settlement analyses were performed in GSI (1999a and 2003) for the adjacent Tract 15900, assuming all undocumented fill and compressible colluvium and near-surface, younger alluvial materials were removed and replaced with compacted fill. Estimated post-construction, total settlement may exceed about 2 inches or more in the Sycamore Flat area, differential settlement may be on the order of about 1½ inches, or more, and dynamic settlements in this area may be on the order of about 2 inches. Estimated post-construction total settlement for proposed fills in alluvial areas (the majority of the site), should be less than 1 inch, differential settlements may be on the order of ¾-inch, and dynamic settlement may be on the order of about ¼- to ½-inch, over 40 feet, on a preliminary basis. Also on a preliminary basis, angular distortion is estimated at about 1/480 to 1/384. Properly designed post-tensioned/mat foundations, or other forms of mitigation, may be necessary in deeper fill areas (fills in excess of 30 feet thick, depending on buried subsurface topography and fill differential thicknesses across the proposed structures), or due to seismic considerations (including liquefaction) and/or dynamic and differential settlement. Settlement evaluations should be performed for the proposed Lytle Creek Ranch project during future, site-specific geotechnical investigations, based on site specific conditions and current standards of practice.

PRELIMINARY EARTHWORK FACTORS

Preliminary earthwork factors (shrinkage and bulking) for the subject property have been previously estimated based upon GSI's field and laboratory testing, visual site observations, and experience. It is apparent that shrinking would vary with depth and with areal extent over the site based on previous site use. Variables include vegetation, weed control, discing, and previous filling or exploring. However, all these factors are difficult to define in a three-dimensional fashion.

Therefore, the information presented below represents preliminary average shrinkage/bulking values:

Undocumented Artificial Fill, Colluvium, and Young Fan Deposits (Afu and Qafy) .... 15-20% shrinkage
Alluvium and Alluvial Fan Deposits (Qal & Qaf) .... 10-20% shrinkage
Older Alluvial Fan Deposits (Qaf_o) .... 5% shrinkage to 5% bulking
Granitic and Metamorphic Bedrock (Ttp, Kgm, Kgc, and Pps) .... 0-5% bulking

An additional shrinkage factor item would include the removal of root systems of individual large plants or trees. These plants and trees vary in size but, when pulled, they may generally result in a loss of ½- to 1½ cubic yard(s), to locally greater than 3 cubic yards of volume, respectively. This factor needs to be multiplied by the number of significant plants, trees, or tree roots present to determine the net loss. Subsidence in non-bedrock areas is anticipated to be on the order of 0.1 to 0.2 feet, depending on haul routes and equipment used. Further, the degree of compaction attained by the contractor, as well as any oversize material required to be removed from the fill, will also affect shrinkage The above facts indicate that earthwork balance for the site would be difficult to define and flexibility in design is essential to achieve a balanced end product.

PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

Based on our previous and current field exploration, laboratory testing, our engineering and geologic analyses, and review of background information (see Appendix A), it is GSI's opinion that the overall project is compatible and favorable with respect to the geologic constraints onsite, from a geologic and geotechnical viewpoint, provided our recommendations are properly incorporated in the planning, design, grading, and construction considerations. Plates 1 through 4 indicate areas of specific geologic/geotechnical considerations discussed generally below:

1. Active faulting has been identified by GSI (1994, 1999b, 2006a, 2007a, and the in-progress investigation within PA 8), GSRA (1980, 1982a, 1982b, 1994a, and 1994b), and LOR Geotechnical Group, Inc. (LOR, 1994b) within the Lytle Creek Ranch project area. Setbacks for structures for human occupancy are therefore warranted. Setback zones are also warranted for portions of the site, located within, or adjacent to Alquist-Priolo Earthquake Fault Zones (APEFZ) where subsurface investigation was limited due to existing infrastructure (roads and underground utilities), or was not performed due to proposed land use. As discussed previously, setback zones are indicated on Plates 1 through 4.

2. Active faults, identified in GSI (2006a), project toward residential PA 98 and Open Space/Recreational PA's 95 and 97 (Neighborhood II). Additional investigation in PA 98 is recommended to evaluate residential development constraints due to potential, active faulting. Similarly, additional investigation in Open Space/Recreational PA's 95 and 97 (Neighborhood II) is recommended to evaluate development constraints due to potential, active faulting, should structures for human occupancy (i.e., golf course, clubhouse, community centers, etc.) be proposed in those areas.

3. With the exception of the aforementioned areas, our review of available data and literature, subsurface investigations, and soil stratigraphy indicates that active faults likely do not exist within the remainder of the property, or are not sufficiently active or well-defined to satisfy Alquist-Priolo criteria for an active fault, or exist in areas that are not proposed for human occupancy (open space). Further, such hypothetical faults would have far less recurrence than typical activity associated with the San Jacinto fault zone (SJFZ) and should have such small, cumulative displacements that they should be effectively mitigated by engineering design, engineering design includes the use of post-tension foundations/structural slabs, and overexcavation. Evidence of faulting associated with the previously mapped onsite groundwater barriers was not observed on the site, in the field, or on the aerial photographs reviewed.

4. The site is in an area of potentially high seismic activity and horizontal seismic accelerations are anticipated to be near 1g, should the design earthquake occur.

Accordingly, there is a potential for more onerous, near-field seismic effects (based on the type and size of the seismic source, distance, and geological aspects), and therefore appropriate mitigation, should be provided based on site specific geotechnical investigations.

5. Ground lurching or deformation and/or tectonic subsidence or uplift at the site as a result of seismic activity should be inherently mitigated by the recommended setback zones, and by typical engineering design/mitigation.

6. Major underground or above-ground utility lines should cross active faults at high angles approaching perpendicular. Cut-off valves should be located on either sides of active fault zones to facilitate repair.

7. Historical well water data for near-site wells indicate that regional groundwater levels have significantly fluctuated in the past, depending upon the amount of up-gradient precipitation. High groundwater stands and artesian conditions have been recorded within parts of the El Rancho Verde Golf Course area of Neighborhood II. Historic groundwater levels in a well near Neighborhood II, ranged from 25 and 171 feet deep between the years 1928 and 2000. Historic groundwater depths in a well near Neighborhood III between January and July 1992 fluctuated between 237 and 267 feet. Historic groundwater records in a well near Neighborhoods I and IV indicated that groundwater levels alternated between ±19 and ±108 feet between 1919 and 2000. Seeps and standing water, likely perched groundwater, were encountered in previous subsurface explorations at the site. During GSI's most recent fault investigation, localized perched groundwater was encountered within younger alluvial areas in PA 8 (Sycamore Flat) of Neighborhood I at depths as shallow as about 8½ feet. Elsewhere within PA 8, perched groundwater was encountered along discontinuities in the bedrock and older fan deposits, or along unconformable contacts with permeability contrasts (i.e., relatively permeable sediments underlain by aquitards).

   Accordingly, the use of subdrains in canyon areas, or within fill lots underlain by bedrock is recommended. Additional subdrains may be required during or after grading. Subdrain outlets should be reviewed by the project design engineer to mitigate the effects of discharge, scouring, and erosion. Further, the design of foundations should consider the potential for perched water conditions (i.e., lower water/cement ratio, more onerous slab underlayment and thickness, thicker vapor retarder, etc.). Thickened edges and cut-off walls for improvements adjoining landscaping areas may be necessary. Grading in areas of high groundwater will need to consider the time of year construction is performed, and the need for drying-back of excavated materials to be placed as compacted fill and/or mixing of such wet/saturated soils with drier materials. The need for dewatering to facilitate remedial removals cannot be entirely precluded in areas of PA 8 underlain by young alluvial fan deposits, and perhaps elsewhere.

8. GSI evaluated the potential for liquefaction to occur at a proposed school site in Neighborhood III. However, this evaluation pre-dates Special Publication 117 (CDMG, 1997), which provides currently accepted guidelines for evaluating liquefaction. Further, GSI observed paleoliquefaction in older, alluvial deposits in Neighborhood II during field work in preparation of GSI (2006a) and in mid-Holocene and younger, alluvial deposits within the Sycamore Canyon area of Neighborhood I during field work in preparation of GSI (2007a). Additionally, GSI (1999b) reports that paleoliquefaction features may have been mis-identified as faults by LOR (1994b) within the Sycamore Flat area of Neighborhood I. Thus, it is recommended that site-specific, liquefaction analyses be performed within the overall project area. Depending upon the magnitude of liquefaction-induced settlement, engineered foundation design and/or ground-improvement techniques are considered acceptable mitigation measures of this potential condition.

9. The potential for settlement and differential settlement should be further evaluated with respect to the tolerance of proposed improvements to be affected by such, based on site-specific geotechnical studies. Depending on the results of those investigations, deep foundations may be required in areas with a high potential for liquefaction, differential settlement, or where heavy building loads are proposed. Differential settlement may be further reduced by laying-back subsurface bedrock geometry, so that the gradient below the pads is no steeper than 3:1 (h:v), keeping the thickness of fill relatively uniform, and compacting the fill to 95 percent of the laboratory standard. Typical standards of practice and industry guidelines require fills thicker than 50 feet in depth (plan and remedial), to be placed at 95 percent of the laboratory standard.

10. Subsidence should be inherently mitigated by the recommended setback zones. If improvements are proposed within setback areas, or structures for human occupancy are proposed in open space/recreation areas, this potential may need to be further evaluated by additional geotechnical investigations. Mitigation may include open space use, improvements that are not settlement sensitive, habitat corridors, etc.

11. Some of the soils on the project are considered erosive, and localized areas of slope failures have occurred onsite, primarily in Neighborhood I. Portions of Neighborhood I also have an elevated potential for rockfall from adjoining highland areas. Additionally, some cut slopes in Neighborhood I exhibit relatively cohesionless sediments. Accordingly, site-specific geotechnical studies and slope stability analyses should be performed on significant fill, cut, and natural slopes, once grading plans have been prepared. Mitigation of such conditions, identified above, may include one or a combination of the following: buttress or stabilization fills with appropriate factors-of-safety (including placing compacted non-structural fill against existing slopes subject to erosion/failure); retaining walls with sufficient freeboard to contain the failed materials; elevating pads sufficiently that they are not

significantly impacted by the failed soils; constructing berms or gabions to protect pads from surficial failures or rockfall; or rock bolting. Other methods of mitigation would need to be evaluated on a case-by-case basis.

12. The potential for ridge-top shattering is elevated in portions of Neighborhood I. Site-specific geotechnical investigations will be required to identify where mitigation should be performed. Mitigation measures may include a compacted fill blanket (overexcavation), and engineering design, incorporating post-tension/structural slabs, mat, or deep foundations.

13. The project civil consultant should evaluate the potential for down-gradient flooding due to precipitation runoff or regional debris flows and/or catastrophic failure of any critical structures (flood-control levees, water tanks, and aqueducts), that may occur as a result of seismic activity.

14. The potential for seiching (and associated down-gradient flooding) in planned lakes should be performed when the location, and side and bottom configuration of the lakes become available. This potential should also be evaluated for any existing lakes that are to remain after construction, if located up-gradient or adjacent to any proposed construction.

15. As indicated above, site-specific preliminary geotechnical studies will be necessary for future development considerations. Such studies will need to address specific onsite geotechnical conditions including, but not limited to: remedial removal depths, foundation designs, slope stability, liquefaction, settlement, and soil and bedrock engineering properties based on subsurface sampling, associated laboratory testing, and engineering analyses, etc.

16. Adverse geologic structures that would preclude overall project feasibility were not encountered.

17. The recommendations presented in this report should be incorporated into the planning, design, grading, and construction considerations of the project.

General

1. Geotechnical engineering and compaction testing services should be provided during all grading operations to assist the contractor in removing unsuitable soils and in his effort to compact the fill.

2. Geologic observations should be performed during any grading to verify and/or further evaluate geologic/geotechnical conditions. Although unlikely, if adverse geologic structures are encountered, supplemental recommendations and earthwork may be warranted.

3. In general and based upon the available data to date, groundwater is not expected to be a major factor in development of the site. However, due to the nature of the site materials, seepage may be encountered, and should be anticipated, throughout the site along with seasonal perched water within any drainage areas. In addition, seepage may be encountered in "daylighted" impermeable layers within the onsite sediments, or within joints or fractures in bedrock. Thus, subdrain systems are recommended within canyon areas, where filled. In addition, subdrainage systems for the control of localized groundwater seepage should be anticipated. Preliminary subdrain locations can be provided when site specific grading plans become available.

4. Due to the noncohesive nature of some of the onsite materials, some caving and sloughing may be anticipated to be a factor in subsurface excavations and trenching. Therefore, current local and state/federal safety ordinances for subsurface trenching should be enforced.

5. General Earthwork, Grading Guidelines, and Preliminary Criteria are provided at the end of this report as Appendix C. Additional recommendations are provided below.

Demolition/Grubbing

1. Any existing surficial/subsurface structures, major vegetation, tree remains, and any miscellaneous debris should be removed from the areas of proposed grading.

2. The project geotechnical engineer should be notified of any previous foundation, irrigation lines, cesspools, septic tanks, leach fields, or other subsurface structures that are uncovered during earthwork and/or remedial grading, so that appropriate mitigation recommendations can be provided.

Treatment of Existing Ground

1. In areas proposed for settlement-sensitive improvements, all undocumented fill (including all trenches and test pits), colluvium, young alluvial fan deposits, near-surface alluvium and alluvial fan deposits, weathered older alluvial fan deposits, and weathered bedrock should be removed, cleaned of deleterious materials, as necessary, moisturized, and recompacted. Based upon a review of GSI (1997) which provided preliminary remedial removal depths in alluvial fan deposits that is generally similar to alluvium and alluvial fan deposits throughout the entire project and the known depths of undocumented fill associated with previous investigations of the site, preliminary removal depths may be on the order of 2 to 31 feet below existing grades. However, deeper removal cannot be precluded and should be anticipated. On a preliminary basis, the field testing criteria for determining suitable bearing soils are an in-place dry density of at least 105 pcf and/or an in-place degree of saturation of at least 85 percent and/or a relative dry

density of 85 percent of the laboratory standard (ASTM D 1557). This criteria has been accepted in various agency jurisdictions throughout various counties in California. It is recommended that additional site-specific geotechnical studies to further evaluate remedial removal quantities be performed in proposed development areas at the time 40- or 100-scale grading plans have been prepared. Actual depths of removals will likely be further evaluated in the field during grading by the soil engineer.

2. Any previous foundations, or remnants of foundations, appurtenant structures, and improvements, cesspools, septic tanks, leach fields, or other subsurface structures uncovered during the recommended removal and recompaction work should be observed by GSI so that appropriate remedial recommendations can be provided during grading.

3. Cavities, loose soils, soft soils, etc. remaining after demolition and site clearance should be cleaned out, inspected by the geotechnical engineer, processed, and replaced with fill which has been moisture conditioned to <u>at least</u> optimum moisture content and compacted to at least 90 percent of the laboratory standard (ASTM D 1557).

4. Remedial removals may also necessitate a special zone (boundary zone) of consideration, on perimeter/confining areas where removals cannot be conducted (laterally or vertically) due to constraints from property boundaries, underground utilities, easements, flood control devices, etc. This potential "perimeter" zone would be approximately equal to the depth of removals, if removals cannot be performed offsite. Thus, any settlement-sensitive improvements (walls, curbs, flatwork, etc.), constructed within this potential, partially mitigated boundary zone may require deepened foundations, reinforcement, etc., or will retain some potential for settlement and associated distress and should be incorporated into project plans and foundation systems. This will require proper disclosure to all owners and any owners association, if this condition exists at the conclusion of grading.

5. Subsequent to the above removals, the upper 12 inches of the exposed subsoils/bedrock should be scarified. In the lowlands alluvial/Holocene-age alluvial fans, the subsoils should be flooded/saturated an additional 3 feet below the removal bottoms, and vibratory compacted in place. In areas of Neighborhoods I, II, and IV underlain by bedrock and/or Pleistocene-age fans, the subsoils should be brought to <u>at least</u> optimum moisture content. All scarified removal bottoms should be recompacted to a minimum relative compaction of 90 percent of the laboratory standard (ASTM D 1557) prior to fill placement.

6. Removed soils may be reused as compacted fill provided that major concentrations of vegetation and miscellaneous debris are removed prior to, or during fill placement.

7. Localized deeper removals may be necessary due to buried drainage channel meanders or dry porous materials. The project geotechnical engineer should observe all removal areas during grading.

8. Considering the site's seismic setting and the potential for earthquake waves to attenuate through the relatively deep alluvium that underlies the site, ground improvement techniques and/or increased relative compaction requirements for placed fill soils may reduce damaging near-source effects.

Fill Placement

1. Fill materials should be brought to at least optimum moisture content, placed in thin 6- to 8-inch lifts and mechanically compacted to obtain a minimum relative compaction of 90 percent of the laboratory standard (ASTM D 1557). Fill greater than 50 feet in depth should be compacted to at least 95 percent of the laboratory standard (ASTM D 1557).

2. Fill materials should be cleansed of major vegetation and debris prior to placement.

3. Any oversized rock materials greater than 12 inches in diameter should be placed under the observation of the geotechnical engineer. Per code, materials greater than 12 inches in diameter should not be placed within 10 feet of finish grades. Preliminary rock disposal recommendations are provided in the "Rock Placement Guidelines" section of this report.

4. Any import materials should be observed and determined suitable by the geotechnical engineer prior to importation or placement on the site. At least three days of lead time is recommended prior to importing so that appropriate laboratory testing can be completed. Foundation designs may be altered if import materials have a greater expansion value than the onsite materials encountered in this investigation.

Subdrains

Local seepage along the contact between the relatively impermeable sediments and overburden materials or along bedding within the relatively impermeable sediments may require a subdrain system. Where removals are below the subdrain flow line, the removal materials may be reused as compacted fill provided they are granular, and at a moisture content of at least 2 percent over optimum moisture content (or 1.2 times optimum moisture content, whichever is greater). Subdrains should also be placed in natural drainage channels where the overlying, fill thickness is 10 feet or greater. Subdrain construction should adhere to the guidelines presented in Appendix C.

Slope Considerations and Slope Design

Based on our review and experience with similar projects, proposed cut and fill slopes constructed using onsite materials, to the likely heights proposed, should be grossly and surficially stable provided the recommendations contained herein are implemented during site development, under normal conditions of care, maintenance, and rainfall. All natural and significant, graded slopes (greater than about 20 feet in height) will require further geotechnical studies and analyses when 40- to 100-scale grading plans are made available.

All slopes should be designed and constructed in accordance with the minimum requirements of the City and County, the recommendations in the General Earthwork, Grading Guidelines, and Preliminary Criteria section of this report (Appendix C), and the following:

1. Fill slopes should be designed and constructed at a 2:1 (h:v) gradient, or flatter, and should not exceed about 20 feet in overall height without further evaluation. Fill slopes should be properly built and compacted to a minimum relative compaction of 90 percent throughout, including the slope faces. Slopes constructed within some areas of the site will likely use non-cohesive soils. As such, they will be more susceptible to erosion/failure, and should be vegetated immediately after grading, and maintained. Alternatively, they may be constructed at a flatter gradient or utilize selective grading (mixing with more cohesive soils). Guidelines for slope construction are presented in Appendix C.

2. Cut slopes should be designed and constructed at a 2:1 (h:v) gradient, or flatter, and should not exceed about 20 feet in overall height without further evaluation. While stabilization of such slopes is not anticipated, locally adverse geologic conditions (i.e., cohesionless lenses, daylighted bedding, daylighted joints/fractures, or severely weathered bedrock) may be encountered which may require remedial grading or laying back of the slope to an angle flatter than the adverse geologic condition.

3. Local areas of highly to severely weathered bedrock or non-cohesive sands may be present. Should these materials be exposed in cut slopes, the potential for long-term maintenance or possible slope failure exists. Evaluation of cut slopes during grading would be necessary in order to identify any areas of severely weathered rock or non-cohesive sands. Should any of these materials be exposed during construction, the geotechnical engineer/geologist, would assess the magnitude and extent of the materials and their potential affect on long-term maintenance or possible slope failures.

4. Loose rock debris and fines remaining on the face of the cut slopes should be removed during grading.

5. Where loose materials are exposed on the cut slopes, the project's engineering geologist would require that the slope be cleaned as described above prior to making their final inspection. Final approval of the cut slope can only be made subsequent to the slope being fully cut and cleaned.

6. Cut slopes should be mapped by the project engineering geologist during grading to allow amendments to the recommendations should exposed conditions warrant alternation of the design or stabilization.

Transition Areas/Overexcavation

In order to reduce the potential for differential settlements between cut and fill materials or materials of differing expansion potentials, the entire cut portion of cut/fill transitions should be overexcavated to a minimum depth of 3 feet below finish grade or 2 feet below the bottom of foundations (whichever is greater) and replaced with compacted fill. Should fill differential thicknesses exceed 3:1 across the proposed building footprint, the subsurface fill/alluvial or fill/bedrock contact should be removed/laid back to no steeper than 3:1. The intent of the above recommendations is to provide a minimum fill blanket thickness of at least two feet below the lowest foundation elements, including isolated piers or columns (if such design can accommodate the estimated preliminary differential settlement values).

ROCK PLACEMENT GUIDELINES

Rock Disposal

GSI anticipates that soils to be utilized as fill material for the subject project may contain some rock. Appropriately, the need for rock disposal may be necessary during grading operations on the site. From a geotechnical standpoint, the depth of any rocks, rock fills, or rock blankets, should be a sufficient distance from finish grade. This depth is generally the same as any overexcavation due to cut-fill transitions in hard rock areas, and generally facilitates the excavation of structural footings and substructures. Should deeper excavations be proposed (i.e., deepened footings, utility trenching, swimming pools, spas, etc.), the developer may consider increasing the hold-down depth of any rock fills to be placed, as appropriate. In addition, some agencies/jurisdictions mandate a specific hold-down depth for oversize materials placed in fills. The hold-down depth, and potential to encounter oversize rock, both within fills, and in occurring in cut or natural areas, would need to be disclosed to all interested/affected parties. Once approved by the governing agency, the hold-down depth for oversized rock (i.e., greater than 12 inches) in fills on this project is provided as 10 feet.

General

Generally for the purpose of this report, the materials may be described as either 12 inches or less, greater than 12 and less than 36 inches, and greater than 36 inches. These three categories set the basic dimensions for where and how the materials are to be placed.

Materials 12 Inches in Diameter or Less

Since rock fragments along with the overburden materials are anticipated to be a part of the materials used in the grading of the site, a criteria is needed to facilitate the placement of these materials within guidelines which would be workable during the rough grading, post-grading improvements, and serve as acceptable compacted fill.

1. Fines and rock fragments 12 inches or less in diameter may be placed as compacted fill cap materials within the building pads, slopes, and street areas as described below. The rock fragments and fines should be brought to at least optimum moisture content and compacted to a minimum relative compaction of 90 percent of the laboratory standard.

2. The purpose for the 12-inch diameter limit is to allow reasonable sized rock fragments into the fill under selected conditions (optimum moisture or above) surrounded with compacted fines. The 12-inch diameter size also allows a greater volume of the rock fragments to be handled during grading, while staying in reasonable limits for later onsite excavation equipment (backhoes and trenchers) to excavate footings and utility line trenches.

3. Fill materials 12 inches or less in diameter should be placed (but not limited to) within the hold-down depth on proposed fill pads, the upper 3 feet of overexcavated cut areas of cut/fill transition pads, and the entire street right-of-way width, including the proposed overexcavated areas and replacement fill areas, from the depth of the lowest utility (within the street and lot), to subgrade, or to the hold-down depth below finish grade. Overexcavation is discussed later in this report.

Materials Greater Than 12 inches and Less Than 36 Inches in Diameter

1. During the process of bedrock excavation, a significant amount of rock fragments or constituents larger than 12 inches in diameter may be generated. These significant amounts of oversized materials, greater than 12 and less than 36 inches in diameter, may be incorporated into the fills utilizing a series of rock blankets.

2. Each rock blanket should consist of rock fragments of approximately greater than 12 and less than 36 inches in diameter along with fines generated from the proposed cuts and overburden materials from removal areas. The blankets should be limited to 24 to 36 inches in thickness and should be placed with granular fines which are flooded into and around the rock fragments.

3. Rock blankets should be restricted to areas which are at least 1 foot below the lowest utility invert within the street right-of-way, at least the hold-down depth below finish grade on the proposed fill lots, and a minimum of 20 horizontal feet from the face of fill slopes, and outside of any utility laterals.

4. Compaction may be achieved by utilizing wheel rolling methods with scrapers and water trucks, track-walking by bulldozers, and sheepsfoot tampers.

5. Each rock blanket should be completed with its surface compacted prior to placement of any subsequent rock blanket or rock windrow.

6. Minor amounts of rock material in this size range may also be placed a rock windrows (see below).

Materials Greater Than 36 Inches in Diameter

1. Oversize rock greater than 36 inches in diameter should be placed in single rock windrows. The windrows should be at least 15 feet or an equipment width apart, whichever is greatest.

2. The void spaces between rocks in windrows should be filled with the more granular soils by flooding them into place.

3. A minimum vertical distance of 3 feet between soil fill and rock lift should be maintained. Also, the windrows should be staggered from lift to lift. Rock windrows should not be placed closer than 20 feet from the face of fill slopes, and outside of any utility laterals.

4. Larger rocks too difficult to be placed into windrows may be individually placed into a dozer trench. Each trench should be excavated into the compacted fill or dense natural ground a minimum of 1 foot deeper than the size of the rock to be buried. After the rocks are placed in the trench (not immediately adjacent to each other), granular fill material should be flooded into the trench to fill the voids.

5. The oversize rock trenches should be no closer together than 15 feet at a particular elevation and at least 20 feet from any fill slope face. Trenches at higher elevations should be staggered and there should be 4 feet of compacted fill between the top of one trench and the bottom of the next higher trench. Placement of rock into these trenches should be under the full-time observation of the geotechnical consultant.

6. Consideration should be given to using oversize materials in open space "green belt" areas that would be designated as non-structural fills.

SUBSTRUCTURES PLACED IN THE HOLD-DOWN DEPTH ZONE

Disclosure to all homeowners and any interested/affected parties regarding the proximity of oversize materials, excavation difficulties, etc., that may potentially impact future improvements is recommended. The cap above the hold-down distance is only intended to support shallow foundations of the residence, appurtenant structures, and builder specified improvements. Utility poles, pools, spas, or similar improvements that penetrate or nearly penetrate the fill cap should have a site-specific subsurface investigation, and review by the geotechnical consultant, prior to planning, design, and construction.

PRELIMINARY RECOMMENDATIONS - FOUNDATIONS

General

The foundation design and construction recommendations are based on previous laboratory testing and engineering analysis of onsite earth materials by GSI, and the potential for strong ground motion (~1g) to occur at the site from earthquakes on nearby faults. Due to the site's seismic setting, post-tension and mat foundations are considered appropriate for residential and commercial structures, respectively. The use of post-tension foundations for support of commercial structures should be evaluated by the project structural engineer based on the size of the building footprint and the anticipated use, and loading conditions. Recommendations for post-tensioned and mat foundation systems are provided in the following sections, and are not intended to preclude the transmission of water or water vapor through the foundations or slabs. Post-tension and mat foundation systems can also be designed to reduce the damaging effects of expansive soils or differential settlement. Specific foundation recommendations for any commercial buildings can be provided once the building layout, location, and loading conditions are known. The foundation systems discussed below may be used to support the proposed structures, provided they are founded in competent bearing material. The proposed foundation systems should be designed and constructed in accordance with the guidelines contained in the UBC (ICBO, 1997) and/or CBC (CBSC, 2007), and the settlement criteria provided previously.

Foundation Design

1. Analyses indicate that an allowable bearing value of 1,500 psf may be used for design of footings which maintain a minimum width of 12 inches (continuous) and 24 inches square (isolated), and a minimum depth of at least 12 inches into the properly compacted fill or bedrock. Foundations should not simultaneously bear on compacted fill and bedrock. The bearing value may be increased by one-third for seismic or other temporary loads. This value may be increased by 200 psf for each additional 12 inches in depth, to a maximum of 2,500 psf.

2. For lateral sliding resistance, a 0.35 coefficient of friction may be utilized for a concrete to soil contact when multiplied by the dead load.

3. Passive earth pressure may be computed as an equivalent fluid having a density of 250 pcf with a maximum earth pressure of 2,500 psf.

4. When combining passive pressure and frictional resistance, the passive pressure component should be reduced by one-third.

5. Foundation setbacks from slopes should minimally comply with Figure 18-I-1 of the UBC (ICBO, 1997). Please note that slope stability analyses may require the need for additional foundation setbacks from slopes.

PRELIMINARY POST-TENSIONED SLAB DESIGN

The recommendations presented below should be followed in addition to those contained in the previous sections. The information and recommendations presented in this section are not meant to supersede design by a registered structural engineer or civil engineer familiar with post-tensioned slab design or corrosion engineering consultant. Post-tensioned slabs should be designed using sound engineering practice and be in accordance with local and/or national code requirements. Upon request, GSI can provide additional data/consultation regarding soil parameters as related to post-tensioned slab design.

From a soil expansion/shrinkage standpoint, a common contributing factor to distress of structures using post-tensioned slabs is a significant fluctuation in the moisture content of soils underlying the perimeter of the slab, compared to the center, causing a "dishing" or "arching" of the slabs. To mitigate this possible phenomenon, a combination of soil presaturation and construction of a perimeter "cut-off" wall grade beam should be employed.

Perimeter cut-off walls should be a minimum of 12, 18, or 24 inches deep for very low to low, medium, or highly expansive soils, respectively. Post-tension slabs should be at least 5 inches thick. We recommend a monolithic pour for post-tensioned slabs and cut-off walls. The cut-off walls should be a minimum of 6 inches wide. The recommendations provided in the "Alternative Slab Underlayment" section of this report should be employed for concrete slab underlayment and concrete design.

Specific soil presaturation is not required for very low to low expansive soils; however, the moisture content of the subgrade soils should be at or above the soils' optimum moisture content to a depth of 12 inches for very low to low expansive soils. Specific soil presaturation is required if medium or highly expansive soils are exposed at finish grade. The moisture content of the slab subgrade soils should be equal to, or greater than, 120 percent of the soil's optimum moisture content to a depth of 18 or 24 inches for medium or highly expansive soils, respectively.

Post-tensioned slabs, if utilized, should be designed in accordance with the recommendations of the Post-Tensioning Institute Method. The slabs should be designed based on the settlement and angular distortion data, provided previously, and a 40-foot span. Based on review of laboratory data for the onsite materials, the average soil modulus subgrade reaction K, to be used for design, is 75 pounds per cubic inch (pci). This is equivalent to a surface bearing value of 1,000 psf.

Post-Tensioning Institute Method

Post-tensioned slabs should have sufficient stiffness to resist excessive bending due to non-uniform swell and shrinkage of subgrade soils. The differential movement can occur at the corner, edge, or center of slab. The potential for differential uplift can be evaluated using the 1997 UBC, Section 1816, based on design specifications of the Post-Tensioning Institute. The following table presents suggested minimum coefficients to be used in the Post-Tensioning Institute design method.

Thornthwaite Moisture Index	-20 inches/year
Correction Factor for Irrigation	20 inches/year
Depth to Constant Soil Suction	7 feet
Constant soil Suction (pf)	3.6
Modulus of Subgrade Reaction (pci)	75
Moisture Velocity	0.7 inches/month

The coefficients are considered minimums and may not be adequate to represent worst case conditions such as adverse drainage and/or improper landscaping and maintenance. The above parameters are applicable provided structures have positive drainage that is maintained away from structures. Therefore, it is important that information regarding drainage, site maintenance, settlements, and effects of expansive soils be passed on to future owners.

Based on the above parameters, the following values were obtained from figures or tables of the 1997 UBC, Section 1816. The values may not be appropriate to account for possible differential settlement of the slab due to other factors. If a stiffer slab is desired, higher values of y_m may be warranted.

E.I. OF SOIL SUBGRADE	VERY LOW E.I.	LOW E.I.	MEDIUM E.I.	HIGH E.I.
e_m center lift	5.0 feet	5.0 feet	5.5 feet	5.5 feet
e_m edge lift	2.5 feet	3.5 feet	4.0 feet	4.5 feet
y_m center lift	1.0 inch	1.7 inches	2.7 inches	3.5 inches
y_m edge lift	0.3 inches	0.75 inches	0.75 inches	1.2 inches

Deepened footings/edges around the slab perimeter must be used to minimize non-uniform surface moisture migration (from an outside source) beneath the slab. An edge depth of 12 inches should be considered a minimum. The bottom of the deepened footing/edge should be designed to resist tension, using cable or reinforcement per the structural engineer. Other applicable recommendations presented under conventional foundation and the California Foundation Slab Method should be adhered to during the design and construction phase of the project.

Mat Slab

As an alternative for residential construction, a mat-slab foundation may be used. Mat slabs may be necessary for commercial structures depending on the size of the building, its intended use, and the anticipated loading conditions. The mat slab should be at least 10 inches thick and should be provided with double mat of reinforcements near the top and near the bottom of the slab. The reinforcements should consist of minimum number 4 bars placed at 12 or 18 inches on center.

For preliminary purposes, a vertical modulus of subgrade reaction (K_s) of 75 pounds per cubic inch (pci) may be used in the design of mat foundations. This value is a unit value for a one-foot square footing and should be reduced in accordance with the following equation when used with the design of larger foundations.

$$K_R = K_S\left[\frac{B+1}{2B}\right]^2$$

where: K_S = unit subgrade modulus
K_R = reduced subgrade modulus
B = foundation width (in feet)

Mat-slab underlayment and concrete mix design should conform to the recommendations provided in the "Alternative Slab Underlayment" section of this report.

ALTERNATIVE SLAB UNDERLAYMENT

GSI has evaluated the potential for vapor or water transmission through the proposed slab-on-grade floors, in light of typical floor coverings and improvements. Please note that typical slab moisture emission rates, range from about 2 to 27 lbs/24 hours/1,000 square feet from a 4-inch slab (Kanare, 2005), while typical floor covering manufacturers recommend about 3 lbs/24 hours as an upper limit. Thus, the Client will need to evaluate the following in light of a cost v. benefit analysis (repairs/replacement), along with disclosure to all interested/affected parties. Considering the anticipated typical slab moisture emission rates and the anticipated floor coverings and improvements (to be chosen by the Client) that can tolerate those rates without distress, the following slab underlayment and concrete mix alternatives are provided:

- Concrete slab underlayment should consist of a 10-mil to 15-mil vapor retarder, or equivalent, with all laps sealed per the UBC/CBC (ICBO, 1997 and 2001) and the manufacturer's recommendation. The vapor retarder should comply with the ASTM E-1745 - Class A or B criteria, and be installed in accordance with ACI 302.1R-04.

- The 10- to 15-mil vapor retarder (ASTM E-1745 - Class A or B) shall be installed per the recommendations of the manufacturer, including lap sealing and all penetrations (i.e., pipe, ducting, rebar, etc.).

- The vapor retarder may be placed directly on suitable bearing, subgrade soils with very low to low expansion potential, and should be overlain by a 2-inch thick layer of washed sand (SE>30). If medium or higher expansive and/or rocky subgrade soils are present, slab underlayment should include a 4-inch layer of fine to coarse, washed, clean gravel (80 to 100 percent greater than #4 sieve) between the vapor retarder and the subgrade soils to break the capillary rise of moisture.

- Concrete should have a maximum water/cement ratio of 0.50. This does not supercede Table 19A-4 of the UBC/CBC (ICBO, 1997 and 2001) for corrosion or other corrosive requirements. Additional concrete mix design recommendations should be provided by the structural consultant and/or waterproofing specialist. Concrete finishing and workablity should be addressed by the structural consultant and a waterproofing specialist.

- Where slab water/cement ratios are as indicated above, and/or admixtures used, the structural consultant should also make changes to the concrete in the grade beams and footings in kind, so that the concrete used in the foundation and slabs are designed and/or treated for more uniform moisture protection.

- Homeowner(s) should be specifically advised which areas are suitable for tile flooring, wood flooring, or other types of water/vapor-sensitive flooring and which are not suitable. In all planned floor areas, flooring shall be installed per the manufactures recommendations.

- Additional recommendations regarding water or vapor transmission should be provided by the architect/structural engineer/slab or foundation designer and should be consistent with the specified floor coverings indicated by the architect.

Regardless of the mitigation, some limited moisture/moisture vapor transmission through the slab should be anticipated. Construction crews may require special training for installation of certain product(s), as well as concrete finishing techniques. The use of specialized product(s) should be approved by the slab designer and water-proofing consultant. A technical representative of the flooring contractor should review the slab and moisture retarder plans and provide comment prior to the construction of the residential foundations or improvements. The vapor retarder contractor should have representatives onsite during the initial installation.

PRELIMINARY WALL DESIGN PARAMETERS

Conventional Retaining Walls

The design parameters provided below assume that either non expansive soils (typically Class 2 permeable filter material or Class 3 aggregate base) or native onsite materials (up to and including an E.I. of 50) are used to backfill any retaining walls. The type of backfill (i.e., select or native), should be specified by the wall designer, and clearly shown on the plans. Building walls, below grade, should be water-proofed. The foundation system for the proposed retaining walls should be designed in accordance with the recommendations presented in this and preceding sections of this report, as appropriate. Footings should be embedded a minimum of 18 inches below adjacent grade (excluding landscape layer, 6 inches) and should be 24 inches in width. There should be no increase in bearing for footing width. Recommendations for specialty walls (i.e., crib, earthstone, geogrid, etc.) can be provided upon request, and would be based on site specific conditions.

Restrained Walls

Any retaining walls that will be restrained prior to placing and compacting backfill material or that have re-entrant or male corners, should be designed for an at-rest equivalent fluid pressure (EFP) of 65 pcf, plus any applicable surcharge loading. For areas of male or re-entrant corners, the restrained wall design should extend a minimum distance of twice the height of the wall (2H) laterally from the corner.

Cantilevered Walls

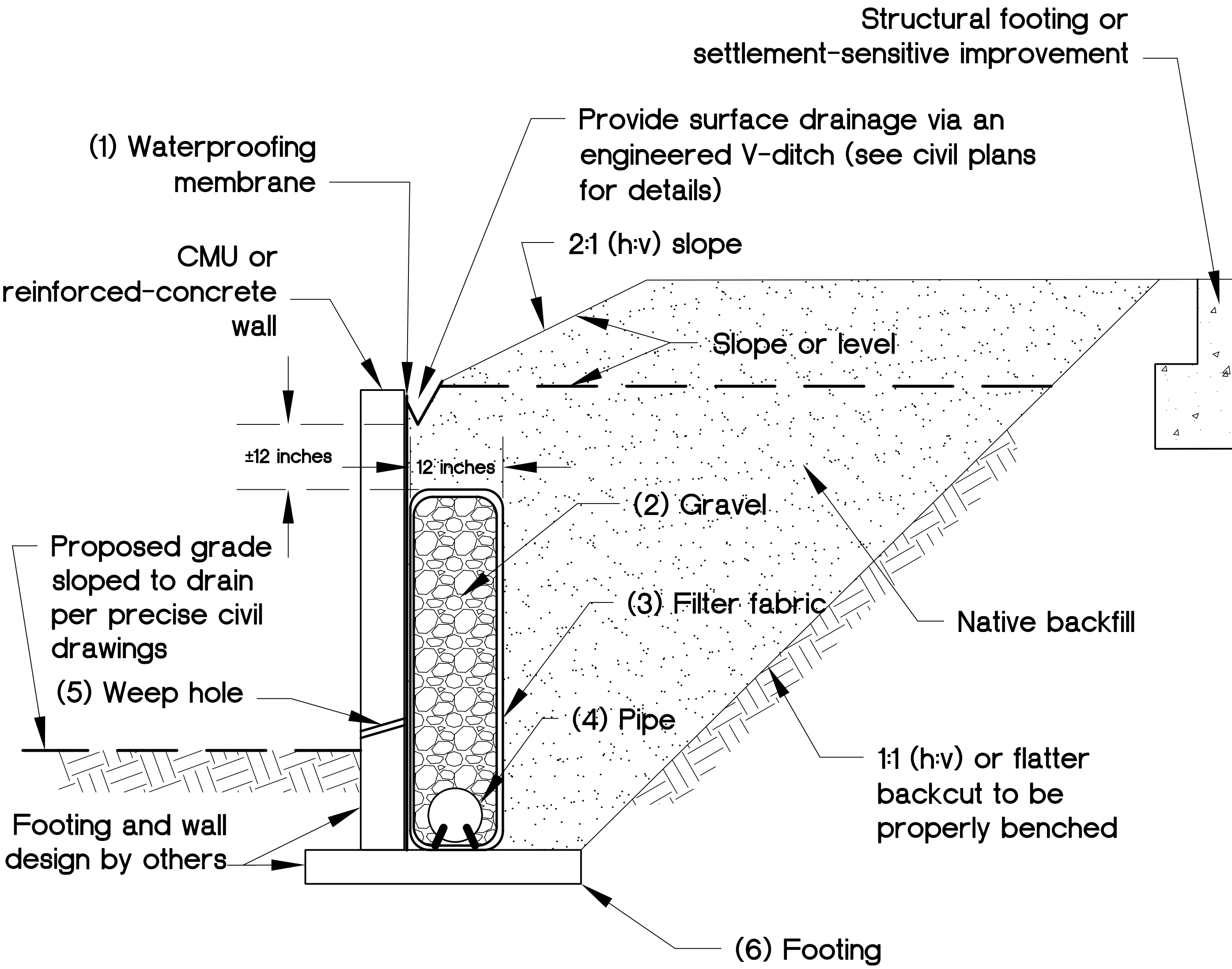
The recommendations presented below are for cantilevered retaining walls up to 10 feet high. Design parameters for walls less than 3 feet in height may be superceded by City and/or County standard design. Active earth pressure may be used for retaining wall design, provided the top of the wall is not restrained from minor deflections. An equivalent fluid pressure approach may be used to compute the horizontal pressure against the wall. Appropriate fluid unit weights are given below for specific slope gradients of the retained material. These do not include other superimposed loading conditions due to traffic, structures, seismic events or adverse geologic conditions. When wall configurations are finalized, the appropriate loading conditions for superimposed loads can be provided upon request.

SURFACE SLOPE OF RETAINED MATERIAL (HORIZONTAL:VERTICAL)	EQUIVALENT FLUID WEIGHT P.C.F. (SELECT BACKFILL*)	EQUIVALENT FLUID WEIGHT P.C.F. (NATIVE BACKFILL [E.I. ≤50, P.I. < 15])
Level**	38	50
2 to 1	55	65

* E.I. ≤20, P.I. < 15, S.E. > 30, < 10 % passing No. 200 sieve.
**Level backfill behind a retaining wall is defined as compacted earth materials, properly drained, without a slope for a distance of 2H behind the wall.

Retaining Wall Backfill and Drainage

Positive drainage must be provided behind all retaining walls in the form of gravel wrapped in geofabric and outlets. A backdrain system is considered necessary for retaining walls that are 2 feet or greater in height. Details 1, 2, and 3, present the back drainage options discussed below. Backdrains should consist of a 4-inch diameter perforated PVC or ABS pipe encased in either Class 2 permeable filter material or ¾-inch to 1½-inch gravel wrapped in approved filter fabric (Mirafi 140 or equivalent). For low expansive backfill, the filter material should extend a minimum of 1 horizontal foot behind the base of the walls and upward at least 1 foot. For native backfill that has up to medium expansion potential, continuous Class 2 permeable drain materials should be used behind the wall. This material should be continuous (i.e., full height) behind the wall, and it should be constructed in accordance with the enclosed Detail 1 (Typical Retaining Wall Backfill and Drainage Detail). For limited access and confined areas, (panel) drainage behind the wall may be constructed in accordance with Detail 2 (Retaining Wall Backfill and Subdrain Detail Geotextile Drain). Materials with an E.I. potential of greater than 50 should not be used as backfill for retaining walls. For more onerous expansive situations, backfill and drainage behind the retaining wall should conform with Detail 3 (Retaining Wall And Subdrain Detail Clean Sand Backfill).



(1) Waterproofing membrane.

(2) Gravel: Clean, crushed, ¾ to 1½ inch.

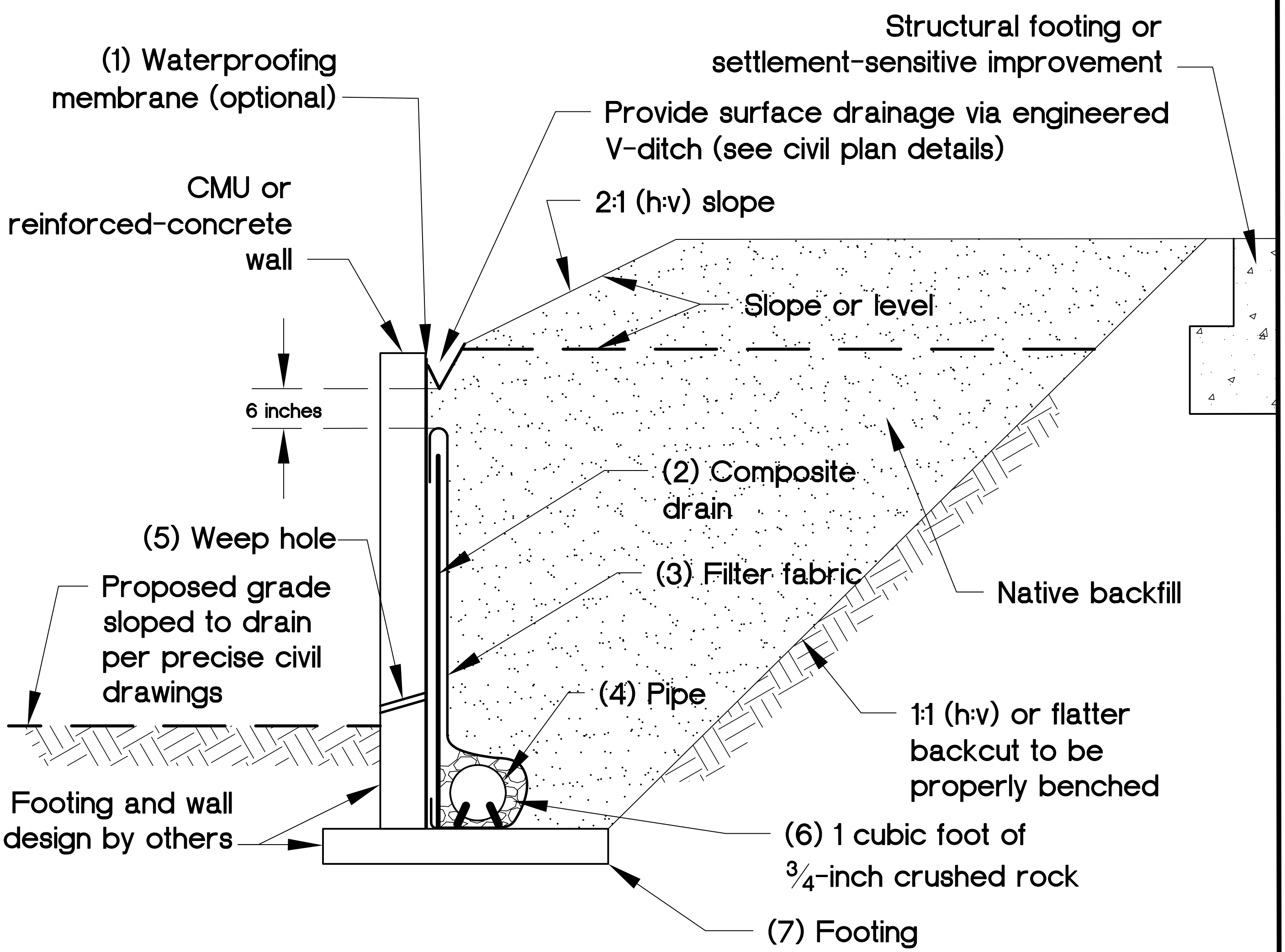
(3) Filter fabric: Mirafi 140N or approved equivalent.

(4) Pipe: 4-inch-diameter perforated PVC, Schedule 40, or approved alternative with minimum of 1 percent gradient sloped to suitable, approved outlet point (perforations down).

(5) Weep hole: Minimum 2-inch diameter placed at 20-foot centers along the wall and placed 3 inches above finished surface. Design civil engineer to provide drainage at toe of wall. No weep holes for below-grade walls.

(6) Footing: If bench is created behind the footing greater than the footing width, use level fill or cut natural earth materials. An additional "heel" drain will likely be required by geotechnical consultant.

GeoSoils, Inc.	RETAINING WALL DETAIL — ALTERNATIVE A	Detail 1



(1) Waterproofing membrane (optional): Liquid boot or approved mastic equivalent.

(2) Drain: Miradrain 6000 or J-drain 200 or equivalent for non-waterproofed walls; Miradrain 6200 or J-drain 200 or equivalent for waterproofed walls (all perforations down).

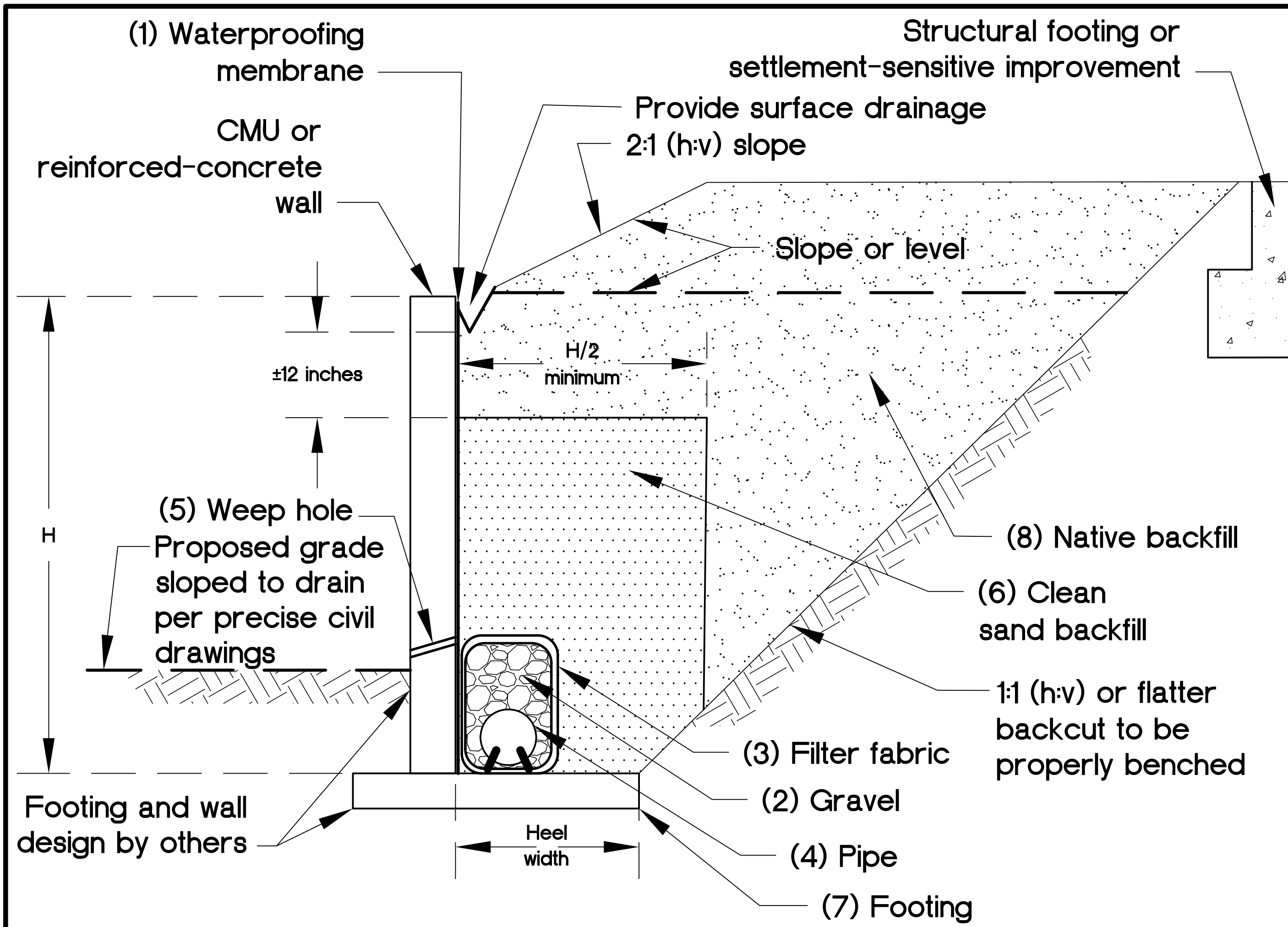
(3) Filter fabric: Mirafi 140N or approved equivalent; place fabric flap behind core.

(4) Pipe: 4-inch-diameter perforated PVC, Schedule 40, or approved alternative with minimum of 1 percent gradient to proper outlet point (perforations down).

(5) Weep hole: Minimum 2-inch diameter placed at 20-foot centers along the wall and placed 3 inches above finished surface. Design civil engineer to provide drainage at toe of wall. No weep holes for below-grade walls.

(6) Gravel: Clean, crushed, ¾ to 1½ inch.

(7) Footing: If bench is created behind the footing greater than the footing width, use level fill or cut natural earth materials. An additional "heel" drain will likely be required by geotechnical consultant.



(1) Waterproofing membrane: Liquid boot or approved masticequivalent.

(2) Gravel: Clean, crushed, ¾ to 1½ inch.

(3) Filter fabric: Mirafi 140N or approved equivalent.

(4) Pipe: 4-inch-diameter perforated PVC, Schedule 40, or approved alternative with minimum of 1 percent gradient to proper outlet point (perforations down).

(5) Weep hole: Minimum 2-inch diameter placed at 20-foot centers along the wall and placed 3 inches above finished surface. Design civil engineer to provide drainage at toe of wall. No weep holes for below-grade walls.

(6) Clean sand backfill: Must have sand equivalent value (S.E.) of 35 or greater; can be densified by water jetting upon approval by geotechnical engineer.

(7) Footing: If bench is created behind the footing greater than the footing width, use level fill or cut natural earth materials. An additional "heel" drain will likely be required by geotechnical consultant.

(8) Native backfill: If E.I. <21 and S.E. ≥35 then all sand requirements also may not be required and will be reviewed by the geotechnical consultant.

GeoSoils, Inc.	RETAINING WALL DETAIL — ALTERNATIVE C	Detail 3

Outlets should consist of a 4-inch diameter solid PVC or ABS pipe spaced no greater than ±100 feet apart, with a minimum of two outlets, one on each end. The use of weep holes, only, in walls higher than 2 feet, is not recommended. The surface of the backfill should be sealed by pavement or the top 18 inches compacted with native soil (E.I. ≤50). Proper surface drainage should also be provided. For additional mitigation, consideration should be given to applying a water-proof membrane to the back of all retaining structures. The use of a waterstop should be considered for all concrete and masonry joints.

Wall/Retaining Wall Footing Transitions

Site walls are anticipated to be founded on footings designed in accordance with the recommendations in this report. Should wall footings transition from cut to fill, the civil designer may specify either:

a) A minimum of a 2-foot overexcavation and recompaction of cut materials for a distance of 2H, from the point of transition.

b) Increase of the amount of reinforcing steel and wall detailing (i.e., expansion joints or crack control joints) such that a angular distortion of 1/360 for a distance of 2H on either side of the transition may be accommodated. Expansion joints should be placed no greater than 20 feet on-center, in accordance with the structural engineer's/wall designer's recommendations, regardless of whether or not transition conditions exist. Expansion joints should be sealed with a flexible, non-shrink grout.

c) Embed the footings entirely into native formational material (i.e., deepened footings).

If transitions from cut to fill transect the wall footing alignment at an angle of less than 45 degrees (plan view), then the designer should follow recommendation "a" (above) and until such transition is between 45 and 90 degrees to the wall alignment.

Retaining Wall Seismic Surcharge

Retaining walls for the proposed development have the potential (during a seismic event) to experience distress, in part, due to the high PHSA (~1g). If walls are greater than 6 feet (H = 6 feet) in retained backfill and are within "H" of the structure's entrance or exit, access driveway, or tract access, GSI recommends that a seismic surcharge (increment) be added to the active wall pressures in a manner similar to a traffic surcharge. This seismic surcharge (seismic increment) should be added as 20H, where "H" is the height of the wall (from the bottom of the wall footing to the top of the backfill, excluding the shear key). This may be added as a resultant 0.5 to 0.6H up from the bottom of the footing and used in the evaluation of wall overturning. Overturning Factor-of-Safety (F.O.S.) for walls with a seismic surcharge should retain a F.O.S. of at least 1.2.

TOP-OF-SLOPE WALLS/FENCES/IMPROVEMENTS

Slope Creep

Some soils at the site may be expansive and therefore, may become desiccated when allowed to dry. Such soils are susceptible to surficial slope creep, especially with seasonal changes in moisture content. Typically in southern California, during the hot and dry summer period, these soils become desiccated and shrink, thereby developing surface cracks. The extent and depth of these shrinkage cracks depend on many factors such as the nature and expansivity of the soils, temperature and humidity, and extraction of moisture from surface soils by plants and roots. When seasonal rains occur, water percolates into the cracks and fissures, causing slope surfaces to expand, with a corresponding loss in soil density and shear strength near the slope surface. With the passage of time and several moisture cycles, the outer 3 to 5 feet of slope materials experience a very slow, but progressive, outward and downward movement, known as slope creep. For slope heights greater than 10 feet, this creep related soil movement will typically impact all rear yard flatwork and other secondary improvements that are located within about 15 feet from the top of slopes, such as swimming pools, concrete flatwork, etc., and in particular top of slope fences/walls. This influence is normally in the form of detrimental settlement, and tilting of the proposed improvements. The dessication/swelling and creep discussed above continues over the life of the improvements, and generally becomes progressively worse. Accordingly, the developer should provide this information to any homeowners and homeowners association.

Top of Slope Walls/Fences

Due to the potential for slope creep for slopes higher than about 10 feet, some settlement and tilting of the walls/fence with the corresponding distresses, should be expected, especially at perimeter confining areas. To mitigate the tilting of top of slope walls/fences, we recommend that the walls/fences be constructed on deepened foundations without any consideration for creep forces, where the expansion index of the materials comprising the outer 15 feet of the slope is less than 50, or a combination of grade beam and caisson foundations, for expansion indices greater than 50 comprising the slope, with creep forces taken into account. The grade beam should be at a minimum of 12 inches by 12 inches in cross section, supported by drilled caissons, 12 inches minimum in diameter, placed at a maximum spacing of 6 feet on center, and with a minimum embedment length of 7 feet below the bottom of the grade beam. The strength of the concrete and grout should be evaluated by the structural engineer of record. The proper ASTM tests for the concrete and mortar should be provided along with the slump quantities. The concrete used should be appropriate to mitigate sulfate corrosion, as warranted. The design of the grade beam and caissons should be in accordance with the recommendations of the project structural engineer, and include the utilization of the following geotechnical parameters:

Creep Zone: 5-foot vertical zone below the slope face and projected upward parallel to the slope face.

Creep Load: The creep load projected on the area of the grade beam should be taken as an equivalent fluid approach, having a density of 60 pcf. For the caisson, it should be taken as a uniform 900 pounds per linear foot of caisson's depth, located above the creep zone.

Point of Fixity: Located a distance of 1.5 times the caisson's diameter, below the creep zone.

Passive Resistance: Passive earth pressure of 300 psf per foot of depth per foot of caisson diameter, to a maximum value of 4,500 psf may be used to determine caisson depth and spacing, provided that they meet or exceed the minimum requirements stated above. To determine the total lateral resistance, the contribution of the creep prone zone above the point of fixity, to passive resistance, should be disregarded.

Allowable Axial Capacity:

Shaft capacity : 350 psf applied below the point of fixity over the surface area of the shaft.

Tip capacity: 4,500 psf.

DRIVEWAY, FLATWORK, AND OTHER IMPROVEMENTS

The soil materials on site may be locally expansive. The effects of expansive soils are cumulative, and typically occur over the lifetime of any improvements. On relatively level areas, when the soils are allowed to dry, the dessication and swelling process tends to cause heaving and distress to flatwork and other improvements. The resulting potential for distress to improvements may be reduced, but not totally eliminated. To that end, it is recommended that the developer should notify any homeowners or homeowners association of this long-term potential for distress. To reduce the likelihood of distress, the following recommendations are presented for all exterior flatwork:

1. The subgrade area for concrete slabs should be compacted to achieve a minimum 90 percent relative compaction, and then be presoaked to 2 to 3 percentage points above (or 125 percent of) the soils' optimum moisture content, to a depth of 18 inches below subgrade elevation. If very low expansive soils are present, only optimum moisture content, or greater, is required and specific presoaking is not

warranted. The moisture content of the subgrade should be proof tested within 72 hours prior to pouring concrete.

2. Concrete slabs should be cast over a non-yielding surface, consisting of a 4-inch layer of crushed rock, gravel, or clean sand, that should be compacted and level prior to pouring concrete. If very low expansive soils are present, the rock or gravel or sand may be deleted. The layer or subgrade should be wet-down completely prior to pouring concrete, to minimize loss of concrete moisture to the surrounding earth materials.

3. Exterior slabs should be a minimum of 4 inches thick. Driveway slabs and approaches should additionally have a thickened edge (12 inches) adjacent to all landscape areas, to help impede infiltration of landscape water under the slab.

4. The use of transverse and longitudinal control joints are recommended to help control slab cracking due to concrete shrinkage or expansion. Two ways to mitigate such cracking are: a) add a sufficient amount of reinforcing steel, increasing tensile strength of the slab; and, b) provide an adequate amount of control and/or expansion joints to accommodate anticipated concrete shrinkage and expansion.

   In order to reduce the potential for unsightly cracks, slabs should be reinforced at mid-height with a minimum of No. 3 bars placed at 18 inches on center, in each direction. If subgrade soils within the top 7 feet from finish grade are very low expansive soils (i.e., E.I. $\leq$20), then 6x6-W1.4xW1.4 welded-wire mesh may be substituted for the rebar, provided the reinforcement is placed on chairs, at slab mid-height. The exterior slabs should be scored or saw cut, ½ to ⅜ inches deep, often enough so that no section is greater than 10 feet by 10 feet. For sidewalks or narrow slabs, control joints should be provided at intervals of every 6 feet. The slabs should be separated from the foundations and sidewalks with expansion joint filler material.

5. No traffic should be allowed upon the newly poured concrete slabs until they have been properly cured to within 75 percent of design strength. Concrete compression strength should be a minimum of 2,500 psi.

6. Driveways, sidewalks, and patio slabs adjacent to the house should be separated from the house with thick expansion joint filler material. In areas directly adjacent to a continuous source of moisture (i.e., irrigation, planters, etc.), all joints should be additionally sealed with flexible mastic.

7. Planters and walls should not be tied to the house.

8. Overhang structures should be supported on the slabs, or structurally designed with continuous footings tied in at least two directions. If very low expansion soils are present, footings need only be tied in one direction.

9. Any masonry landscape walls that are to be constructed throughout the property should be grouted and articulated in segments no more than 20 feet long. These segments should be keyed or doweled together.

10. Utilities should be enclosed within a closed utilidor (vault) or designed with flexible connections to accommodate differential settlement and expansive soil conditions.

11. Positive site drainage should be maintained at all times. Finish grade on the lots should provide a minimum of 1 to 2 percent fall to the street, as indicated herein. It should be kept in mind that drainage reversals could occur, including post-construction settlement, if relatively flat yard drainage gradients are not periodically maintained by the homeowner or homeowners association.

12. Air conditioning (A/C) units should be supported by slabs that are incorporated into the building foundation or constructed on a rigid slab with flexible couplings for plumbing and electrical lines. A/C waste water lines should be drained to a suitable non-erosive outlet.

13. Shrinkage cracks could become excessive if proper finishing and curing practices are not followed. Finishing and curing practices should be performed per the Portland Cement Association Guidelines. Mix design should incorporate rate of curing for climate and time of year, sulfate content of soils, corrosion potential of soils, and fertilizers used on site.

DEVELOPMENT CRITERIA

Slope Deformation

Compacted fill slopes designed using customary factors of safety for gross or surficial stability and constructed in general accordance with the design specifications should be expected to undergo some differential vertical heave or settlement in combination with differential lateral movement in the out-of-slope direction, after grading. This post-construction movement occurs in two forms: slope creep, and lateral fill extension (LFE). Slope creep is caused by alternate wetting and drying of the fill soils which results in slow downslope movement. This type of movement is expected to occur throughout the life of the slope, and is anticipated to potentially affect improvements or structures (e.g., separations and/or cracking), placed near the top-of-slope, up to a maximum distance of approximately 15 feet from the top-of-slope, depending on the slope height. This movement generally results in rotation and differential settlement of improvements located within the creep zone. LFE occurs due to deep wetting from irrigation and rainfall on slopes comprised of expansive materials. Although some movement should be expected, long-term movement from this source may be minimized, but not eliminated, by placing the fill throughout the slope region, wet of the fill's optimum moisture content.

It is generally not practical to attempt to eliminate the effects of either slope creep or LFE. Suitable mitigative measures to reduce the potential of lateral deformation typically include: setback of improvements from the slope faces (per the 1997 UBC and/or adopted California Building Code), positive structural separations (i.e., joints) between improvements, and stiffening and deepening of foundations. Expansion joints in walls should be placed no greater than 20 feet on-center, and in accordance with the structural engineer's recommendations. All of these measures are recommended for design of structures and improvements. The ramifications of the above conditions, and recommendations for mitigation, should be provided to each homeowner and/or any homeowners association.

Slope Maintenance and Planting

Water has been shown to weaken the inherent strength of all earth materials. Slope stability is significantly reduced by overly wet conditions. Positive surface drainage away from slopes should be maintained and only the amount of irrigation necessary to sustain plant life should be provided for planted slopes. Over-watering should be avoided as it adversely affects site improvements, and causes perched groundwater conditions. Graded slopes constructed utilizing onsite materials would be erosive. Eroded debris may be minimized and surficial slope stability enhanced by establishing and maintaining a suitable vegetation cover soon after construction. Compaction to the face of fill slopes would tend to minimize short-term erosion until vegetation is established. Plants selected for landscaping should be light weight, deep rooted types that require little water and are capable of surviving the prevailing climate. Jute-type matting or other fibrous covers may aid in allowing the establishment of a sparse plant cover. Utilizing plants other than those recommended above will increase the potential for perched water, staining, mold, etc., to develop. A rodent control program to prevent burrowing should be implemented. Irrigation of natural (ungraded) slope areas is generally not recommended. These recommendations regarding plant type, irrigation practices, and rodent control should be provided to each homeowner. Over-steepening of slopes should be avoided during building construction activities and landscaping.

Drainage

Adequate lot surface drainage is a very important factor in reducing the likelihood of adverse performance of foundations, hardscape, and slopes. Surface drainage should be sufficient to prevent ponding of water anywhere on a lot, and especially near structures and tops of slopes. Lot surface drainage should be carefully taken into consideration during fine grading, landscaping, and building construction. Therefore, care should be taken that future landscaping or construction activities do not create adverse drainage conditions. Positive site drainage within lots and common areas should be provided and maintained at all times. Drainage should not flow uncontrolled down any descending slope. Water should be directed away from foundations and not allowed to pond and/or seep into the ground. In general, the area within 5 feet around a structure should slope away from the structure. We recommend that unpaved lawn and landscape areas have a minimum gradient of 1 percent sloping away from structures, and whenever possible, should be above adjacent paved areas. Consideration should be given to avoiding construction of planters adjacent to structures (buildings, pools, spas, etc.). Pad drainage should be directed toward the street or other approved area(s). Although not a geotechnical requirement, roof gutters, down spouts, or other appropriate means may be utilized to control roof drainage. Down spouts, or drainage devices should outlet a minimum of 5 feet from structures or into a subsurface drainage system. Areas of seepage may develop due to irrigation or heavy rainfall, and should be anticipated. Minimizing irrigation will lessen this potential. If areas of seepage develop, recommendations for minimizing this effect could be provided upon request.

Toe of Slope Drains/Toe Drains

Where significant slopes intersect pad areas, surface drainage down the slope allows for some seepage into the subsurface materials, sometimes creating conditions causing or contributing to perched and/or ponded water. Toe of slope/toe drains may be beneficial in the mitigation of this condition due to surface drainage. The general criteria to be utilized by the design engineer for evaluating the need for this type of drain is as follows:

- Is there a source of irrigation above or on the slope that could contribute to saturation of soil at the base of the slope?
- Are the slopes hard rock and/or impermeable, or relatively permeable, or; do the slopes already have or are they proposed to have subdrains (i.e., stabilization fills, etc.)?
- Are there cut-fill transitions (i.e., fill over bedrock), within the slope?
- Was the lot at the base of the slope overexcavated or is it proposed to be overexcavated? Overexcavated lots located at the base of a slope could accumulate subsurface water along the base of the fill cap.
- Are the slopes north facing? North facing slopes tend to receive less sunlight (less evaporation) relative to south facing slopes and are more exposed to the currently prevailing seasonal storm tracks.

- What is the slope height? It has been our experience that slopes with heights in excess of approximately 10 feet tend to have more problems due to storm runoff and irrigation than slopes of a lesser height.

- Do the slopes "toe out" into a residential lot or a lot where perched or ponded water may adversely impact its proposed use?

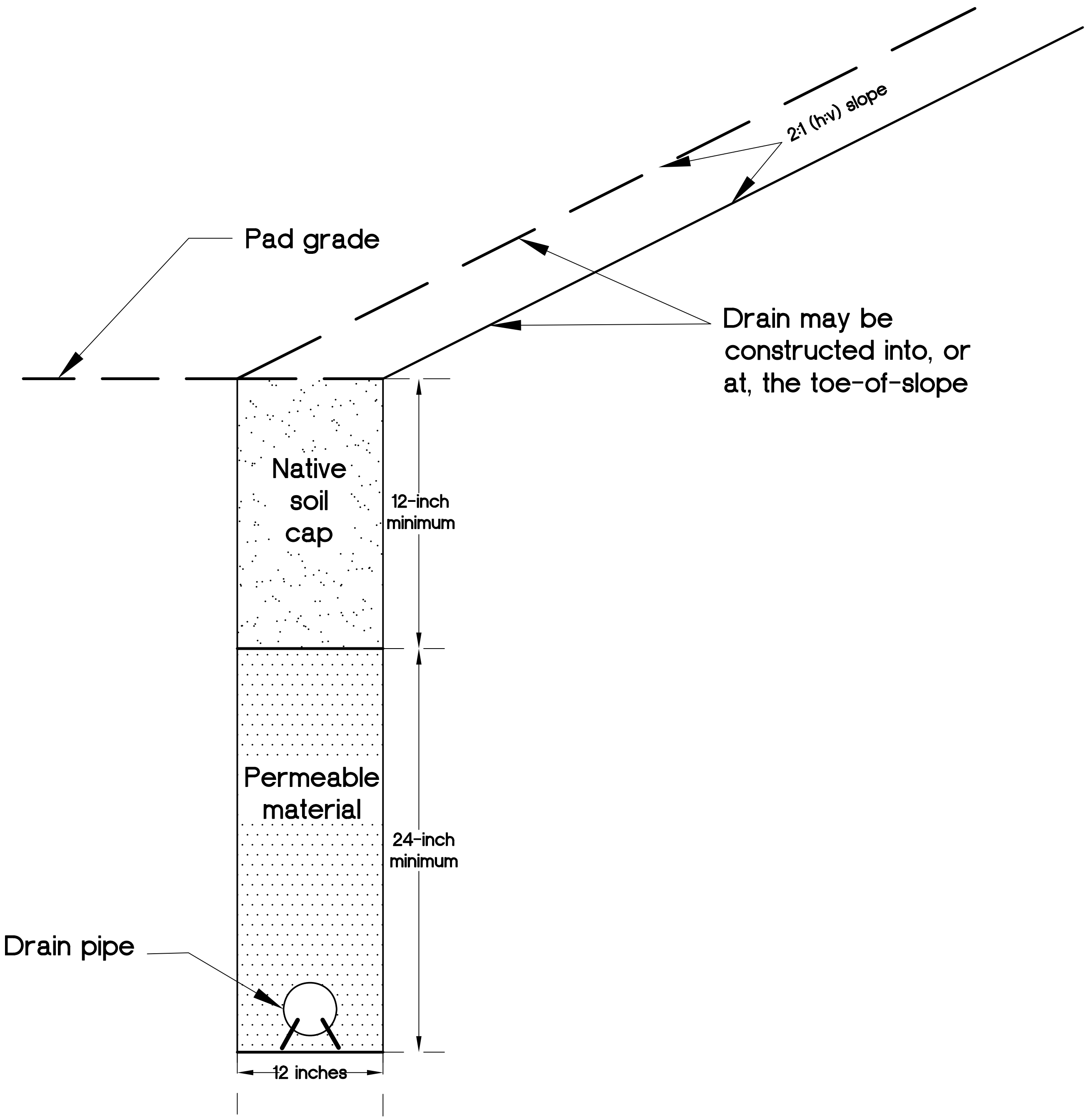
Based on these general criteria, the construction of toe drains may be considered by the design engineer along the toe of slopes, or at retaining walls in slopes, descending to the rear of such lots. Following are Detail 4 (Schematic Toe Drain Detail) and Detail 5 (Subdrain Along Retaining Wall Detail). Other drains may be warranted due to unforeseen conditions, homeowner irrigation, or other circumstances. Where drains are constructed during grading, including subdrains, the locations/elevations of such drains should be surveyed, and recorded on the final as-built grading plans by the design engineer. It is recommended that the above be disclosed to all interested parties, including homeowners and any homeowners association.

Erosion Control

Cut and fill slopes will be subject to surficial erosion during and after grading. Onsite earth materials have a moderate to high erosion potential. Consideration should be given to providing hay bales and silt fences for the temporary control of surface water, from a geotechnical viewpoint.

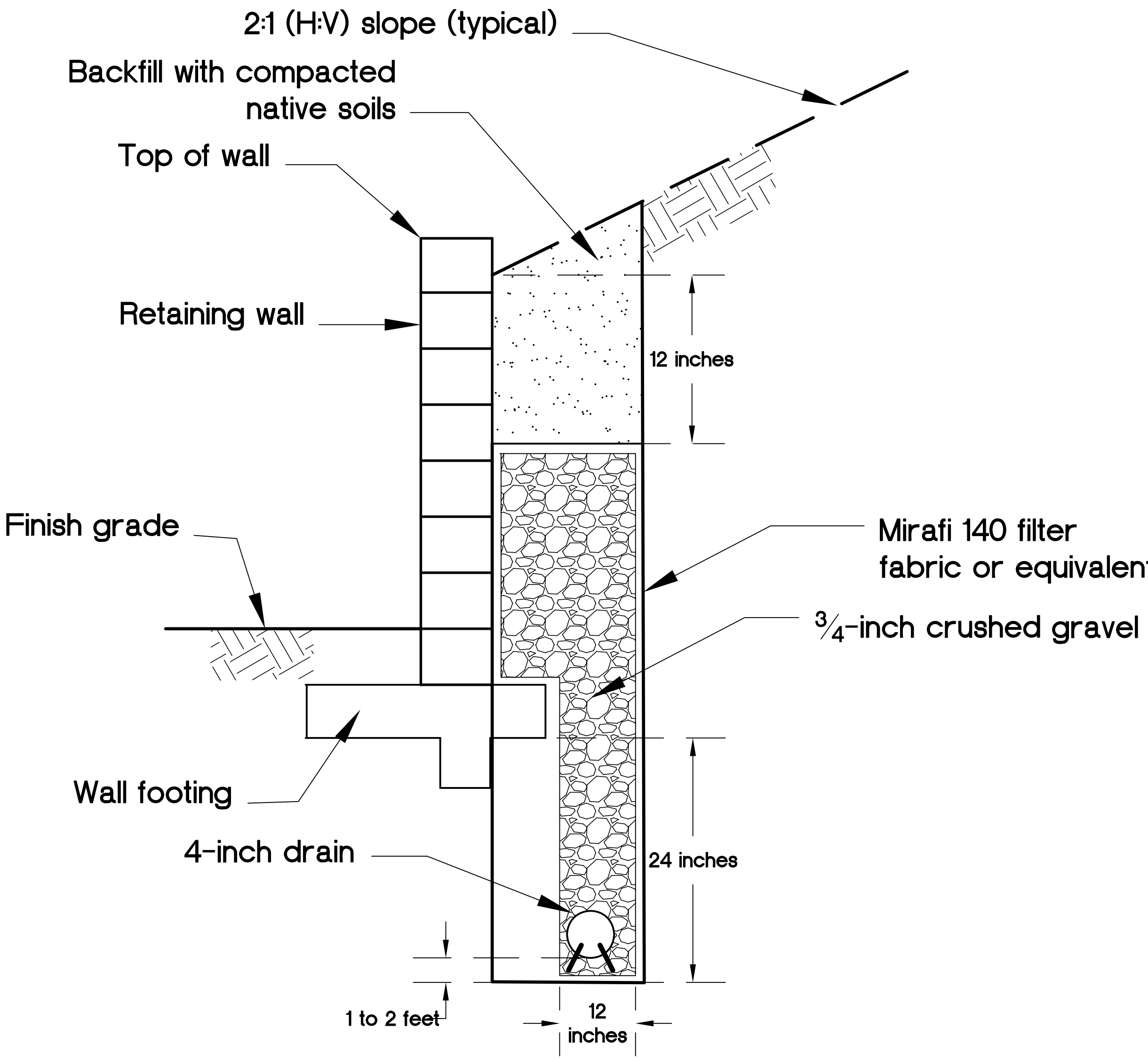
Landscape Maintenance

Only the amount of irrigation necessary to sustain plant life should be provided. Over-watering the landscape areas will adversely affect proposed site improvements. We would recommend that any proposed open-bottom planters adjacent to proposed structures be eliminated for a minimum distance of 10 feet. As an alternative, closed-bottom type planters could be utilized. An outlet placed in the bottom of the planter, could be installed to direct drainage away from structures or any exterior concrete flatwork. If planters are constructed adjacent to structures, the sides and bottom of the planter should be provided with a moisture retarder to prevent penetration of irrigation water into the subgrade. Provisions should be made to drain the excess irrigation water from the planters without saturating the subgrade below or adjacent to the planters. Graded slope areas should be planted with drought resistant vegetation. Consideration should be given to the type of vegetation chosen and their potential effect upon surface improvements (i.e., some trees will have an effect on concrete flatwork with their extensive root systems). From a geotechnical standpoint leaching is not recommended for establishing landscaping. If the surface soils are processed for the purpose of adding amendments, they should be recompacted to 90 percent minimum relative compaction.



1. Soil cap compacted to 90 percent relative compaction.
2. Permeable material may be gravel wrapped in filter fabric (Mirafi 140N or equivalent).
3. 4-inch-diameter, perforated pipe (SDR-35 or equivalent) with perforations down.
4. Pipe to maintain a minimum 1 percent fall.
5. Concrete cut-off wall to be provided at transition to solid outlet pipe.
6. Solid outlet pipe to drain to approved area.
7. Cleanouts are recommended at each property line.

GeoSoils, Inc.	SCHEMATIC TOE DRAIN DETAIL	Detail 4



NOTES:

1. Soil cap compacted to 90 percent relative compaction.
2. Permeable material may be gravel wrapped in filter fabric (Mirafi 140N or equivalent).
3. 4-inch-diameter, perforated pipe (SDR-35 or equivalent) with perforations down.
4. Pipe to maintain a minimum 1 percent fall.
5. Concrete cut-off wall to be provided at transition to solid outlet pipe.
6. Solid outlet pipe to drain to approved area.
7. Cleanouts are recommended at each property line.
8. Effort to compact should be applied to drain rock.

GeoSoils, Inc.	SUBDRAIN ALONG RETAINING WALL DETAIL	Detail 5

Gutters and Downspouts

As previously discussed in the drainage section, the installation of gutters and downspouts should be considered to collect roof water that may otherwise infiltrate the soils adjacent to the structures. If utilized, the downspouts should be drained into PVC collector pipes or other non-erosive devices (e.g., paved swales or ditches; below grade, solid tight-lined PVC pipes; etc.), that will carry the water away from the house, to an appropriate outlet, in accordance with the recommendations of the design civil engineer. Downspouts and gutters are not a requirement; however, from a geotechnical viewpoint, provided that positive drainage is incorporated into project design (as discussed previously).

Subsurface and Surface Water

Subsurface and surface water are not anticipated to affect site development, provided that the recommendations contained in this report are incorporated into final design and construction and that prudent surface and subsurface drainage practices are incorporated into the construction plans. Perched groundwater conditions along zones of contrasting permeabilities may not be precluded from occurring in the future due to site irrigation, poor drainage conditions, or damaged utilities, and should be anticipated. Should perched groundwater conditions develop, this office could assess the affected area(s) and provide the appropriate recommendations to mitigate the observed groundwater conditions. Groundwater conditions may change with the introduction of irrigation, rainfall, or other factors.

Site Improvements

If in the future, any additional improvements (e.g., pools, spas, etc.) are planned for the site, recommendations concerning the geological or geotechnical aspects of design and construction of said improvements could be provided upon request. Pools and/or spas should not be constructed without specific design and construction recommendations from GSI, and this construction recommendation should be provided to the homeowners, any homeowners association, and/or other interested parties. This office should be notified in advance of any fill placement, grading of the site, or trench backfilling after rough grading has been completed. This includes any grading, utility trench and retaining wall backfills, flatwork, etc.

Tile Flooring

Tile flooring can crack, reflecting cracks in the concrete slab below the tile, although small cracks in a conventional slab may not be significant. Therefore, the designer should consider additional steel reinforcement for concrete slabs-on-grade where tile will be placed. The tile installer should consider installation methods that reduce possible cracking of the tile such as slipsheets. Slipsheets or a vinyl crack isolation membrane (approved by the Tile Council of America/Ceramic Tile Institute) are recommended between tile and concrete slabs on grade.

Additional Grading

This office should be notified in advance of any fill placement, supplemental regrading of the site, or trench backfilling after rough grading has been completed. This includes completion of grading in the street, driveway approaches, driveways, parking areas, and utility trench and retaining wall backfills.

Footing Trench Excavation

All footing excavations should be observed by a representative of this firm subsequent to trenching and prior to concrete form and reinforcement placement. The purpose of the observations is to evaluate that the excavations have been made into the recommended bearing material and to the minimum widths and depths recommended for construction. If loose or compressible materials are exposed within the footing excavation, a deeper footing or removal and recompaction of the subgrade materials would be recommended at that time. Footing trench spoil and any excess soils generated from utility trench excavations should be compacted to a minimum relative compaction of 90 percent, if not removed from the site.

Trenching/Temporary Construction Backcuts

Considering the nature of the onsite earth materials, it should be anticipated that caving or sloughing could be a factor in subsurface excavations and trenching. Shoring or excavating the trench walls/backcuts at the angle of repose (typically 25 to 45 degrees [except as specifically superceded within the text of this report]), should be anticipated. All excavations should be observed by an engineering geologist or soil engineer from GSI, prior to workers entering the excavation or trench, and minimally conform to CAL-OSHA, state, and local safety codes. Should adverse conditions exist, appropriate recommendations would be offered at that time. The above recommendations should be provided to any contractors and/or subcontractors, or homeowners, etc., that may perform such work.

Utility Trench Backfill

1. All interior utility trench backfill should be brought to at least 2 percent above optimum moisture content and then compacted to obtain a minimum relative compaction of 90 percent of the laboratory standard. As an alternative for shallow (12-inch to 18-inch) under-slab trenches, sand having a sand equivalent value of 30 or greater may be utilized and jetted or flooded into place. Observation, probing and testing should be provided to evaluate the desired results.

2. Exterior trenches adjacent to, and within areas extending below a 1:1 plane projected from the outside bottom edge of the footing, and all trenches beneath hardscape features and in slopes, should be compacted to at least 90 percent of the laboratory standard. Sand backfill, unless excavated from the trench, should

not be used in these backfill areas. Compaction testing and observations, along with probing, should be accomplished to evaluate the desired results.

3. All trench excavations should conform to CAL-OSHA, state, and local safety codes.

4. Utilities crossing grade beams, perimeter beams, or footings should either pass below the footing or grade beam utilizing a hardened collar or foam spacer, or pass through the footing or grade beam in accordance with the recommendations of the structural engineer.

SUMMARY OF RECOMMENDATIONS REGARDING GEOTECHNICAL OBSERVATION AND TESTING

We recommend that observation and/or testing be performed by GSI at each of the following construction stages:

- During grading/recertification.
- During excavation.
- During placement of subdrains, toe drains, or other subdrainage devices, prior to placing fill and/or backfill.
- After excavation of building footings, retaining wall footings, and free standing walls footings, prior to the placement of reinforcing steel or concrete.
- Prior to pouring any slabs or flatwork, after presoaking/presaturation of building pads and other flatwork subgrade, before the placement of concrete, reinforcing steel, capillary break (i.e., sand, pea-gravel, etc.), or vapor retarders (i.e., visqueen, etc.).
- During retaining wall subdrain installation, prior to backfill placement.
- During placement of backfill for area drain, interior plumbing, utility line trenches, and retaining wall backfill.
- During slope construction/repair.
- When any unusual soil conditions are encountered during any construction operations, subsequent to the issuance of this report.
- When any developer or homeowner improvements, such as flatwork, spas, pools, walls, etc., are constructed, prior to construction. GSI should review and approve the improvement plans prior to construction.

- A report of geotechnical observation and testing should be provided at the conclusion of each of the above stages, in order to provide concise and clear documentation of site work, and/or to comply with code requirements.

- GSI should review project sales documents to homeowners/homeowners associations for geotechnical aspects, including irrigation practices, the conditions outlined above, etc., prior to any sales. At that stage, GSI will provide homeowners maintenance guidelines which should be incorporated into such documents.

OTHER DESIGN PROFESSIONALS/CONSULTANTS

The design civil engineer, structural engineer, post-tension designer, architect, landscape architect, wall designer, etc., should review the recommendations provided herein, incorporate those recommendations into all their respective plans, and by explicit reference, make this report part of their project plans. This report presents minimum design criteria for the design of slabs, foundations and other elements possibly applicable to the project. These criteria should not be considered as substitutes for actual designs by the structural engineer/designer. Please note that the recommendations contained herein are not intended to preclude the transmission of water or vapor through the slab or foundation. The structural engineer/foundation and/or slab designer should provide recommendations to not allow water or vapor to enter into the structure so as to cause damage to another building component, or so as to limit the installation of the type of flooring materials typically used for the particular application. Homeowners should be advised of the potential for water or water vapor transmission through foundations and slabs.

The structural engineer/designer should analyze actual soil-structure interaction and consider, as needed, bearing, expansive soil influence, and strength, stiffness and deflections in the various slab, foundation, and other elements in order to develop appropriate, design-specific details. As conditions dictate, it is possible that other influences will also have to be considered. The structural engineer/designer should consider all applicable codes and authoritative sources where needed. If analyses by the structural engineer/designer result in less critical details than are provided herein as minimums, the minimums presented herein should be adopted. It is considered likely that some, more restrictive details will be required.

If the structural engineer/designer has any questions or requires further assistance, they should not hesitate to call or otherwise transmit their requests to GSI. In order to mitigate potential distress, the foundation and/or improvement's designer should confirm to GSI and the governing agency, in writing, that the proposed foundations and/or improvements can tolerate the amount of differential settlement and/or expansion characteristics and other design criteria specified herein.

PLAN REVIEW

Final project plans (grading, precise grading, foundation, retaining wall, landscaping, etc.), should be reviewed by this office prior to construction, so that construction is in accordance with the conclusions and recommendations of this report. Based on our review, supplemental recommendations and/or further geotechnical studies may be warranted.

LIMITATIONS

The materials encountered on the project site and utilized for our analysis are believed representative of the area; however, soil and bedrock materials vary in character between excavations and natural outcrops or conditions exposed during mass grading. Site conditions may vary due to seasonal changes or other factors.

Inasmuch as our study is based upon our review and engineering analyses and laboratory data, the conclusions and recommendations are professional opinions. These opinions have been derived in accordance with current standards of practice, and no warranty, either express or implied, is given. Standards of practice are subject to change with time. GSI assumes no responsibility or liability for work or testing performed by others, or their inaction; or work performed when GSI is not requested to be onsite, to evaluate if our recommendations have been properly implemented. Use of this report constitutes an agreement and consent by the user to all the limitations outlined above, notwithstanding any other agreements that may be in place. In addition, this report may be subject to review by the controlling authorities. Thus, this report brings to completion our scope of services for this portion of the project.

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APPENDIX A

REFERENCES

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APPENDIX A

REFERENCES

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APPENDIX B

EQFAULT, EQSEARCH, AND FRISKSP PRINTOUTS

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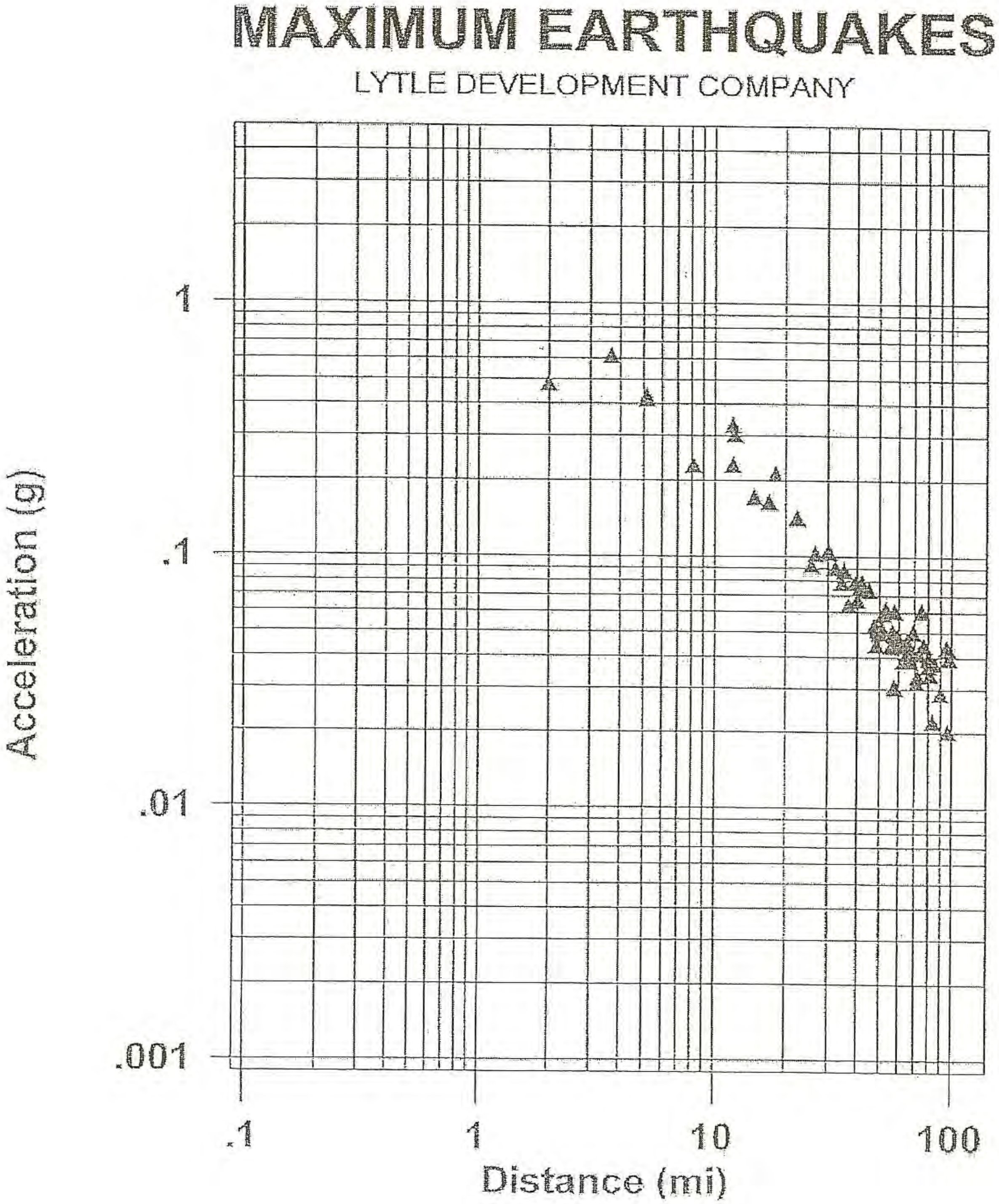
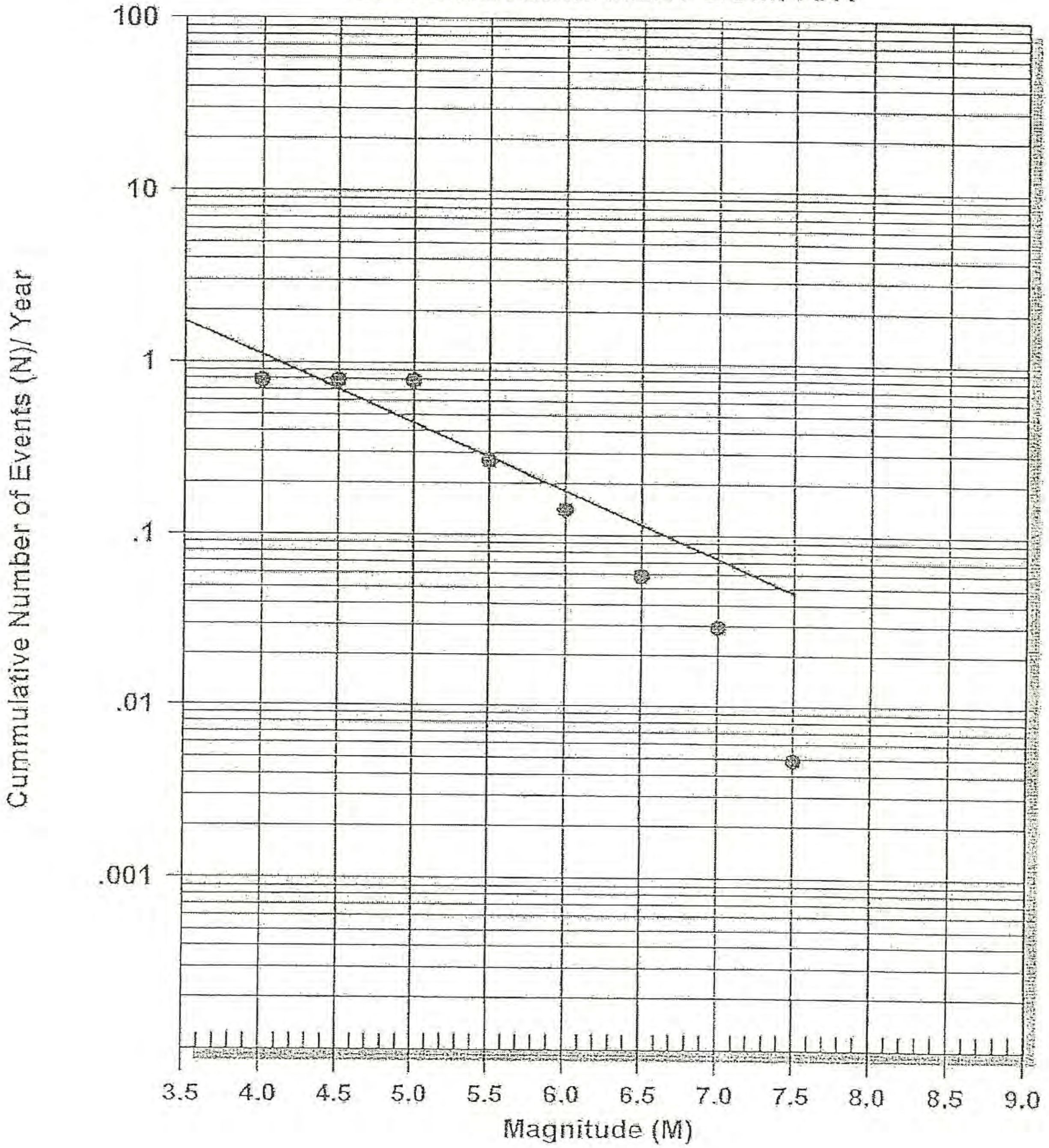

MAXIMUM EARTHQUAKES
LYTLE DEVELOPMENT COMPANY
Acceleration (g)
1
.1
.01
.001
.1
1
10
100
Distance (mi)

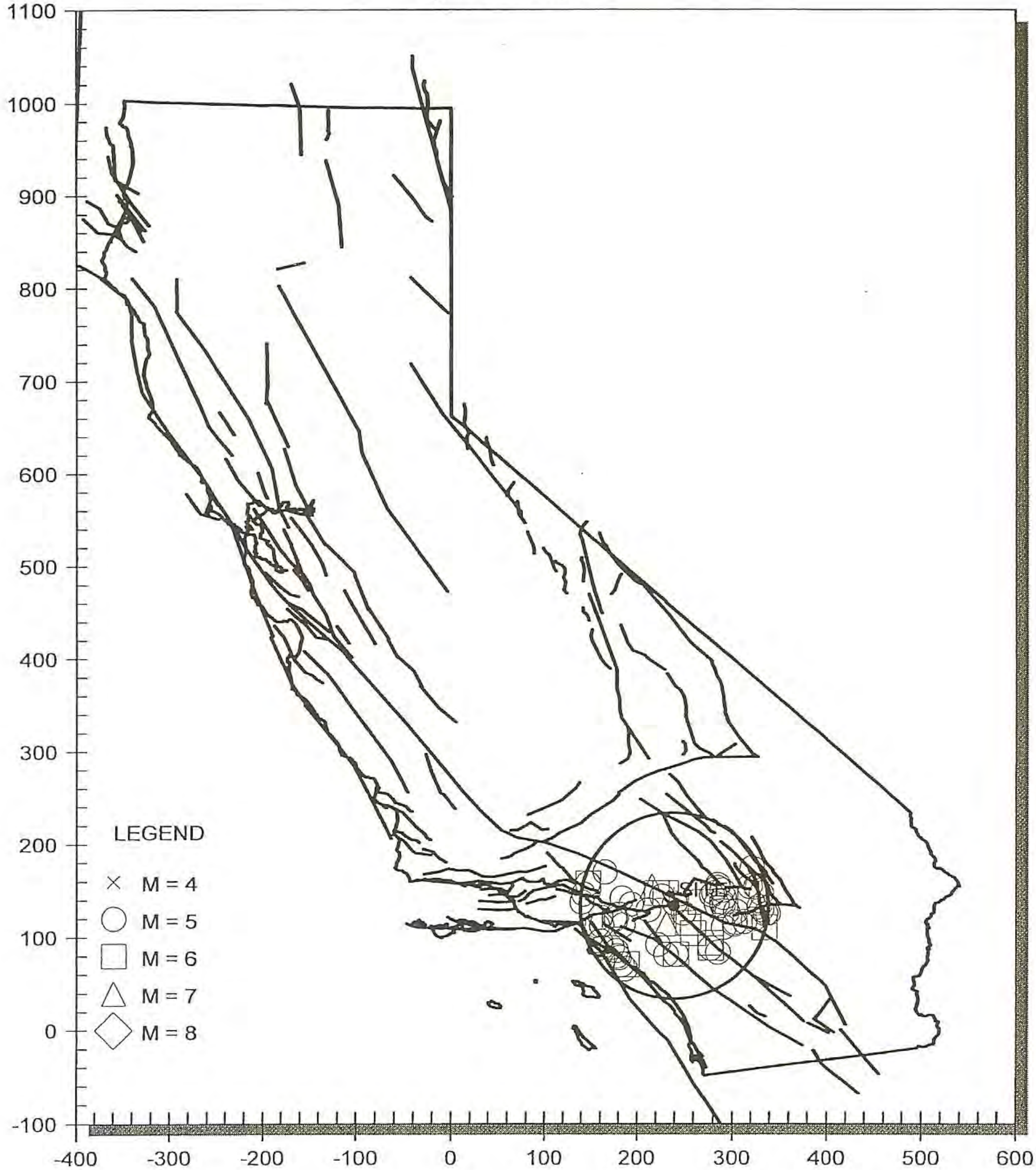
EARTHQUAKE RECURRENCE CURVE

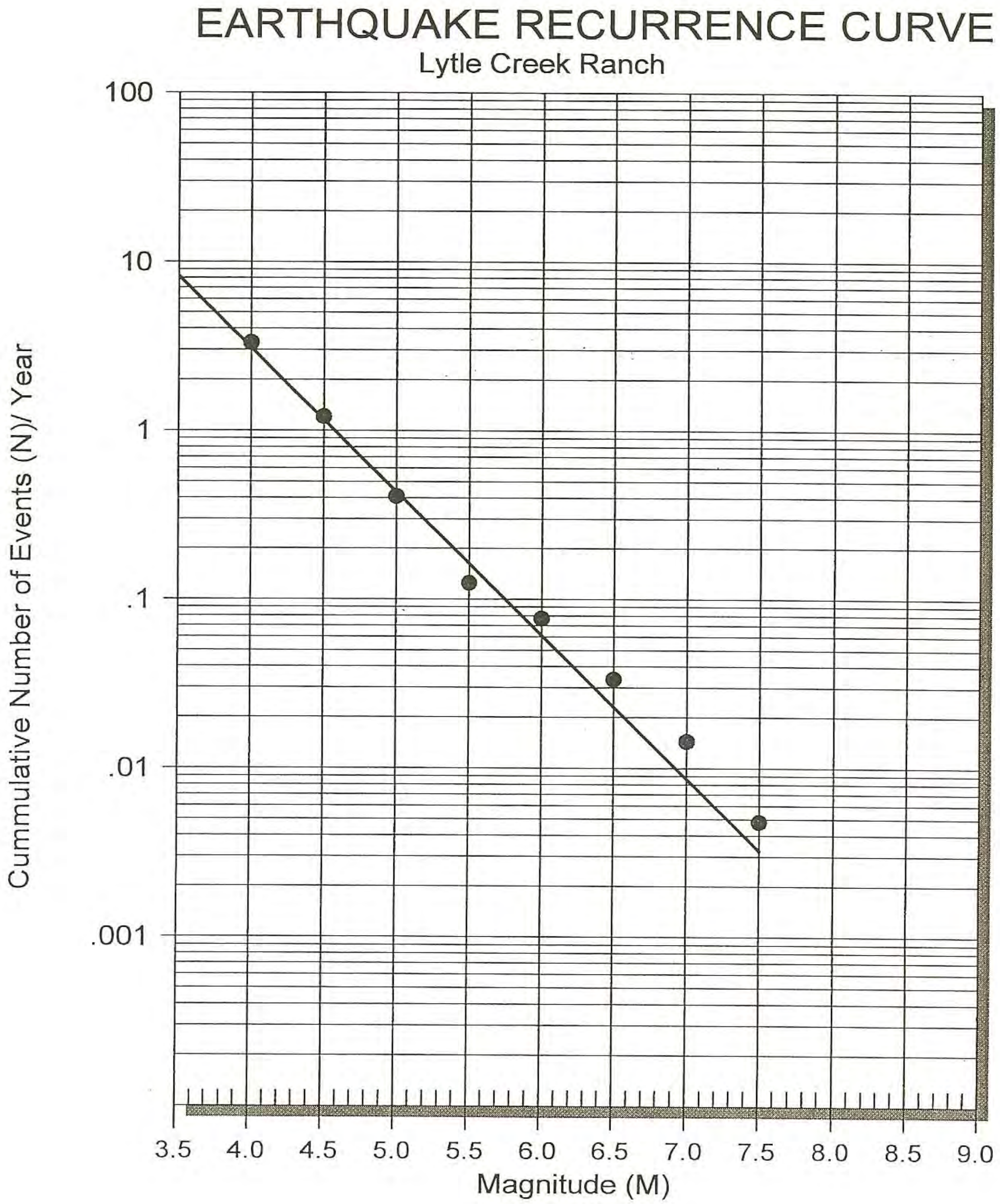
LYTLE DEVELOPMENT COMPANY



EARTHQUAKE EPICENTER MAP

Lytle Creek Ranch




EARTHQUAKE RECURRENCE CURVE
Lytle Creek Ranch
Cummulative Number of Events (N)/ Year
100
10
1
.1
.01
.001
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
Magnitude (M)

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*                       *
*     E Q S E A R C H   *
*                       *
*     Version 3.00      *
*                       *
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ESTIMATION OF
PEAK ACCELERATION FROM
CALIFORNIA EARTHQUAKE CATALOGS

JOB NUMBER: W.O. 5049-A3-SC

DATE: 05-19-2008

JOB NAME: Lytle Creek Ranch

EARTHQUAKE-CATALOG-FILE NAME: ALLQUAKE.DAT

MAGNITUDE RANGE:
MINIMUM MAGNITUDE: 4.00
MAXIMUM MAGNITUDE: 9.00

SITE COORDINATES:
SITE LATITUDE: 34.1728
SITE LONGITUDE: 117.4082

SEARCH DATES:
START DATE: 1800
END DATE: 2008

SEARCH RADIUS:
62.1 mi
100.0 km

ATTENUATION RELATION: 10) Bozorgnia Campbell Niazi (1999) Hor.-Holocene Soil-Cor.
UNCERTAINTY (M=Median, S=Sigma): S Number of Sigmas: 1.0
ASSUMED SOURCE TYPE: SS [SS=Strike-slip, DS=Reverse-slip, BT=Blind-thrust]
SCOND: 0 Depth Source: A
Basement Depth: .16 km Campbell SSR: 0 Campbell SHR: 0
COMPUTE PEAK HORIZONTAL ACCELERATION

MINIMUM DEPTH VALUE (km): 3.0

EARTHQUAKE SEARCH RESULTS

Page 1

FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
GSP	34.1900	117.3900	12/28/1989	094108.1	15.0	4.50	0.212	VIII	1.6(2.5)
DMG	34.2000	117.4000	07/22/1899	046 0.0	0.0	5.50	0.396	X	1.9(3.1)
USG	34.1390	117.3860	02/21/1987	231530.1	2.6	4.07	0.158	VIII	2.7(4.3)
DMG	34.1320	117.4260	04/15/1965	20 833.3	5.5	4.50	0.188	VIII	3.0(4.8)
PAS	34.1350	117.4480	01/08/1983	71930.4	4.6	4.10	0.147	VIII	3.5(5.6)
GSP	34.1250	117.4380	01/06/2005	143527.7	4.0	4.40	0.166	VIII	3.7(6.0)
GSP	34.1680	117.3370	06/28/1997	214525.1	9.0	4.20	0.144	VIII	4.1(6.6)
DMG	34.1120	117.4260	03/19/1937	12338.4	10.0	4.00	0.128	VIII	4.3(6.9)
DMG	34.2170	117.4670	03/25/1941	234341.0	0.0	4.00	0.125	VII	4.5(7.3)
DMG	34.1400	117.3390	02/26/1936	93327.6	10.0	4.00	0.124	VII	4.6(7.3)
T-A	34.1700	117.3200	12/02/1859	2210 0.0	0.0	4.30	0.136	VIII	5.0(8.1)
DMG	34.1270	117.3380	02/23/1936	222042.7	10.0	4.50	0.149	VIII	5.1(8.2)
DMG	34.1240	117.4800	05/15/1955	17 326.0	7.6	4.00	0.114	VII	5.3(8.5)
DMG	34.1180	117.3410	09/22/1951	82239.1	11.9	4.30	0.131	VIII	5.4(8.7)
DMG	34.1160	117.4750	06/28/1960	20 048.0	12.0	4.10	0.118	VII	5.5(8.8)
DMG	34.2000	117.5000	06/14/1892	1325 0.0	0.0	4.90	0.174	VIII	5.6(9.0)
MGI	34.2000	117.3000	04/13/1913	1045 0.0	0.0	4.00	0.101	VII	6.5(10.4)
DMG	34.1400	117.5150	01/01/1965	8 418.0	5.9	4.40	0.122	VII	6.5(10.5)
DMG	34.1670	117.5330	03/01/1948	81213.0	0.0	4.70	0.133	VIII	7.1(11.5)
DMG	34.1270	117.5210	12/27/1938	10 928.6	10.0	4.00	0.093	VII	7.2(11.5)
PAS	34.2110	117.5300	10/19/1979	122237.8	4.9	4.10	0.095	VII	7.4(12.0)
DMG	34.2110	117.5300	09/01/1937	1348 8.2	10.0	4.50	0.116	VII	7.4(12.0)
MGI	34.1000	117.3000	12/27/1901	11 0 0.0	0.0	4.60	0.116	VII	8.0(12.8)
DMG	34.1000	117.3000	02/16/1931	1327 0.0	0.0	4.00	0.086	VII	8.0(12.8)
MGI	34.1000	117.3000	07/15/1905	2041 0.0	0.0	5.30	0.173	VIII	8.0(12.8)
MGI	34.1000	117.3000	11/22/1911	257 0.0	0.0	4.00	0.086	VII	8.0(12.8)
DMG	34.1830	117.5480	09/01/1937	163533.5	10.0	4.50	0.110	VII	8.0(12.9)
DMG	34.2670	117.5180	09/12/1970	141011.2	8.0	4.10	0.081	VII	9.0(14.5)
DMG	34.1830	117.5830	10/03/1948	24628.0	0.0	4.00	0.071	VI	10.0(16.1)
DMG	34.2700	117.5400	09/12/1970	143053.0	8.0	5.40	0.152	VIII	10.1(16.2)
DMG	34.0330	117.3500	04/18/1940	184343.9	0.0	4.40	0.085	VII	10.2(16.4)
DMG	34.3000	117.5000	07/22/1899	2032 0.0	0.0	6.50	0.296	IX	10.2(16.4)
DMG	34.0330	117.3170	09/03/1935	647 0.0	0.0	4.50	0.084	VII	11.0(17.6)
T-A	34.0800	117.2500	10/07/1869	0 0 0.0	0.0	4.30	0.075	VII	11.1(17.8)
DMG	34.2810	117.5520	09/13/1970	44748.6	8.0	4.40	0.079	VII	11.1(17.9)
MGI	34.0000	117.4000	05/22/1907	652 0.0	0.0	4.60	0.082	VII	11.9(19.2)
T-A	34.0000	117.4200	04/12/1888	1315 0.0	0.0	4.30	0.070	VI	11.9(19.2)
T-A	34.0000	117.4200	09/10/1920	1415 0.0	0.0	4.30	0.070	VI	11.9(19.2)
GSP	34.0470	117.2550	02/21/2000	134943.1	15.0	4.50	0.076	VII	12.3(19.8)
MGI	34.1000	117.2000	04/23/1923	2113 0.0	0.0	4.00	0.056	VI	12.9(20.8)
DMG	34.3040	117.5700	05/05/1969	16 2 9.6	8.8	4.40	0.069	VI	12.9(20.8)
MGI	34.0000	117.5000	12/16/1858	10 0 0.0	0.0	7.00	0.320	IX	13.0(21.0)
DMG	34.0000	117.5000	07/03/1908	1255 0.0	0.0	4.00	0.056	VI	13.0(21.0)

DMG	34.0430	117.2280	04/03/1939	25044.7	10.0	4.00	0.054	VI	13.6(22.0)
DMG	34.0000	117.2830	11/07/1939	1852 8.4	0.0	4.70	0.075	VII	13.9(22.4)
PAS	34.0230	117.2450	10/02/1985	234412.4	15.2	4.80	0.079	VII	13.9(22.4)
DMG	34.3000	117.6000	07/30/1894	512 0.0	0.0	6.00	0.163	VIII	14.0(22.6)
GSP	34.0240	117.2300	03/11/1998	121851.8	14.0	4.50	0.065	VI	14.5(23.3)
DMG	33.9960	117.2700	02/17/1952	123658.3	16.0	4.50	0.065	VI	14.5(23.4)
DMG	34.0000	117.2500	07/23/1923	73026.0	0.0	6.25	0.178	VIII	15.0(24.1)
DMG	34.0000	117.2500	11/01/1932	445 0.0	0.0	4.00	0.049	VI	15.0(24.1)
GSP	34.1400	117.6900	03/02/1990	172625.4	6.0	4.60	0.061	VI	16.3(26.2)
DMG	34.1000	117.6830	01/18/1934	214 0.0	0.0	4.00	0.045	VI	16.5(26.5)

EARTHQUAKE SEARCH RESULTS

Page 2

FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
DMG	34.1000	117.6830	01/09/1934	1410 0.0	0.0	4.50	0.057	VI	16.5(26.5)
DMG	33.9330	117.3670	10/24/1943	02921.0	0.0	4.00	0.044	VI	16.7(26.9)
GSP	34.1400	117.7000	02/28/1990	234336.6	5.0	5.20	0.083	VII	16.8(27.1)
GSP	34.1300	117.7000	03/01/1990	003457.1	4.0	4.00	0.043	VI	16.9(27.2)
PAS	34.1360	117.7090	06/26/1988	15 458.5	7.9	4.60	0.057	VI	17.4(28.0)
DMG	34.2000	117.1000	09/20/1907	154 0.0	0.0	6.00	0.129	VIII	17.7(28.5)
GSP	34.1500	117.7200	03/01/1990	032303.0	11.0	4.70	0.059	VI	17.9(28.8)
GSP	34.1920	117.0950	04/06/1994	190104.1	7.0	4.80	0.062	VI	17.9(28.9)
GSP	34.1100	117.7200	04/17/1990	223227.2	4.0	4.60	0.054	VI	18.3(29.5)
DMG	33.9500	117.5830	04/11/1941	12024.0	0.0	4.00	0.040	V	18.3(29.5)
DMG	34.3700	117.6500	12/08/1812	15 0 0.0	0.0	7.00	0.222	IX	19.4(31.2)
GSP	34.3740	117.6490	08/20/1998	234958.4	9.0	4.40	0.046	VI	19.5(31.4)
PDP	34.3850	117.6350	10/16/2007	085344.1	8.0	4.20	0.042	VI	19.5(31.4)
MGI	34.0000	117.7000	12/03/1929	9 5 0.0	0.0	4.00	0.036	V	20.5(33.0)
PAS	34.0060	117.7390	02/18/1989	717 4.8	3.3	4.30	0.039	V	22.1(35.6)
GSP	34.1800	117.0200	12/04/1991	081703.5	11.0	4.00	0.033	V	22.2(35.7)
DMG	33.9000	117.2000	12/19/1880	0 0 0.0	0.0	6.00	0.102	VII	22.3(35.9)
DMG	34.1000	117.8000	03/31/1931	2033 0.0	0.0	4.00	0.032	V	22.9(36.9)
GSP	33.9510	117.7090	01/05/1998	181406.5	11.0	4.30	0.037	V	23.0(37.1)
GSP	34.0540	117.0300	06/27/2005	221733.6	12.0	4.00	0.032	V	23.1(37.2)
DMG	34.0170	117.0500	02/19/1940	12 655.7	0.0	4.60	0.043	VI	23.1(37.2)
DMG	33.8330	117.4000	06/05/1940	82727.0	0.0	4.00	0.031	V	23.5(37.8)
GSP	34.1200	116.9980	06/29/1992	144126.0	4.0	4.40	0.038	V	23.7(38.2)
GSP	34.0580	117.0100	06/16/2005	205326.0	11.0	4.90	0.049	VI	24.1(38.8)
GSP	34.0970	116.9960	12/05/1997	170438.9	4.0	4.10	0.032	V	24.1(38.8)
DMG	34.1670	116.9830	10/16/1951	1241 5.0	0.0	4.00	0.030	V	24.3(39.1)
GSP	33.9550	117.7460	12/14/2001	120135.5	13.0	4.00	0.030	V	24.5(39.4)
GSP	34.0850	116.9890	06/30/1992	214900.3	3.0	4.40	0.036	V	24.7(39.8)
PDP	34.1570	116.9760	12/19/2007	121409.0	7.0	4.00	0.030	V	24.7(39.8)
PAS	34.1510	116.9720	11/20/1978	655 9.5	6.1	4.30	0.034	V	25.0(40.2)
PAS	34.1980	116.9590	04/01/1978	105227.4	8.0	4.00	0.028	V	25.7(41.4)
DMG	34.3330	117.0000	02/27/1942	1 853.0	0.0	4.00	0.028	V	25.8(41.5)
DMG	34.2670	116.9670	08/29/1943	35754.0	0.0	4.00	0.028	V	26.0(41.9)
DMG	34.2670	116.9670	08/29/1943	51630.0	0.0	4.00	0.028	V	26.0(41.9)
DMG	34.2670	116.9670	08/29/1943	34513.0	0.0	5.50	0.064	VI	26.0(41.9)
DMG	34.0000	117.0000	06/30/1923	022 0.0	0.0	4.50	0.036	V	26.2(42.2)
DMG	34.1330	116.9500	06/10/1938	1440 0.0	0.0	4.00	0.028	V	26.3(42.4)
DMG	34.4000	117.8000	02/24/1946	6 752.0	0.0	4.10	0.028	V	27.3(43.9)
GSP	33.9170	117.7760	09/03/2002	070851.9	12.0	4.80	0.040	V	27.5(44.2)

GSP	34.2900	116.9460	02/10/2001	210505.8	9.0	5.10	0.047	VI	27.6(44.4)
GSP	34.1210	116.9280	08/16/1998	133440.2	6.0	4.70	0.038	V	27.7(44.5)
GSP	34.2870	116.9420	02/11/2001	003916.0	8.0	4.20	0.029	V	27.8(44.7)
GSP	34.1780	116.9220	06/28/1992	170131.9	13.0	4.70	0.038	V	27.8(44.7)
DMG	34.1800	116.9200	01/16/1930	034 3.6	0.0	5.10	0.047	VI	27.9(44.9)
DMG	34.1800	116.9200	01/16/1930	02433.9	0.0	5.20	0.050	VI	27.9(44.9)
DMG	33.8000	117.6000	09/16/1903	1210 0.0	0.0	4.00	0.026	V	28.0(45.0)
MGI	33.8000	117.6000	04/22/1918	2115 0.0	0.0	5.00	0.044	VI	28.0(45.0)
DMG	34.2000	117.9000	07/13/1935	105416.5	0.0	4.70	0.037	V	28.1(45.3)
DMG	34.2000	117.9000	08/28/1889	215 0.0	0.0	5.50	0.059	VI	28.1(45.3)
GSP	34.1120	116.9200	10/01/1998	181816.0	4.0	4.70	0.037	V	28.2(45.4)
GSP	34.2560	116.9120	06/28/1992	170557.5	8.0	4.60	0.034	V	28.9(46.5)
MGI	34.2000	116.9000	10/10/1915	5 6 0.0	0.0	4.00	0.025	V	29.1(46.8)
DMG	34.3200	116.9250	04/18/1968	174213.4	4.7	4.00	0.025	V	29.4(47.3)

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FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
PAS	34.2460	116.9010	06/29/1979	55320.5	5.7	4.60	0.034	V	29.4(47.3)
PAS	34.2490	116.9000	06/30/1979	7 353.0	5.6	4.50	0.032	V	29.5(47.5)
DMG	33.8540	117.7520	10/04/1961	22131.6	4.3	4.10	0.026	V	29.5(47.5)
DMG	33.7480	117.4790	06/22/1971	104119.0	8.0	4.20	0.027	V	29.6(47.6)
PAS	34.2430	116.8960	06/30/1979	03411.6	5.8	4.90	0.039	V	29.6(47.7)
DMG	34.4330	116.9830	04/18/1945	458 2.0	0.0	4.30	0.028	V	30.2(48.6)
MGI	34.3000	116.9000	12/01/1915	14 5 0.0	0.0	4.00	0.024	V	30.3(48.8)
DMG	34.1000	116.8830	10/24/1935	1451 0.0	0.0	4.50	0.031	V	30.4(49.0)
DMG	34.1000	116.8830	10/24/1935	1527 0.0	0.0	4.00	0.024	V	30.4(49.0)
DMG	34.1000	116.8830	10/24/1935	1452 0.0	0.0	4.50	0.031	V	30.4(49.0)
PDP	33.7330	117.4660	09/02/2007	172914.0	2.0	4.70	0.034	V	30.5(49.1)
DMG	33.7330	117.4670	10/26/1954	162226.0	0.0	4.10	0.025	V	30.5(49.2)
GSP	34.3620	116.9230	12/07/1992	033331.5	1.0	4.00	0.024	IV	30.6(49.3)
DMG	34.3370	116.9090	11/30/1962	2351 5.5	7.0	4.30	0.028	V	30.7(49.3)
GSP	33.8060	117.7150	03/07/2000	002028.2	11.0	4.00	0.024	IV	30.8(49.6)
PAS	33.9650	117.8860	01/01/1976	172012.9	6.2	4.20	0.026	V	30.9(49.7)
GSP	34.3610	116.9130	12/04/1992	125942.1	0.0	4.20	0.026	V	31.1(50.0)
GSP	34.3400	116.9000	11/27/1992	160057.5	1.0	5.30	0.047	VI	31.2(50.2)
GSP	34.1950	116.8620	08/17/1992	204152.1	11.0	5.30	0.047	VI	31.2(50.3)
GSP	34.1980	116.8620	08/18/1992	094640.7	12.0	4.20	0.026	V	31.2(50.3)
GSP	34.3770	116.9180	12/04/1992	052511.2	2.0	4.80	0.035	V	31.3(50.4)
DMG	33.7250	117.4980	01/03/1956	02548.9	13.7	4.70	0.033	V	31.3(50.4)
GSP	34.1410	116.8570	09/19/1997	223714.5	10.0	4.10	0.024	V	31.6(50.8)
GSP	34.1630	116.8550	06/28/1992	144321.0	6.0	5.30	0.046	VI	31.6(50.9)
DMG	34.3240	116.8850	12/01/1962	03548.8	9.6	4.30	0.027	V	31.6(50.9)
GSP	34.3640	116.9040	11/27/1992	183225.0	1.0	4.10	0.024	V	31.6(50.9)
DMG	34.3120	116.8790	01/31/1972	155 4.2	8.0	4.00	0.023	IV	31.7(51.0)
DMG	34.3330	116.8830	10/14/1943	142844.0	0.0	4.50	0.029	V	31.9(51.4)
DMG	33.7170	117.5070	08/06/1938	22 056.0	10.0	4.00	0.023	IV	32.0(51.4)
DMG	33.7170	117.5170	06/19/1935	1117 0.0	0.0	4.00	0.023	IV	32.1(51.6)
DMG	34.4000	116.9170	02/01/1942	151555.0	0.0	4.00	0.023	IV	32.1(51.7)
DMG	34.4000	116.9170	02/01/1942	151828.0	0.0	4.50	0.029	V	32.1(51.7)
DMG	34.4000	116.9170	01/25/1942	215133.0	0.0	4.00	0.023	IV	32.1(51.7)
DMG	34.4000	116.9170	02/01/1942	16 334.0	0.0	4.50	0.029	V	32.1(51.7)
GSP	34.3690	116.8970	12/04/1992	020857.5	3.0	5.30	0.045	VI	32.2(51.7)

DMG	34.3250	116.8750	12/02/1962	04138.4	6.7	4.40	0.028	V	32.2(51.8)
GSP	34.2320	116.8460	07/10/1992	012940.0	0.0	4.20	0.025	V	32.4(52.1)
GSP	34.2250	116.8440	07/09/1992	023435.0	0.0	4.10	0.024	IV	32.4(52.2)
DMG	33.7380	117.1870	04/27/1962	91232.1	5.7	4.10	0.023	IV	32.6(52.4)
DMG	33.7000	117.4000	05/15/1910	1547 0.0	0.0	6.00	0.068	VI	32.6(52.5)
DMG	33.7000	117.4000	05/13/1910	620 0.0	0.0	5.00	0.038	V	32.6(52.5)
DMG	33.7000	117.4000	04/11/1910	757 0.0	0.0	5.00	0.038	V	32.6(52.5)
DMG	34.3250	116.8650	10/29/1962	24253.9	8.6	4.80	0.034	V	32.7(52.7)
GSP	34.2390	116.8370	07/09/1992	014357.6	0.0	5.30	0.044	VI	32.9(53.0)
GSP	34.3700	116.8800	11/29/1992	142120.5	3.0	4.00	0.022	IV	33.1(53.2)
GSP	34.3240	116.8580	02/22/2003	141608.4	4.0	4.10	0.023	IV	33.1(53.2)
GSP	34.3260	116.8570	02/22/2003	122513.6	9.0	4.00	0.022	IV	33.2(53.4)
GSP	34.3110	116.8510	02/22/2003	122133.1	4.0	4.30	0.025	V	33.2(53.4)
GSP	34.1630	116.8270	06/28/1992	150451.5	12.0	4.40	0.027	V	33.2(53.4)
DMG	34.3500	116.8670	10/15/1943	1650 1.0	0.0	4.50	0.028	V	33.2(53.4)
GSP	34.3100	116.8500	02/22/2003	193345.8	3.0	4.50	0.028	V	33.2(53.5)
DMG	33.6990	117.5110	05/31/1938	83455.4	10.0	5.50	0.049	VI	33.2(53.5)
DMG	33.9680	116.8820	06/27/1959	162211.1	13.8	4.00	0.022	IV	33.2(53.5)

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FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
GSN	34.2030	116.8270	06/28/1992	150530.7	5.0	6.70	0.106	VII	33.3(53.5)
GSG	34.3100	116.8480	02/22/2003	121910.6	1.0	5.20	0.041	V	33.3(53.7)
GSP	34.3110	116.8470	02/22/2003	122015.6	4.0	4.00	0.022	IV	33.4(53.8)
GSP	34.3200	116.8500	10/27/1998	154017.1	4.0	4.10	0.023	IV	33.4(53.8)
GSP	34.3040	116.8430	02/27/2003	050021.7	4.0	4.00	0.022	IV	33.5(53.9)
GSP	34.2500	117.9900	06/28/1991	170055.5	9.0	4.30	0.025	V	33.6(54.1)
GSP	34.3150	116.8440	02/25/2003	040304.8	2.0	4.60	0.029	V	33.7(54.2)
GSP	34.3220	116.8460	09/20/1999	070249.2	2.0	4.20	0.024	IV	33.7(54.2)
GSP	34.3230	116.8440	10/27/1998	010840.7	5.0	4.90	0.034	V	33.8(54.4)
MGI	34.2000	118.0000	01/09/1921	530 0.0	0.0	4.60	0.029	V	33.8(54.5)
DMG	34.3070	116.8350	08/28/1950	194526.4	11.7	4.20	0.024	IV	34.0(54.7)
MGI	33.8000	117.8000	11/10/1926	1723 0.0	0.0	4.60	0.029	V	34.1(54.9)
MGI	33.8000	117.8000	05/20/1917	945 0.0	0.0	4.00	0.021	IV	34.1(54.9)
MGI	33.8000	117.8000	11/07/1926	1948 0.0	0.0	4.60	0.029	V	34.1(54.9)
MGI	33.8000	117.8000	05/19/1917	719 0.0	0.0	4.00	0.021	IV	34.1(54.9)
MGI	33.8000	117.8000	11/04/1926	2238 0.0	0.0	4.60	0.029	V	34.1(54.9)
MGI	33.8000	117.8000	05/19/1917	635 0.0	0.0	4.00	0.021	IV	34.1(54.9)
MGI	33.8000	117.8000	11/09/1926	1535 0.0	0.0	4.60	0.029	V	34.1(54.9)
MGI	34.1000	118.0000	01/27/1930	2026 0.0	0.0	4.60	0.029	V	34.2(55.0)
GSP	34.2370	116.8110	06/28/1992	125730.8	10.0	4.00	0.021	IV	34.4(55.3)
GSP	34.2620	118.0020	06/28/1991	144354.5	11.0	5.40	0.045	VI	34.5(55.4)
GSP	34.3540	116.8430	11/13/2004	173916.9	9.0	4.20	0.023	IV	34.6(55.7)
GSP	34.3290	116.8320	12/03/2005	074934.6	5.0	4.10	0.022	IV	34.6(55.7)
GSP	34.1830	116.8020	06/28/1992	192637.6	1.0	4.00	0.021	IV	34.6(55.7)
DMG	33.9960	117.9750	06/15/1967	458 5.5	10.0	4.10	0.022	IV	34.6(55.7)
DMG	33.8000	117.0000	12/25/1899	1225 0.0	0.0	6.40	0.083	VII	34.8(55.9)
DMG	33.6820	117.5530	07/05/1938	18 655.7	10.0	4.50	0.027	V	34.9(56.1)
DMG	34.1000	116.8000	10/24/1935	1448 7.6	0.0	5.10	0.037	V	35.1(56.5)
DMG	34.2290	116.7950	05/11/1956	163050.5	13.3	4.70	0.029	V	35.2(56.7)
PAS	34.3220	116.8150	08/29/1985	759 8.7	6.1	4.10	0.022	IV	35.4(56.9)
DMG	33.9500	116.8500	09/28/1946	719 9.0	0.0	5.00	0.034	V	35.4(57.0)

GSP	34.2980	116.8040	07/05/1992	200303.1	3.0	4.00	0.020	IV	35.6(57.2)
MGI	34.0000	118.0000	05/05/1929	735 0.0	0.0	4.00	0.020	IV	35.9(57.7)
MGI	34.0000	118.0000	05/05/1929	1 7 0.0	0.0	4.60	0.027	V	35.9(57.7)
MGI	34.0000	118.0000	12/25/1903	1745 0.0	0.0	5.00	0.034	V	35.9(57.7)
DMG	34.4170	116.8500	02/11/1932	231120.0	0.0	4.00	0.020	IV	36.0(58.0)
DMG	34.3170	116.8000	08/12/1950	21717.0	0.0	4.30	0.023	IV	36.1(58.1)
DMG	33.7670	117.8170	08/22/1936	521 0.0	0.0	4.00	0.020	IV	36.5(58.7)
GSP	34.2190	116.7710	07/21/1992	211029.0	1.0	4.10	0.021	IV	36.5(58.8)
DMG	34.2990	116.7840	03/18/1956	24217.3	6.3	4.40	0.024	V	36.7(59.0)
GSP	34.2670	116.7750	12/02/2000	082807.4	3.0	4.10	0.021	IV	36.7(59.1)
DMG	34.2500	116.7700	03/16/1956	203344.3	0.8	4.00	0.020	IV	36.8(59.3)
GSP	34.2730	116.7740	08/24/1992	135146.0	1.0	4.30	0.023	IV	36.9(59.3)
DMG	34.0290	116.7870	04/30/1954	03623.9	11.1	4.20	0.022	IV	36.9(59.3)
PAS	34.0770	118.0470	02/11/1988	152555.7	12.5	4.70	0.028	V	37.1(59.7)
DMG	33.7000	117.1000	06/11/1902	245 0.0	0.0	4.50	0.025	V	37.1(59.7)
GSP	34.2110	116.7600	06/28/1992	152429.3	6.0	4.50	0.025	V	37.1(59.7)
GSP	34.2070	116.7570	06/28/1992	161719.2	3.0	4.20	0.021	IV	37.3(60.0)
DMG	33.7500	117.0000	06/06/1918	2232 0.0	0.0	5.00	0.033	V	37.4(60.2)
DMG	33.7500	117.0000	04/21/1918	223225.0	0.0	6.80	0.100	VII	37.4(60.2)
DMG	34.4360	116.8340	07/14/1973	8 020.1	8.0	4.80	0.029	V	37.4(60.3)
DMG	33.9670	116.8000	09/07/1945	153424.0	0.0	4.30	0.022	IV	37.6(60.5)
DMG	34.1170	116.7500	08/22/1942	125913.0	0.0	4.00	0.019	IV	37.8(60.8)

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FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
DMG	34.2640	116.7550	03/16/1956	203613.6	3.3	4.00	0.019	IV	37.8(60.9)
GSP	34.0140	116.7750	10/18/2005	040841.5	16.0	4.10	0.020	IV	37.8(60.9)
GSP	34.0120	116.7750	10/18/2005	073103.5	18.0	4.40	0.023	IV	37.9(60.9)
DMG	34.0140	116.7710	06/10/1944	111150.5	10.0	4.50	0.024	V	38.0(61.2)
MGI	33.8000	117.9000	05/22/1902	740 0.0	0.0	4.30	0.022	IV	38.1(61.4)
DMG	34.3060	116.7590	03/16/1956	202933.6	1.3	4.80	0.029	V	38.2(61.4)
GSP	34.1300	116.7340	06/30/1992	212254.4	12.0	4.80	0.028	V	38.6(62.2)
DMG	33.9760	116.7750	10/17/1965	94519.0	17.0	4.90	0.030	V	38.7(62.2)
MGI	33.8000	116.9000	04/29/1918	2 0 0.0	0.0	4.00	0.019	IV	38.8(62.5)
MGI	33.8000	116.9000	06/14/1918	1024 0.0	0.0	4.00	0.019	IV	38.8(62.5)
MGI	33.8000	116.9000	12/18/1920	1726 0.0	0.0	4.00	0.019	IV	38.8(62.5)
MGI	33.8000	116.9000	04/23/1918	1415 0.0	0.0	4.00	0.019	IV	38.8(62.5)
DMG	33.9730	116.7690	06/10/1944	111531.9	10.0	4.00	0.018	IV	39.1(62.9)
PAS	34.0610	118.0790	10/01/1987	144220.0	9.5	5.90	0.053	VI	39.1(62.9)
GSP	34.2750	116.7300	07/01/1992	204617.8	1.0	4.20	0.020	IV	39.4(63.3)
DMG	33.9670	118.0500	01/30/1941	13446.9	0.0	4.10	0.019	IV	39.4(63.3)
GSP	34.2810	116.7310	07/01/1992	205356.8	1.0	4.00	0.018	IV	39.4(63.4)
PAS	34.0760	118.0900	10/01/1987	1448 3.1	11.7	4.10	0.019	IV	39.5(63.6)
DMG	34.3360	116.7420	03/16/1956	233456.4	1.7	4.40	0.022	IV	39.6(63.8)
GSP	34.2500	116.7190	06/29/1992	164141.9	1.0	4.90	0.029	V	39.7(63.9)
PAS	34.0500	118.0870	10/01/1987	155953.5	10.4	4.00	0.018	IV	39.7(63.9)
MGI	34.1000	118.1000	07/11/1855	415 0.0	0.0	6.30	0.067	VI	39.8(64.1)
PAS	34.0520	118.0900	10/01/1987	151231.8	10.8	4.70	0.026	V	39.9(64.1)
PAS	34.0730	118.0980	10/04/1987	105938.2	8.2	5.30	0.036	V	40.0(64.4)
PAS	34.0600	118.1000	10/01/1987	1449 5.9	11.7	4.70	0.026	V	40.3(64.9)
DMG	34.4500	116.7830	05/22/1942	151829.0	0.0	4.00	0.018	IV	40.5(65.1)
PAS	34.0490	118.1010	10/01/1987	144541.5	13.6	4.70	0.025	V	40.5(65.2)

DMG	34.1000	116.7000	02/07/1889	520 0.0	0.0	5.30	0.035	V	40.8(65.6)
DMG	33.9330	116.7500	08/06/1938	228 0.0	0.0	4.00	0.017	IV	41.1(66.2)
DMG	33.9330	116.7500	10/28/1944	183016.0	0.0	4.40	0.021	IV	41.1(66.2)
GSP	34.2740	116.6920	07/01/1992	170715.1	4.0	4.20	0.019	IV	41.5(66.7)
PAS	34.1490	118.1350	12/03/1988	113826.4	13.3	4.90	0.028	V	41.6(66.9)
DMG	33.9500	116.7330	04/26/1942	151023.0	0.0	4.00	0.017	IV	41.6(66.9)
DMG	33.9760	116.7210	06/12/1944	104534.7	10.0	5.10	0.031	V	41.6(66.9)
DMG	33.9170	116.7500	01/25/1933	1444 0.0	0.0	4.00	0.017	IV	41.6(66.9)
DMG	33.9940	116.7120	06/12/1944	111636.0	10.0	5.30	0.035	V	41.7(67.1)
PAS	33.9760	116.7130	08/06/1984	81436.6	14.2	4.30	0.020	IV	42.0(67.6)
DMG	34.0000	116.7000	08/25/1944	73025.0	0.0	4.20	0.019	IV	42.2(67.9)
DMG	33.7100	116.9250	09/23/1963	144152.6	16.5	5.00	0.029	V	42.3(68.0)
DMG	33.9810	116.7020	06/12/1944	222119.5	10.0	4.20	0.019	IV	42.5(68.4)
DMG	33.8000	118.0000	10/21/1913	938 0.0	0.0	4.00	0.017	IV	42.5(68.5)
MGI	33.7000	117.9000	07/08/1902	945 0.0	0.0	4.00	0.017	IV	43.1(69.4)
DMG	34.7000	117.0000	07/16/1916	1150 0.0	0.0	4.50	0.021	IV	43.2(69.5)
DMG	34.7000	117.0000	07/16/1916	1230 0.0	0.0	4.00	0.017	IV	43.2(69.5)
T-A	34.1700	118.1700	03/07/1888	1554 0.0	0.0	4.30	0.019	IV	43.5(70.0)
PAS	33.9790	116.6810	12/16/1988	553 5.0	8.1	4.80	0.025	V	43.7(70.3)
GSP	34.1110	116.6460	06/28/1992	140928.8	7.0	4.10	0.017	IV	43.8(70.4)
GSP	34.6000	116.8400	06/04/1989	213358.1	2.0	4.50	0.021	IV	43.8(70.5)
DMG	33.9000	118.1000	07/08/1929	1646 6.7	13.0	4.70	0.023	IV	43.8(70.5)
PAS	34.0310	116.6570	07/08/1986	92412.8	6.0	4.40	0.020	IV	44.0(70.9)
DMG	33.9170	116.7000	11/17/1943	112841.0	0.0	4.50	0.021	IV	44.2(71.1)
DMG	33.9500	118.1330	10/25/1933	7 046.0	0.0	4.30	0.019	IV	44.2(71.2)
DMG	33.7500	118.0000	11/16/1934	2126 0.0	0.0	4.00	0.016	IV	44.7(72.0)

EARTHQUAKE SEARCH RESULTS

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FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
PAS	33.9910	116.6490	07/17/1986	215445.2	7.4	4.40	0.019	IV	45.2(72.7)
GSP	34.0300	118.1800	06/12/1989	165718.4	16.0	4.40	0.019	IV	45.2(72.8)
DMG	34.4050	116.6670	07/02/1955	162938.5	10.0	4.20	0.017	IV	45.2(72.8)
PAS	33.9890	116.6490	07/17/1986	203515.0	6.2	4.00	0.016	IV	45.2(72.8)
GSP	34.0200	118.1800	06/12/1989	172225.5	16.0	4.10	0.017	IV	45.4(73.0)
MGI	34.1000	118.2000	05/02/1916	1432 0.0	0.0	4.00	0.016	IV	45.5(73.3)
MGI	34.1000	118.2000	04/21/1921	1538 0.0	0.0	4.00	0.016	IV	45.5(73.3)
MGI	34.1000	118.2000	01/27/1860	830 0.0	0.0	4.30	0.018	IV	45.5(73.3)
DMG	33.9590	116.6510	09/23/1949	214440.1	12.2	4.00	0.016	IV	45.8(73.6)
PAS	33.7010	116.8370	08/22/1979	2 136.3	5.0	4.10	0.016	IV	46.2(74.3)
PAS	34.4010	116.6410	02/10/1975	125117.6	8.0	4.40	0.019	IV	46.5(74.8)
MGI	34.0000	118.2000	06/26/1917	2130 0.0	0.0	4.60	0.021	IV	46.8(75.3)
MGI	34.0000	118.2000	06/26/1917	2115 0.0	0.0	4.60	0.021	IV	46.8(75.3)
MGI	34.0000	118.2000	02/13/1917	13 5 0.0	0.0	4.60	0.021	IV	46.8(75.3)
MGI	34.0000	118.2000	06/26/1917	2120 0.0	0.0	4.60	0.021	IV	46.8(75.3)
MGI	34.0000	118.2000	06/26/1917	424 0.0	0.0	4.00	0.015	IV	46.8(75.3)
PAS	33.9670	116.6170	07/08/1986	155526.2	6.0	4.00	0.015	IV	47.4(76.3)
PAS	33.9670	116.6170	07/08/1986	102240.6	6.0	4.40	0.018	IV	47.4(76.3)
PAS	33.9980	116.6060	07/08/1986	92044.5	11.7	5.60	0.036	V	47.4(76.3)
GSP	33.6200	117.9000	04/07/1989	200730.2	13.0	4.50	0.019	IV	47.4(76.3)
PAS	34.3820	116.6130	06/11/1984	222110.4	1.8	4.00	0.015	IV	47.6(76.6)
DMG	33.6800	117.9930	11/20/1961	85334.7	4.4	4.00	0.015	IV	47.7(76.8)
DMG	33.6650	117.9790	10/20/1961	214240.7	7.2	4.00	0.015	IV	47.9(77.2)

DMG	33.8000	116.7000	08/11/1911	2340 0.0	0.0	4.50	0.019	IV	48.0(77.3)
DMG	33.8000	116.7000	08/11/1911	1820 0.0	0.0	4.00	0.015	IV	48.0(77.3)
DMG	34.0650	116.5740	08/26/1959	53250.2	16.7	4.30	0.017	IV	48.3(77.7)
DMG	33.6590	117.9810	10/20/1961	20 714.5	6.1	4.00	0.015	IV	48.3(77.8)
DMG	33.9390	118.2050	01/11/1950	214135.0	0.4	4.10	0.016	IV	48.3(77.8)
DMG	33.7500	118.0830	03/11/1933	211 0.0	0.0	4.40	0.018	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	323 0.0	0.0	5.00	0.025	V	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	1025 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/13/1933	131828.0	0.0	5.30	0.030	V	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	11 0 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/14/1933	036 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	1045 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/19/1933	2123 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	2 9 0.0	0.0	5.00	0.025	V	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	436 0.0	0.0	4.60	0.020	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	1956 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	2240 0.0	0.0	4.40	0.018	IV	48.4(77.9)
DMG	33.7500	118.0830	04/01/1933	642 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	2232 0.0	0.0	4.10	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/12/1933	1825 0.0	0.0	4.10	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	23 5 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/20/1933	1358 0.0	0.0	4.10	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/13/1933	1929 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/15/1933	432 0.0	0.0	4.10	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/12/1933	546 0.0	0.0	4.40	0.018	IV	48.4(77.9)
DMG	33.7500	118.0830	03/15/1933	540 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	22 0 0.0	0.0	4.40	0.018	IV	48.4(77.9)
DMG	33.7500	118.0830	03/12/1933	1651 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	3 5 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	515 0.0	0.0	4.00	0.015	IV	48.4(77.9)

EARTHQUAKE SEARCH RESULTS

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FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
DMG	33.7500	118.0830	03/12/1933	1738 0.0	0.0	4.50	0.019	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	759 0.0	0.0	4.10	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/12/1933	2128 0.0	0.0	4.10	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	347 0.0	0.0	4.10	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/23/1933	1831 0.0	0.0	4.10	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	2 4 0.0	0.0	4.90	0.024	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	2 5 0.0	0.0	4.30	0.017	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	910 0.0	0.0	5.10	0.026	V	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	210 0.0	0.0	4.60	0.020	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	926 0.0	0.0	4.10	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	216 0.0	0.0	4.80	0.022	IV	48.4(77.9)
DMG	33.7500	118.0830	03/16/1933	1530 0.0	0.0	4.10	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/14/1933	1219 0.0	0.0	4.50	0.019	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	230 0.0	0.0	5.10	0.026	V	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	524 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	1138 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	252 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	1147 0.0	0.0	4.40	0.018	IV	48.4(77.9)
DMG	33.7500	118.0830	03/12/1933	15 2 0.0	0.0	4.20	0.016	IV	48.4(77.9)

DMG	33.7500	118.0830	03/12/1933	835 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	1357 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	513 0.0	0.0	4.70	0.021	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	311 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	751 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	8 8 0.0	0.0	4.50	0.019	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	339 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	1653 0.0	0.0	4.80	0.022	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	1944 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/25/1933	1346 0.0	0.0	4.10	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/30/1933	1225 0.0	0.0	4.40	0.018	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	2231 0.0	0.0	4.40	0.018	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	635 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/12/1933	740 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	04/02/1933	1536 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	553 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	521 0.0	0.0	4.40	0.018	IV	48.4(77.9)
DMG	33.7500	118.0830	03/12/1933	448 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/15/1933	2 8 0.0	0.0	4.10	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/12/1933	6 1 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	258 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	259 0.0	0.0	4.60	0.020	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	911 0.0	0.0	4.40	0.018	IV	48.4(77.9)
DMG	33.7500	118.0830	03/13/1933	1532 0.0	0.0	4.10	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/16/1933	1529 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/18/1933	2052 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	3 9 0.0	0.0	4.40	0.018	IV	48.4(77.9)
DMG	33.7500	118.0830	03/12/1933	2354 0.0	0.0	4.50	0.019	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	832 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/13/1933	432 0.0	0.0	4.70	0.021	IV	48.4(77.9)
DMG	33.7500	118.0830	03/13/1933	617 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	439 0.0	0.0	4.90	0.024	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	257 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/16/1933	1456 0.0	0.0	4.00	0.015	IV	48.4(77.9)

EARTHQUAKE SEARCH RESULTS

FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
DMG	33.7500	118.0830	03/11/1933	618 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	611 0.0	0.0	4.40	0.018	IV	48.4(77.9)
DMG	33.7500	118.0830	04/02/1933	8 0 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	222 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	227 0.0	0.0	4.60	0.020	IV	48.4(77.9)
DMG	33.7500	118.0830	03/21/1933	326 0.0	0.0	4.10	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	1141 0.0	0.0	4.20	0.016	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	555 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	837 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	440 0.0	0.0	4.70	0.021	IV	48.4(77.9)
DMG	33.7500	118.0830	03/31/1933	1049 0.0	0.0	4.10	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/23/1933	840 0.0	0.0	4.10	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/13/1933	343 0.0	0.0	4.10	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	1129 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/17/1933	1651 0.0	0.0	4.10	0.015	IV	48.4(77.9)

DMG	33.7500	118.0830	03/12/1933	034 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	336 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/14/1933	2242 0.0	0.0	4.10	0.015	IV	48.4(77.9)
DMG	33.7500	118.0830	03/12/1933	616 0.0	0.0	4.60	0.020	IV	48.4(77.9)
DMG	33.7500	118.0830	03/12/1933	027 0.0	0.0	4.40	0.018	IV	48.4(77.9)
DMG	33.7500	118.0830	03/11/1933	1547 0.0	0.0	4.00	0.015	IV	48.4(77.9)
DMG	34.5650	118.1130	02/28/1969	45612.4	5.3	4.30	0.017	IV	48.4(78.0)
DMG	33.6710	118.0120	10/20/1961	223534.2	5.6	4.10	0.015	IV	49.0(78.8)
DMG	33.5450	117.8070	10/27/1969	1316 2.3	6.5	4.50	0.019	IV	49.0(78.9)
MGI	33.9000	118.2000	10/08/1927	1914 0.0	0.0	4.60	0.020	IV	49.1(78.9)
DMG	33.6540	117.9940	10/20/1961	194950.5	4.6	4.30	0.017	IV	49.1(79.0)
MGI	34.0800	118.2600	07/16/1920	18 8 0.0	0.0	5.00	0.025	V	49.1(79.0)
DMG	33.7670	118.1170	11/04/1939	2141 0.0	0.0	4.00	0.014	IV	49.3(79.4)
DMG	33.7830	118.1330	10/02/1933	91017.6	0.0	5.40	0.031	V	49.5(79.6)
DMG	33.7830	118.1330	01/13/1940	749 7.0	0.0	4.00	0.014	IV	49.5(79.6)
DMG	33.7830	118.1330	11/20/1933	1032 0.0	0.0	4.00	0.014	IV	49.5(79.6)
T-A	34.0000	118.2500	05/02/1856	810 0.0	0.0	4.30	0.017	IV	49.6(79.8)
T-A	34.0000	118.2500	01/10/1856	0 0 0.0	0.0	5.00	0.024	V	49.6(79.8)
T-A	34.0000	118.2500	03/26/1860	0 0 0.0	0.0	5.00	0.024	V	49.6(79.8)
T-A	34.0000	118.2500	05/04/1857	6 0 0.0	0.0	4.30	0.017	IV	49.6(79.8)
T-A	34.0000	118.2500	09/23/1827	0 0 0.0	0.0	5.00	0.024	V	49.6(79.8)
T-A	34.0000	118.2500	01/17/1857	1 0 0.0	0.0	4.30	0.017	IV	49.6(79.8)
T-A	34.0000	118.2500	03/21/1880	1425 0.0	0.0	4.30	0.017	IV	49.6(79.8)
PAS	33.9870	116.5690	07/09/1986	01232.1	6.0	4.40	0.018	IV	49.7(79.9)
DMG	33.7000	118.0670	03/11/1933	51022.0	0.0	5.10	0.026	V	49.9(80.3)
DMG	33.7000	118.0670	02/08/1940	165617.0	0.0	4.00	0.014	IV	49.9(80.3)
DMG	33.7000	118.0670	03/11/1933	85457.0	0.0	5.10	0.026	V	49.9(80.3)
DMG	33.7000	118.0670	07/20/1940	4 113.0	0.0	4.00	0.014	IV	49.9(80.3)
DMG	33.7330	118.1000	03/11/1933	1447 0.0	0.0	4.40	0.017	IV	49.9(80.3)
DMG	33.7330	118.1000	03/11/1933	15 9 0.0	0.0	4.40	0.017	IV	49.9(80.3)
DMG	33.7330	118.1000	03/11/1933	1350 0.0	0.0	4.40	0.017	IV	49.9(80.3)
DMG	33.6830	118.0500	03/11/1933	1250 0.0	0.0	4.40	0.017	IV	50.0(80.4)
DMG	33.6830	118.0500	03/11/1933	658 3.0	0.0	5.50	0.032	V	50.0(80.4)
DMG	33.6170	117.9670	03/11/1933	154 7.8	0.0	6.30	0.053	VI	50.0(80.4)
DMG	33.8670	118.2000	11/13/1933	2128 0.0	0.0	4.00	0.014	IV	50.0(80.4)
PAS	33.9530	116.5720	10/15/1986	22847.8	8.7	4.70	0.020	IV	50.2(80.7)
T-A	33.5000	117.0700	12/29/1880	7 0 0.0	0.0	4.30	0.016	IV	50.3(81.0)
DMG	33.7500	118.1330	03/11/1933	11 4 0.0	0.0	4.60	0.019	IV	50.7(81.7)

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FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
DMG	33.8670	118.2170	06/19/1944	3 6 7.0	0.0	4.40	0.017	IV	50.9(81.9)
DMG	33.8670	118.2170	06/19/1944	0 333.0	0.0	4.50	0.018	IV	50.9(81.9)
DMG	34.5190	118.1980	08/23/1952	10 9 7.1	13.1	5.00	0.024	IV	51.0(82.0)
MGI	34.1000	118.3000	07/16/1920	2130 0.0	0.0	4.60	0.019	IV	51.2(82.4)
MGI	34.1000	118.3000	07/26/1920	1215 0.0	0.0	4.00	0.014	IV	51.2(82.4)
MGI	34.1000	118.3000	07/16/1920	2127 0.0	0.0	4.60	0.019	IV	51.2(82.4)
MGI	34.1000	118.3000	07/16/1920	2022 0.0	0.0	4.60	0.019	IV	51.2(82.4)
GSP	34.3410	116.5290	06/28/1992	124053.5	6.0	5.20	0.026	V	51.5(82.9)
DMG	33.8980	116.5690	11/17/1964	145228.2	10.3	4.00	0.014	IV	51.6(83.1)
DMG	33.6170	118.0170	10/02/1933	1326 1.0	0.0	4.00	0.014	III	51.9(83.5)
DMG	33.6170	118.0170	03/15/1933	111332.0	0.0	4.90	0.022	IV	51.9(83.5)

DMG	33.6170	118.0170	03/14/1933	19 150.0	0.0	5.10	0.024	V	51.9(83.5)
DMG	33.5000	117.0000	08/08/1925	1013 0.0	0.0	4.50	0.018	IV	52.0(83.7)
DMG	33.6000	118.0000	03/11/1933	217 0.0	0.0	4.50	0.018	IV	52.1(83.8)
DMG	33.6000	118.0000	03/11/1933	231 0.0	0.0	4.40	0.017	IV	52.1(83.8)
DMG	33.6500	116.7500	09/05/1950	191956.0	0.0	4.80	0.021	IV	52.2(84.0)
GSP	33.9220	118.2700	10/28/2001	162745.6	21.0	4.00	0.014	III	52.3(84.1)
PAS	34.4220	116.5420	07/18/1985	14 525.8	6.0	4.20	0.015	IV	52.3(84.2)
DMG	33.7500	118.1670	05/16/1933	205855.0	0.0	4.00	0.014	III	52.3(84.2)
MGI	34.0000	118.3000	09/03/1905	540 0.0	0.0	5.30	0.027	V	52.4(84.3)
MGI	34.0000	118.3000	06/22/1920	2035 0.0	0.0	4.00	0.014	III	52.4(84.3)
MGI	34.0000	118.3000	06/30/1920	350 0.0	0.0	4.00	0.014	III	52.4(84.3)
GSP	34.6220	116.6670	07/15/2003	061550.8	7.0	4.20	0.015	IV	52.4(84.3)
DMG	33.8170	118.2170	10/22/1941	65718.5	0.0	4.90	0.022	IV	52.4(84.3)
DMG	33.6170	118.0330	05/21/1938	944 0.0	0.0	4.00	0.014	III	52.5(84.5)
GSP	33.6500	116.7400	12/02/1989	231647.8	14.0	4.20	0.015	IV	52.6(84.7)
DMG	33.9830	118.3000	02/11/1940	192410.0	0.0	4.00	0.013	III	52.7(84.7)
PAS	34.3020	116.4990	03/31/1979	016 8.6	0.1	4.20	0.015	IV	52.7(84.7)
DMG	33.7830	118.2000	12/27/1939	192849.0	0.0	4.70	0.019	IV	52.7(84.8)
DMG	33.6000	118.0170	12/25/1935	1715 0.0	0.0	4.50	0.017	IV	52.7(84.9)
DMG	34.3700	118.3020	02/10/1971	31212.0	0.8	4.00	0.013	III	52.8(84.9)
DMG	33.5750	117.9830	03/11/1933	518 4.0	0.0	5.20	0.025	V	52.8(85.0)
DMG	34.3610	118.3060	02/09/1971	141021.5	5.0	4.70	0.019	IV	52.8(85.0)
DMG	33.8000	116.6000	09/10/1931	436 0.0	0.0	4.00	0.013	III	52.9(85.2)
DMG	34.0170	116.5000	07/26/1947	231351.0	0.0	4.10	0.014	IV	53.0(85.3)
DMG	34.0170	116.5000	07/26/1947	12415.0	0.0	4.20	0.015	IV	53.0(85.3)
DMG	34.0170	116.5000	07/26/1947	24941.0	0.0	5.10	0.024	V	53.0(85.3)
DMG	34.0170	116.5000	08/01/1947	17 137.0	0.0	4.10	0.014	IV	53.0(85.3)
DMG	34.0170	116.5000	07/24/1947	221046.0	0.0	5.50	0.030	V	53.0(85.3)
DMG	34.0170	116.5000	07/24/1947	225426.0	0.0	4.90	0.021	IV	53.0(85.3)
DMG	34.0170	116.5000	07/25/1947	61949.0	0.0	5.20	0.025	V	53.0(85.3)
DMG	34.0170	116.5000	07/25/1947	161453.0	0.0	4.50	0.017	IV	53.0(85.3)
DMG	34.0170	116.5000	07/24/1947	225341.0	0.0	4.30	0.016	IV	53.0(85.3)
DMG	34.0170	116.5000	07/29/1947	163615.0	0.0	4.20	0.015	IV	53.0(85.3)
DMG	34.0170	116.5000	07/25/1947	04631.0	0.0	5.00	0.023	IV	53.0(85.3)
DMG	34.0170	116.5000	07/25/1947	75730.0	0.0	4.20	0.015	IV	53.0(85.3)
DMG	34.0170	116.5000	08/08/1947	64745.0	0.0	4.00	0.013	III	53.0(85.3)
DMG	34.0170	116.5000	07/30/1947	52217.0	0.0	4.20	0.015	IV	53.0(85.3)
DMG	34.0170	116.5000	07/25/1947	51752.0	0.0	4.30	0.016	IV	53.0(85.3)
DMG	34.0170	116.5000	07/25/1947	15647.0	0.0	4.60	0.018	IV	53.0(85.3)
DMG	34.0170	116.5000	07/26/1947	23 425.0	0.0	4.50	0.017	IV	53.0(85.3)
GSP	34.6020	116.6350	10/02/1992	071957.4	3.0	4.30	0.016	IV	53.1(85.4)
DMG	33.7500	118.1830	08/04/1933	41748.0	0.0	4.00	0.013	III	53.1(85.5)

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FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
DMG	33.5670	117.9830	07/07/1937	1112 0.0	0.0	4.00	0.013	III	53.2(85.7)
DMG	33.5670	117.9830	04/17/1934	1833 0.0	0.0	4.00	0.013	III	53.2(85.7)
DMG	34.3680	118.3140	04/25/1971	1448 6.5	-2.0	4.00	0.013	III	53.4(85.9)
GSP	34.5950	116.6220	06/28/1992	163210.2	0.0	4.40	0.016	IV	53.4(86.0)
GSP	34.1520	116.4680	06/28/1992	224822.9	11.0	4.10	0.014	IV	53.7(86.5)
DMG	34.5780	116.6030	06/01/1937	154144.3	10.0	4.00	0.013	III	53.7(86.5)
GSP	34.6440	116.6560	06/30/1992	172629.7	0.0	4.30	0.015	IV	53.8(86.6)

DMG	34.3350	118.3310	02/09/1971	155820.7	14.2	4.80	0.020	IV	53.8(86.6)
GSP	34.6430	116.6530	06/30/1992	200025.4	0.0	4.30	0.015	IV	53.9(86.7)
DMG	34.3390	118.3320	02/09/1971	141612.9	11.1	4.10	0.014	IV	53.9(86.8)
DMG	33.8500	118.2670	03/11/1933	629 0.0	0.0	4.40	0.016	IV	54.0(86.8)
DMG	33.8500	118.2670	03/11/1933	1425 0.0	0.0	5.00	0.022	IV	54.0(86.8)
GSG	34.4880	116.5400	06/29/1992	015808.8	5.0	4.10	0.014	IV	54.1(87.0)
DMG	34.0830	116.4670	03/01/1942	104631.0	0.0	4.00	0.013	III	54.1(87.1)
DMG	34.0830	116.4670	01/26/1934	1844 0.0	0.0	4.00	0.013	III	54.1(87.1)
DMG	33.5000	116.9170	11/04/1935	355 0.0	0.0	4.50	0.017	IV	54.3(87.4)
GSP	33.6320	116.7190	07/19/1999	220927.5	14.0	4.20	0.014	IV	54.3(87.5)
GSP	34.3420	116.4670	07/07/1992	220928.3	2.0	4.40	0.016	IV	55.0(88.5)
DMG	34.4110	118.3290	02/10/1971	5 636.0	4.7	4.30	0.015	IV	55.0(88.6)
GSP	34.3320	116.4620	07/01/1992	074029.9	9.0	5.40	0.027	V	55.1(88.7)
DMG	34.0000	116.4670	12/06/1948	246 8.0	0.0	4.30	0.015	IV	55.1(88.7)
DMG	34.0000	116.4670	12/05/1948	05057.0	0.0	4.40	0.016	IV	55.1(88.7)
GSP	34.2940	116.4530	06/28/1992	173121.5	6.0	4.10	0.013	III	55.2(88.8)
DMG	33.7830	118.2500	11/14/1941	84136.3	0.0	5.40	0.027	V	55.2(88.8)
DMG	34.3810	116.4740	01/06/1964	234712.8	12.3	4.50	0.017	IV	55.2(88.8)
GSP	34.3010	116.4520	09/28/1997	155723.0	7.0	4.40	0.016	IV	55.3(89.0)
GSP	34.2390	116.4430	06/29/1992	030156.4	7.0	4.40	0.016	IV	55.3(89.0)
GSP	34.1990	116.4390	09/05/1995	202718.4	0.0	4.40	0.016	IV	55.4(89.1)
GSN	34.2010	116.4360	06/28/1992	115734.1	1.0	7.60	0.117	VII	55.6(89.4)
DMG	33.8830	118.3170	03/11/1933	1457 0.0	0.0	4.90	0.020	IV	55.7(89.7)
GSP	34.1980	116.4320	07/20/1992	040822.6	0.0	4.10	0.013	III	55.8(89.8)
PAS	34.3480	116.4530	03/15/1979	213425.6	1.5	4.50	0.016	IV	55.8(89.8)
PAS	34.2570	116.4350	07/13/1979	226 3.5	5.0	4.00	0.013	III	55.9(89.9)
GSP	34.3130	116.4440	07/02/1992	001622.4	6.0	4.00	0.013	III	55.9(89.9)
GSP	34.1390	116.4310	06/28/1992	123640.6	10.0	5.10	0.023	IV	55.9(89.9)
DMG	33.6170	118.1170	01/20/1934	2117 0.0	0.0	4.50	0.016	IV	55.9(89.9)
PAS	34.3270	116.4450	03/15/1979	21 716.5	2.5	5.20	0.024	V	56.0(90.1)
GSP	34.3770	116.4580	08/08/1992	153743.3	2.0	4.40	0.015	IV	56.0(90.1)
PAS	34.3090	116.4400	03/15/1979	201749.9	2.0	4.90	0.020	IV	56.1(90.2)
GSP	34.2450	116.4290	07/08/1993	225744.9	2.0	4.00	0.013	III	56.1(90.3)
PAS	34.3300	116.4430	03/15/1979	23 758.2	2.8	4.80	0.019	IV	56.1(90.3)
DMG	33.7590	118.2530	08/31/1938	31814.2	10.0	4.50	0.016	IV	56.2(90.4)
GSP	34.4050	116.4640	02/15/1993	075933.2	5.0	4.20	0.014	IV	56.2(90.4)
DMG	34.0670	116.4320	12/04/1957	25144.0	3.7	4.30	0.015	IV	56.3(90.6)
DMG	33.5610	118.0580	01/15/1937	183547.0	10.0	4.00	0.013	III	56.3(90.6)
GSP	34.0950	116.4270	06/28/1992	211316.5	3.0	4.60	0.017	IV	56.3(90.6)
DMG	34.0500	116.4330	02/08/1938	739 0.0	0.0	4.00	0.013	III	56.4(90.7)
GSP	34.0890	116.4260	06/28/1992	143906.9	0.0	4.30	0.015	IV	56.4(90.8)
GSP	34.3830	116.4520	07/02/1992	051632.2	0.0	4.00	0.013	III	56.4(90.8)
GSP	34.0590	118.3870	09/09/2001	235918.0	4.0	4.20	0.014	IV	56.5(90.9)
DMG	34.3870	118.3640	02/09/1971	143917.8	-1.6	4.00	0.013	III	56.5(90.9)
GSP	34.4140	116.4610	06/28/1992	131050.5	10.0	4.80	0.019	IV	56.5(91.0)
GSP	34.2930	118.3890	12/06/1994	034834.5	9.0	4.50	0.016	IV	56.6(91.1)

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FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
DMG	33.9670	116.4500	12/11/1948	161220.0	0.0	4.50	0.016	IV	56.6(91.1)
GSP	34.4570	116.4760	07/06/1992	180636.3	0.0	4.30	0.015	IV	56.7(91.2)
DMG	34.3960	118.3660	02/10/1971	173855.1	6.2	4.20	0.014	IV	56.8(91.4)

GSP	34.0960	116.4170	07/18/1992	000611.2	2.0	4.00	0.012	III	56.9(91.6)
GSP	34.1120	116.4150	07/28/1992	182703.9	0.0	4.60	0.017	IV	56.9(91.6)
GSP	34.4560	116.4690	08/31/1992	092540.6	11.0	4.30	0.014	IV	57.0(91.8)
GSP	34.3120	118.3930	05/25/1994	125657.1	7.0	4.40	0.015	IV	57.0(91.8)
GSP	34.1710	116.4090	06/30/1992	151905.0	0.0	4.00	0.012	III	57.1(91.8)
GSP	34.4890	116.4830	07/24/1992	072356.1	9.0	4.00	0.012	III	57.1(91.9)
GSP	34.0920	116.4140	12/21/1992	114402.9	3.0	4.00	0.012	III	57.1(91.9)
PAS	34.0220	116.4260	08/14/1975	8 849.8	10.9	4.00	0.012	III	57.1(91.9)
DMG	33.8000	118.3000	11/03/1931	16 5 0.0	0.0	4.00	0.012	III	57.2(92.0)
MGI	33.8000	118.3000	12/31/1928	1045 0.0	0.0	4.00	0.012	III	57.2(92.0)
PAS	34.5160	116.4950	06/01/1975	13849.2	4.5	5.20	0.023	IV	57.2(92.0)
GSP	34.1110	116.4100	06/28/1992	135045.7	0.0	4.90	0.020	IV	57.2(92.0)
DMG	34.3000	116.4170	08/07/1942	12358.0	0.0	4.00	0.012	III	57.3(92.1)
DMG	34.3000	116.4170	08/07/1942	15314.0	0.0	4.00	0.012	III	57.3(92.1)
DMG	34.3000	116.4170	08/07/1942	11533.0	0.0	4.50	0.016	IV	57.3(92.1)
GSP	34.3110	118.3980	06/15/1994	055948.6	7.0	4.20	0.014	III	57.3(92.2)
GSP	34.1620	116.4050	06/28/1992	132605.1	6.0	4.90	0.020	IV	57.3(92.2)
GSP	34.2890	118.4030	01/14/2001	025053.7	8.0	4.00	0.012	III	57.3(92.3)
GSP	34.2840	118.4040	01/14/2001	022614.1	8.0	4.30	0.014	IV	57.4(92.3)
DMG	33.4560	116.8960	06/16/1938	55916.9	10.0	4.00	0.012	III	57.6(92.6)
DMG	33.9670	116.4330	12/05/1948	04235.0	0.0	4.60	0.017	IV	57.6(92.6)
GSP	34.1080	116.4040	06/29/1992	141338.8	9.0	5.40	0.026	V	57.6(92.6)
DMG	33.4540	116.8980	07/29/1936	142252.8	10.0	4.00	0.012	III	57.6(92.7)
DMG	34.4310	118.3690	08/14/1974	144555.2	8.2	4.20	0.014	III	57.6(92.7)
GSP	34.1060	116.4020	06/29/1992	140837.7	11.0	4.90	0.020	IV	57.7(92.8)
GSP	34.2720	116.4030	12/11/1992	013834.2	2.0	4.10	0.013	III	57.8(93.0)
GSP	34.0880	116.4020	08/15/1992	082414.7	0.0	4.80	0.018	IV	57.8(93.0)
GSP	34.2680	116.4020	06/16/1994	162427.5	3.0	5.00	0.021	IV	57.8(93.0)
GSP	34.1270	116.3970	06/30/1992	000608.5	2.0	4.30	0.014	IV	57.9(93.1)
MGI	34.0000	118.4000	01/29/1927	2324 0.0	0.0	4.00	0.012	III	58.0(93.3)
MGI	34.0000	118.4000	02/07/1927	429 0.0	0.0	4.60	0.017	IV	58.0(93.3)
MGI	34.0000	118.4000	10/01/1930	040 0.0	0.0	4.60	0.017	IV	58.0(93.3)
MGI	34.0000	118.4000	02/22/1920	1610 0.0	0.0	4.60	0.017	IV	58.0(93.3)
DMG	33.9630	116.4250	01/13/1950	5 719.4	5.9	4.10	0.013	III	58.1(93.4)
MGI	33.5000	116.8000	03/30/1918	16 5 0.0	0.0	4.60	0.017	IV	58.1(93.5)
MGI	33.5000	116.8000	11/26/1916	17 5 0.0	0.0	4.00	0.012	III	58.1(93.5)
MGI	33.5000	116.8000	05/31/1917	435 0.0	0.0	4.00	0.012	III	58.1(93.5)
MGI	33.5000	116.8000	06/02/1917	435 0.0	0.0	4.00	0.012	III	58.1(93.5)
DMG	34.3570	118.4060	02/09/1971	141950.2	11.8	4.00	0.012	III	58.3(93.9)
PAS	34.3290	116.3980	03/16/1979	173659.1	5.0	4.00	0.012	III	58.6(94.4)
DMG	34.4000	116.4170	11/10/1947	22255.0	0.0	4.50	0.016	IV	58.7(94.4)
DMG	33.6330	118.2000	11/01/1940	20 046.0	0.0	4.00	0.012	III	58.7(94.5)
GSP	34.1020	116.3830	08/04/1992	190612.3	0.0	4.00	0.012	III	58.8(94.6)
DMG	33.6300	118.2000	09/13/1929	132338.2	0.0	4.00	0.012	III	58.8(94.7)
GSB	34.2990	118.4280	01/23/1994	085508.7	6.0	4.20	0.013	III	58.9(94.7)
GSP	34.0970	116.3820	07/01/1992	070149.2	0.0	4.30	0.014	IV	58.9(94.7)
DMG	34.0000	118.4170	12/07/1938	338 0.0	0.0	4.00	0.012	III	58.9(94.8)
DMG	34.4110	118.4010	02/09/1971	14 444.0	8.0	4.10	0.013	III	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 1 8.0	8.0	5.80	0.032	V	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 8 4.0	8.0	4.00	0.012	III	59.0(94.9)

EARTHQUAKE SEARCH RESULTS

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FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]

DMG	34.4110	118.4010	02/09/1971	14 140.0	8.0	4.10	0.013	III	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 154.0	8.0	4.20	0.013	III	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 853.0	8.0	4.60	0.016	IV	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 541.0	8.0	4.10	0.013	III	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 446.0	8.0	4.20	0.013	III	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	141028.0	8.0	5.30	0.024	V	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 159.0	8.0	4.10	0.013	III	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 2 3.0	8.0	4.10	0.013	III	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 244.0	8.0	5.80	0.032	V	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 041.8	8.4	6.40	0.048	VI	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 745.0	8.0	4.50	0.015	IV	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 133.0	8.0	4.20	0.013	III	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 8 7.0	8.0	4.20	0.013	III	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 150.0	8.0	4.50	0.015	IV	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 439.0	8.0	4.10	0.013	III	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 434.0	8.0	4.20	0.013	III	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 730.0	8.0	4.00	0.012	III	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 4 7.0	8.0	4.10	0.013	III	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 346.0	8.0	4.10	0.013	III	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 231.0	8.0	4.70	0.017	IV	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 710.0	8.0	4.00	0.012	III	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 325.0	8.0	4.40	0.015	IV	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 838.0	8.0	4.50	0.015	IV	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 230.0	8.0	4.30	0.014	IV	59.0(94.9)
DMG	34.4110	118.4010	02/09/1971	14 550.0	8.0	4.10	0.013	III	59.0(94.9)
PAS	33.9850	116.4020	02/15/1985	232626.6	2.3	4.00	0.012	III	59.0(94.9)
GSP	34.0690	116.3820	07/07/1992	082103.1	3.0	4.00	0.012	III	59.1(95.1)
DMG	33.8800	116.4370	04/17/1959	1619 0.2	22.2	4.20	0.013	III	59.1(95.2)
GSG	34.1570	116.3730	06/29/1992	103657.8	5.0	4.00	0.012	III	59.1(95.2)
GSP	34.0820	116.3780	07/06/1992	194137.9	3.0	4.40	0.015	IV	59.2(95.3)
DMG	34.4330	118.3980	02/09/1971	144017.4	-2.0	4.10	0.013	III	59.2(95.3)
GSP	35.0170	117.2030	06/29/1992	041642.6	3.0	4.00	0.012	III	59.4(95.7)
GSP	34.2990	118.4390	02/03/1994	162335.4	8.0	4.20	0.013	III	59.5(95.7)
DMG	34.5160	116.4510	04/05/1974	104250.7	4.8	4.10	0.012	III	59.5(95.7)
DMG	33.4880	116.7770	06/12/1959	11 313.0	5.7	4.00	0.012	III	59.5(95.8)
DMG	34.2680	118.4450	08/30/1964	225737.1	15.4	4.00	0.012	III	59.6(95.8)
PAS	33.5080	118.0710	11/20/1988	53928.7	6.0	4.50	0.015	IV	59.6(95.9)
GSP	34.0610	116.3740	08/11/1992	061117.3	0.0	4.30	0.014	III	59.6(95.9)
DMG	34.9540	116.9610	10/01/1953	193516.2	6.0	4.10	0.012	III	59.6(96.0)
DMG	34.9500	116.9500	12/18/1948	234517.0	0.0	4.40	0.014	IV	59.6(96.0)
GSP	34.0920	116.3690	07/06/1992	120059.2	1.0	4.50	0.015	IV	59.6(96.0)
GSP	34.0300	116.3790	06/28/1992	160115.2	1.0	4.10	0.012	III	59.7(96.0)
DMG	34.3990	118.4190	02/10/1971	134953.7	9.7	4.30	0.014	III	59.7(96.1)
PAS	34.2300	116.3630	03/18/1979	2253 2.7	3.4	4.20	0.013	III	59.8(96.3)
DMG	34.0000	116.3830	05/05/1944	134715.0	0.0	4.00	0.012	III	59.8(96.3)
GSP	34.0570	116.3710	06/28/1992	160953.9	3.0	4.10	0.012	III	59.8(96.3)
GSP	33.9450	116.3990	07/05/1992	054938.2	3.0	4.00	0.012	III	59.8(96.3)
GSP	33.9530	116.3950	01/12/2005	081046.4	7.0	4.30	0.014	III	59.9(96.4)
DMG	34.4280	118.4130	04/01/1971	15 3 3.6	8.0	4.10	0.012	III	60.0(96.5)
DMG	34.4260	118.4140	02/10/1971	518 7.2	5.8	4.50	0.015	IV	60.0(96.5)
GSP	34.3310	118.4420	01/17/1994	141430.3	1.0	4.50	0.015	IV	60.0(96.6)
DMG	33.9330	116.4000	12/10/1948	204257.0	0.0	4.40	0.014	IV	60.0(96.6)
DMG	34.3920	118.4270	02/21/1971	71511.7	7.2	4.50	0.015	IV	60.1(96.6)

EARTHQUAKE SEARCH RESULTS

FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
GSP	34.0620	116.3660	05/14/1999	075403.2	1.0	4.90	0.019	IV	60.1(96.7)
PAS	33.5580	116.6670	06/15/1982	234921.3	12.2	4.80	0.018	IV	60.1(96.7)
GSP	34.6400	116.5170	08/01/1994	213431.1	9.0	4.90	0.019	IV	60.1(96.8)
DMG	33.5170	118.1000	03/22/1941	82240.0	0.0	4.00	0.012	III	60.2(96.9)
DMG	34.9760	116.9960	11/07/1958	1738 3.7	12.2	4.10	0.012	III	60.2(96.9)
GSP	34.3010	118.4520	01/21/1994	185244.2	7.0	4.30	0.014	III	60.2(96.9)
GSP	34.0640	116.3610	09/15/1992	084711.3	9.0	5.20	0.022	IV	60.3(97.1)
DMG	34.9330	116.8830	04/27/1932	233518.3	0.0	4.00	0.012	III	60.4(97.2)
DMG	34.3080	118.4540	02/09/1971	144346.7	6.2	5.20	0.022	IV	60.4(97.2)
GSP	34.1750	116.3500	06/11/1992	002419.2	0.0	4.30	0.014	III	60.4(97.3)
PAS	34.4630	118.4090	09/24/1977	212824.3	5.0	4.20	0.013	III	60.5(97.3)
DMG	34.0170	116.3670	06/06/1940	235637.2	0.0	4.40	0.014	IV	60.5(97.3)
GSP	34.2970	118.4580	01/21/1994	185344.6	7.0	4.30	0.014	III	60.5(97.4)
GSP	34.3110	118.4560	01/17/1994	193534.3	2.0	4.00	0.012	III	60.6(97.5)
GSP	34.3170	118.4550	01/17/1994	132644.7	2.0	4.70	0.017	IV	60.6(97.5)
GSP	34.0340	116.3600	05/14/1999	105235.2	1.0	4.20	0.013	III	60.7(97.7)
GSP	34.0580	116.3550	06/28/1992	221312.0	7.0	4.00	0.012	III	60.7(97.7)
DMG	34.3970	118.4390	02/21/1971	55052.6	6.9	4.70	0.017	IV	60.8(97.9)
DMG	34.2960	118.4640	03/30/1971	85443.3	2.6	4.10	0.012	III	60.9(97.9)
GSP	34.2450	118.4710	01/18/1994	155144.9	12.0	4.00	0.012	III	60.9(98.0)
GSP	34.2870	118.4660	01/19/1994	071406.2	11.0	4.00	0.012	III	60.9(98.0)
GSP	33.9460	116.3790	04/24/1992	123605.7	10.0	4.10	0.012	III	60.9(98.0)
DMG	33.9330	116.3830	12/04/1948	234317.0	0.0	6.50	0.049	VI	60.9(98.1)
GSP	34.2920	118.4660	01/19/1994	144635.2	6.0	4.00	0.012	III	60.9(98.1)
GSP	34.0040	116.3610	06/30/1992	143811.6	0.0	4.80	0.017	IV	61.0(98.2)
GSB	34.3000	118.4660	01/21/1994	183915.3	10.0	4.70	0.017	IV	61.0(98.2)
GSP	34.2310	118.4750	03/20/1994	212012.3	13.0	5.30	0.023	IV	61.0(98.2)
DMG	34.3530	118.4560	03/07/1971	13340.5	3.3	4.50	0.015	IV	61.1(98.3)
DMG	34.9670	116.9330	12/30/1947	191914.0	0.0	4.00	0.012	III	61.1(98.4)
GSP	34.9710	116.9390	07/20/1992	044801.5	4.0	4.60	0.016	IV	61.2(98.5)
PAS	33.4710	118.0610	02/27/1984	101815.0	6.0	4.00	0.012	III	61.2(98.5)
GSP	34.9710	116.9370	07/01/1992	102947.7	0.0	4.30	0.013	III	61.3(98.6)
DMG	34.4570	118.4270	02/09/1971	161926.5	-1.0	4.20	0.013	III	61.3(98.7)
GSP	34.9790	116.9520	08/05/1992	222240.8	0.0	4.80	0.017	IV	61.4(98.8)
DMG	33.9030	118.4310	11/29/1938	192115.8	10.0	4.00	0.011	III	61.4(98.8)
GSP	34.9730	116.9360	07/01/1992	103252.3	0.0	4.10	0.012	III	61.4(98.8)
GSP	34.9790	116.9510	11/26/1992	214117.2	0.0	4.00	0.011	III	61.4(98.9)
GSP	34.3040	118.4730	01/17/1994	150703.2	2.0	4.20	0.013	III	61.4(98.9)
DMG	34.3840	118.4550	02/10/1971	113134.6	6.0	4.20	0.013	III	61.5(98.9)
GSP	34.2910	118.4760	02/06/1994	131926.9	11.0	4.10	0.012	III	61.5(99.0)
DMG	34.2330	116.3330	05/11/1947	5 620.0	0.0	4.90	0.018	IV	61.5(99.0)
GSB	34.3100	118.4740	01/21/1994	184228.8	7.0	4.20	0.013	III	61.6(99.1)
DMG	34.4460	118.4360	02/10/1971	185441.7	8.1	4.20	0.013	III	61.6(99.1)
PAS	34.3040	116.3410	11/15/1975	61327.6	5.8	4.60	0.016	IV	61.6(99.1)
PAS	34.3800	118.4590	08/12/1977	21926.1	9.5	4.50	0.015	IV	61.6(99.2)
DMG	35.0000	117.0000	08/01/1947	154230.0	0.0	4.00	0.011	III	61.6(99.2)
DMG	34.1000	116.3330	06/01/1940	65428.0	0.0	4.30	0.013	III	61.6(99.2)
DMG	34.0830	116.3330	06/01/1940	527 1.2	0.0	4.70	0.016	IV	61.8(99.4)
DMG	34.0830	116.3330	06/02/1940	61310.2	0.0	4.50	0.015	IV	61.8(99.4)
DMG	33.9330	116.3670	12/05/1948	0 721.0	0.0	4.90	0.018	IV	61.8(99.5)
DMG	34.0670	116.3330	05/18/1940	72132.7	0.0	5.00	0.019	IV	61.9(99.6)
DMG	34.0670	116.3330	05/18/1940	55120.2	0.0	5.20	0.022	IV	61.9(99.6)
GSP	34.0500	116.3350	04/26/1992	172138.0	0.0	4.30	0.013	III	61.9(99.7)

EARTHQUAKE SEARCH RESULTS

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FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
DMG	34.3560	118.4740	03/25/1971	2254 9.9	4.6	4.20	0.013	III	62.1(100.0)

-END OF SEARCH- 690 EARTHQUAKES FOUND WITHIN THE SPECIFIED SEARCH AREA.

TIME PERIOD OF SEARCH: 1800 TO 2008

LENGTH OF SEARCH TIME: 209 years

THE EARTHQUAKE CLOSEST TO THE SITE IS ABOUT 1.6 MILES (2.5 km) AWAY.

LARGEST EARTHQUAKE MAGNITUDE FOUND IN THE SEARCH RADIUS: 7.6

LARGEST EARTHQUAKE SITE ACCELERATION FROM THIS SEARCH: 0.396 g

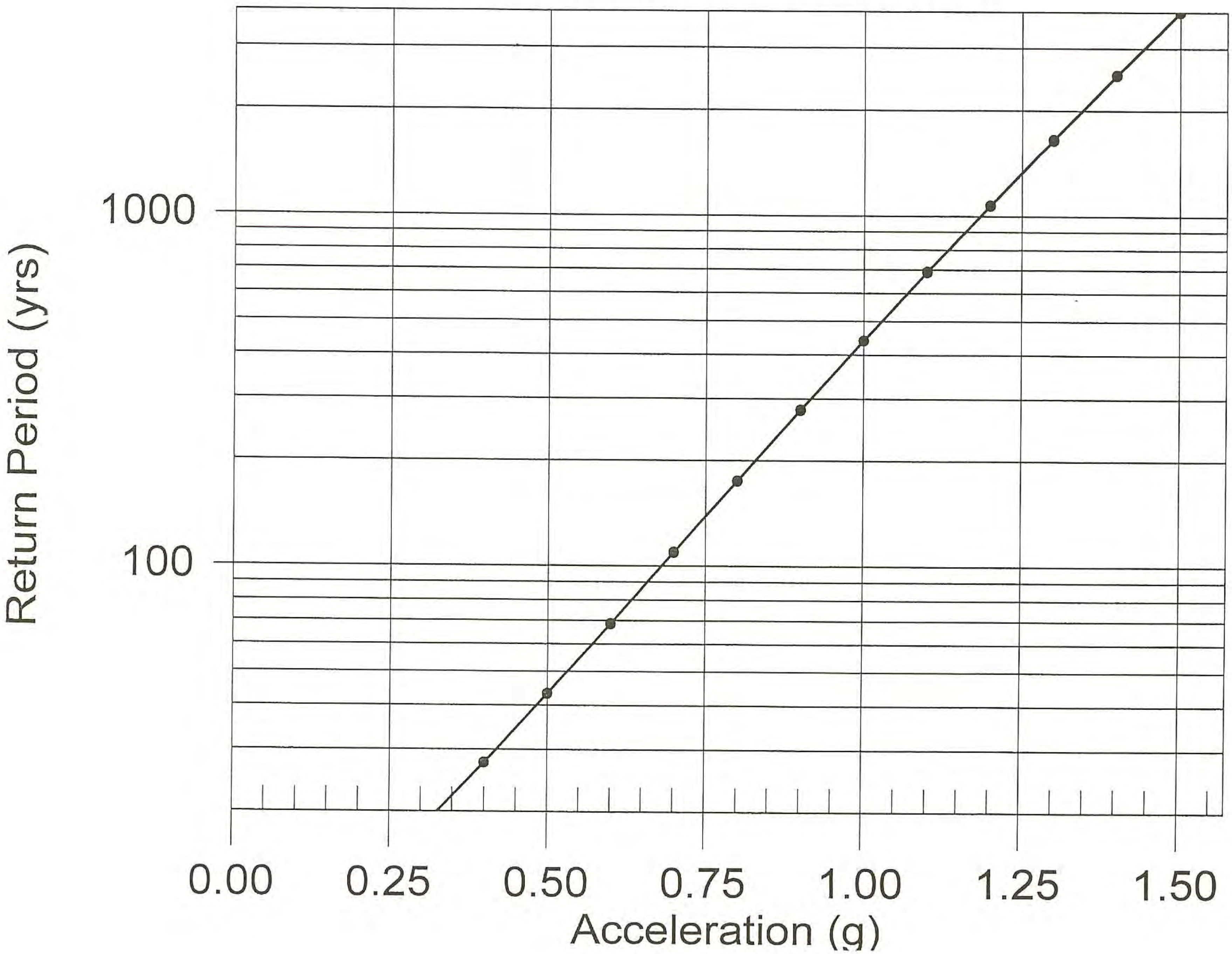
COEFFICIENTS FOR GUTENBERG & RICHTER RECURRENCE RELATION:
a-value= 3.891
b-value= 0.851
beta-value= 1.959

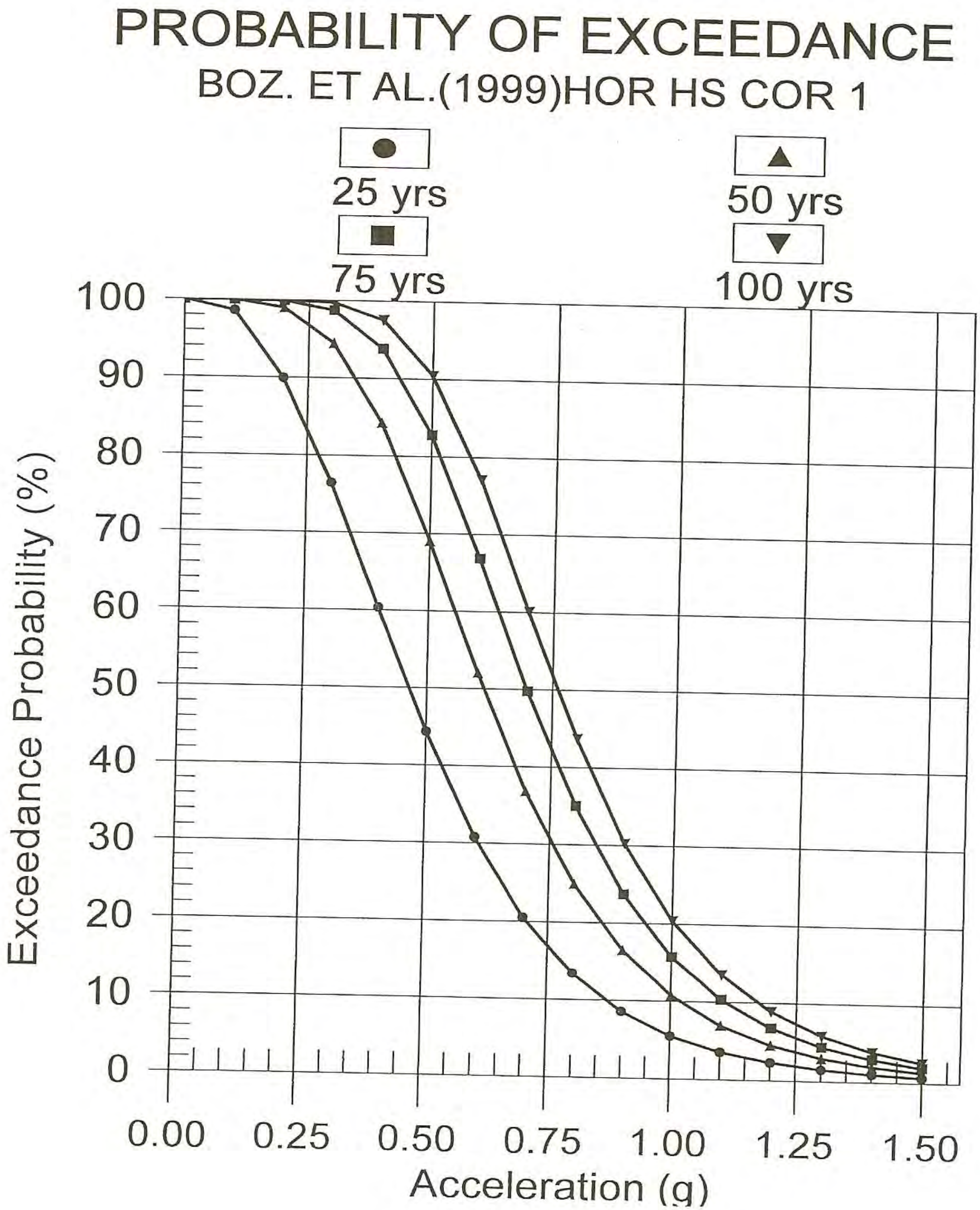
TABLE OF MAGNITUDES AND EXCEEDANCES:

Earthquake Magnitude	Number of Times Exceeded	Cumulative No. / Year
4.0	690	3.30144
4.5	251	1.20096
5.0	85	0.40670
5.5	26	0.12440
6.0	16	0.07656
6.5	7	0.03349
7.0	3	0.01435
7.5	1	0.00478

RETURN PERIOD vs. ACCELERATION

BOZ. ET AL.(1999)HOR HS COR 1




PROBABILITY OF EXCEEDANCE
BOZ. ET AL.(1999)HOR HS COR 1
25 yrs
75 yrs
50 yrs
100 yrs
Exceedance Probability (%)
0
10
20
30
40
50
60
70
80
90
100
0.00
0.25
0.50
0.75
1.00
1.25
1.50
Acceleration (g)

APPENDIX C

GENERAL EARTHWORK, GRADING GUIDELINES AND PRELIMINARY CRITERIA

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GENERAL EARTHWORK, GRADING GUIDELINES, AND PRELIMINARY CRITERIA

General

These guidelines present general procedures and requirements for earthwork and grading as shown on the approved grading plans, including preparation of areas to be filled, placement of fill, installation of subdrains, excavations, and appurtenant structures or flatwork. The recommendations contained in the geotechnical report are part of these earthwork and grading guidelines and would supercede the provisions contained hereafter in the case of conflict. Evaluations performed by the consultant during the course of grading may result in new or revised recommendations which could supercede these guidelines or the recommendations contained in the geotechnical report. Generalized details follow this text.

The contractor is responsible for the satisfactory completion of all earthwork in accordance with provisions of the project plans and specifications and latest adopted code. In the case of conflict, the most onerous provisions shall prevail. The project geotechnical engineer and engineering geologist (geotechnical consultant), and/or their representatives, should provide observation and testing services, and geotechnical consultation during the duration of the project.

EARTHWORK OBSERVATIONS AND TESTING

Geotechnical Consultant

Prior to the commencement of grading, a qualified geotechnical consultant (soil engineer and engineering geologist) should be employed for the purpose of observing earthwork procedures and testing the fills for general conformance with the recommendations of the geotechnical report(s), the approved grading plans, and applicable grading codes and ordinances.

The geotechnical consultant should provide testing and observation so that an evaluation may be made that the work is being accomplished as specified. It is the responsibility of the contractor to assist the consultants and keep them apprised of anticipated work schedules and changes, so that they may schedule their personnel accordingly.

All remedial removals, clean-outs, prepared ground to receive fill, key excavations, and subdrain installation should be observed and documented by the geotechnical consultant prior to placing any fill. It is the contractor's responsibility to notify the geotechnical consultant when such areas are ready for observation.

Laboratory and Field Tests

Maximum dry density tests to determine the degree of compaction should be performed in accordance with American Standard Testing Materials test method ASTM designation D-1557. Random or representative field compaction tests should be performed in accordance with test methods ASTM designation D-1556, D-2937 or D-2922, and D-3017, at intervals of approximately ±2 feet of fill height or approximately every 1,000 cubic yards placed. These criteria would vary depending on the soil conditions and the size of the project. The location and frequency of testing would be at the discretion of the geotechnical consultant.

Contractor's Responsibility

All clearing, site preparation, and earthwork performed on the project should be conducted by the contractor, with observation by a geotechnical consultant, and staged approval by the governing agencies, as applicable. It is the contractor's responsibility to prepare the ground surface to receive the fill, to the satisfaction of the geotechnical consultant, and to place, spread, moisture condition, mix, and compact the fill in accordance with the recommendations of the geotechnical consultant. The contractor should also remove all non-earth material considered unsatisfactory by the geotechnical consultant.

Notwithstanding the services provided by the geotechnical consultant, it is the sole responsibility of the contractor to provide adequate equipment and methods to accomplish the earthwork in strict accordance with applicable grading guidelines, latest adopted codes or agency ordinances, geotechnical report(s), and approved grading plans. Sufficient watering apparatus and compaction equipment should be provided by the contractor with due consideration for the fill material, rate of placement, and climatic conditions. If, in the opinion of the geotechnical consultant, unsatisfactory conditions such as questionable weather, excessive oversized rock or deleterious material, insufficient support equipment, etc., are resulting in a quality of work that is not acceptable, the consultant will inform the contractor, and the contractor is expected to rectify the conditions, and if necessary, stop work until conditions are satisfactory.

During construction, the contractor shall properly grade all surfaces to maintain good drainage and prevent ponding of water. The contractor shall take remedial measures to control surface water and to prevent erosion of graded areas until such time as permanent drainage and erosion control measures have been installed.

SITE PREPARATION

All major vegetation, including brush, trees, thick grasses, organic debris, and other deleterious material, should be removed and disposed of off-site. These removals must be concluded prior to placing fill. In-place existing fill, soil, alluvium, colluvium, or rock materials, as evaluated by the geotechnical consultant as being unsuitable, should be removed prior to any fill placement. Depending upon the soil conditions, these materials may be reused as compacted fills. Any materials incorporated as part of the compacted fills should be approved by the geotechnical consultant.

Any underground structures such as cesspools, cisterns, mining shafts, tunnels, septic tanks, wells, pipelines, or other structures not located prior to grading, are to be removed or treated in a manner recommended by the geotechnical consultant. Soft, dry, spongy, highly fractured, or otherwise unsuitable ground, extending to such a depth that surface processing cannot adequately improve the condition, should be overexcavated down to firm ground and approved by the geotechnical consultant before compaction and filling operations continue. Overexcavated and processed soils, which have been properly mixed and moisture conditioned, should be re-compacted to the minimum relative compaction as specified in these guidelines.

Existing ground, which is determined to be satisfactory for support of the fills, should be scarified (ripped) to a minimum depth of 6 to 8 inches, or as directed by the geotechnical consultant. After the scarified ground is brought to optimum moisture content, or greater and mixed, the materials should be compacted as specified herein. If the scarified zone is greater than 6 to 8 inches in depth, it may be necessary to remove the excess and place the material in lifts restricted to about 6 to 8 inches in compacted thickness.

Existing ground which is not satisfactory to support compacted fill should be overexcavated as required in the geotechnical report, or by the on-site geotechnical consultant. Scarification, disc harrowing, or other acceptable forms of mixing should continue until the soils are broken down and free of large lumps or clods, until the working surface is reasonably uniform and free from ruts, hollows, hummocks, mounds, or other uneven features, which would inhibit compaction as described previously.

Where fills are to be placed on ground with slopes steeper than 5:1 (horizontal to vertical [h:v]), the ground should be stepped or benched. The lowest bench, which will act as a key, should be a minimum of 15 feet wide and should be at least 2 feet deep into firm material, and approved by the geotechnical consultant. In fill-over-cut slope conditions, the recommended minimum width of the lowest bench or key is also 15 feet, with the key founded on firm material, as designated by the geotechnical consultant. As a general rule, unless specifically recommended otherwise by the geotechnical consultant, the minimum width of fill keys should be equal to ½ the height of the slope.

Standard benching is generally 4 feet (minimum) vertically, exposing firm, acceptable material. Benching may be used to remove unsuitable materials, although it is understood that the vertical height of the bench may exceed 4 feet. Pre-stripping may be considered for unsuitable materials in excess of 4 feet in thickness.

All areas to receive fill, including processed areas, removal areas, and the toes of fill benches, should be observed and approved by the geotechnical consultant prior to placement of fill. Fills may then be properly placed and compacted until design grades (elevations) are attained.

COMPACTED FILLS

Any earth materials imported or excavated on the property may be utilized in the fill provided that each material has been evaluated to be suitable by the geotechnical consultant. These materials should be free of roots, tree branches, other organic matter, or other deleterious materials. All unsuitable materials should be removed from the fill as directed by the geotechnical consultant. Soils of poor gradation, undesirable expansion potential, or substandard strength characteristics may be designated by the consultant as unsuitable and may require blending with other soils to serve as a satisfactory fill material.

Fill materials derived from benching operations should be dispersed throughout the fill area and blended with other approved material. Benching operations should not result in the benched material being placed only within a single equipment width away from the fill/bedrock contact.

Oversized materials defined as rock, or other irreducible materials, with a maximum dimension greater than 12 inches, should not be buried or placed in fills unless the location of materials and disposal methods are specifically approved by the geotechnical consultant. Oversized material should be taken offsite, or placed in accordance with recommendations of the geotechnical consultant in areas designated as suitable for rock disposal. GSI anticipates that soils to be utilized as fill material for the subject project may contain some rock. Appropriately, the need for rock disposal may be necessary during grading operations on the site. From a geotechnical standpoint, the depth of any rocks, rock fills, or rock blankets, should be a sufficient distance from finish grade. This depth is generally the same as any overexcavation due to cut-fill transitions in hard rock areas, and generally facilitates the excavation of structural footings and substructures. Should deeper excavations be proposed (i.e., deepened footings, utility trenching, swimming pools, spas, etc.), the developer may consider increasing the hold-down depth of any rocky fills to be placed, as appropriate. In addition, some agencies/jurisdictions mandate a specific hold-down depth for oversize materials placed in fills. The hold-down depth, and potential to encounter oversize rock, both within fills, and occurring in cut or natural areas, would need to be disclosed to all interested/affected parties. Once approved by the governing agency, the hold-down depth for oversized rock (i.e., greater than 12 inches) in fills on this project is provided as 10 feet, unless specified differently in the text of this report. The governing agency may require that these materials need to be deeper, crushed, or reduced to less than 12 inches in maximum dimension, at their discretion.

To facilitate future trenching, rock (or oversized material), should not be placed within the hold-down depth feet from finish grade, the range of foundation excavations, future utilities, or underground construction unless specifically approved by the governing agency, the geotechnical consultant, and/or the developer's representative.

If import material is required for grading, representative samples of the materials to be utilized as compacted fill should be analyzed in the laboratory by the geotechnical consultant to evaluate it's physical properties and suitability for use onsite. Such testing should be performed three (3) days prior to importation. If any material other than that previously tested is encountered during grading, an appropriate analysis of this material should be conducted by the geotechnical consultant as soon as possible.

Approved fill material should be placed in areas prepared to receive fill in near horizontal layers, that when compacted, should not exceed about 6 to 8 inches in thickness. The geotechnical consultant may approve thick lifts if testing indicates the grading procedures are such that adequate compaction is being achieved with lifts of greater thickness. Each layer should be spread evenly and blended to attain uniformity of material and moisture suitable for compaction.

Fill layers at a moisture content less than optimum should be watered and mixed, and wet fill layers should be aerated by scarification, or should be blended with drier material. Moisture conditioning, blending, and mixing of the fill layer should continue until the fill materials have a uniform moisture content at, or above, optimum moisture.

After each layer has been evenly spread, moisture conditioned, and mixed, it should be uniformly compacted to a minimum of 90 percent of the maximum density as evaluated by ASTM test designation D-1557, or as otherwise recommended by the geotechnical consultant. Compaction equipment should be adequately sized and should be specifically designed for soil compaction, or of proven reliability to efficiently achieve the specified degree of compaction.

Where tests indicate that the density of any layer of fill, or portion thereof, is below the required relative compaction, or improper moisture is in evidence, the particular layer or portion shall be re-worked until the required density and/or moisture content has been attained. No additional fill shall be placed in an area until the last placed lift of fill has been tested and found to meet the density and moisture requirements, and is approved by the geotechnical consultant.

In general, per the 1997 UBC and/or latest adopted version of the California Building Code (CBC), fill slopes should be designed and constructed at a gradient of 2:1 (h:v), or flatter. Compaction of slopes should be accomplished by over-building a minimum of 3 feet horizontally, and subsequently trimming back to the design slope configuration. Testing shall be performed as the fill is elevated to evaluate compaction as the fill core is being developed. Special efforts may be necessary to attain the specified compaction in the fill slope zone. Final slope shaping should be performed by trimming and removing loose materials with appropriate equipment. A final evaluation of fill slope compaction should be based on observation and/or testing of the finished slope face. Where compacted fill slopes are designed steeper than 2:1 (h:v), prior approval from the governing agency, specific material types, a higher minimum relative compaction, special reinforcement, and special grading procedures will be recommended.

If an alternative to over-building and cutting back the compacted fill slopes is selected, then special effort should be made to achieve the required compaction in the outer 10 feet of each lift of fill by undertaking the following:

1. An extra piece of equipment consisting of a heavy, short-shanked sheepsfoot should be used to roll (horizontal) parallel to the slopes continuously as fill is placed. The sheepsfoot roller should also be used to roll perpendicular to the slopes, and extend out over the slope to provide adequate compaction to the face of the slope.

2. Loose fill should not be spilled out over the face of the slope as each lift is compacted. Any loose fill spilled over a previously completed slope face should be trimmed off or be subject to re-rolling.

3. Field compaction tests will be made in the outer (horizontal) ± 2 to ± 8 feet of the slope at appropriate vertical intervals, subsequent to compaction operations.

4. After completion of the slope, the slope face should be shaped with a small tractor and then re-rolled with a sheepsfoot to achieve compaction to near the slope face. Subsequent to testing to evaluate compaction, the slopes should be grid-rolled to achieve compaction to the slope face. Final testing should be used to evaluate compaction after grid rolling.

5. Where testing indicates less than adequate compaction, the contractor will be responsible to rip, water, mix, and recompact the slope material as necessary to achieve compaction. Additional testing should be performed to evaluate compaction.

SUBDRAIN INSTALLATION

Subdrains should be installed in approved ground in accordance with the approximate alignment and details indicated by the geotechnical consultant. Subdrain locations or materials should not be changed or modified without approval of the geotechnical consultant. The geotechnical consultant may recommend and direct changes in subdrain line, grade, and drain material in the field, pending exposed conditions. The location of constructed subdrains, especially the outlets, should be recorded/surveyed by the project civil engineer. Drainage at the subdrain outlets should be provided by the project civil engineer.

EXCAVATIONS

Excavations and cut slopes should be examined during grading by the geotechnical consultant. If directed by the geotechnical consultant, further excavations or overexcavation and refilling of cut areas should be performed, and/or remedial grading of cut slopes should be performed. When fill-over-cut slopes are to be graded, unless otherwise approved, the cut portion of the slope should be observed by the geotechnical consultant prior to placement of materials for construction of the fill portion of the slope. The geotechnical consultant should observe all cut slopes, and should be notified by the contractor when excavation of cut slopes commence.

If, during the course of grading, unforeseen adverse or potentially adverse geologic conditions are encountered, the geotechnical consultant should investigate, evaluate, and make appropriate recommendations for mitigation of these conditions. The need for cut slope buttressing or stabilizing should be based on in-grading evaluation by the geotechnical consultant, whether anticipated or not.

Unless otherwise specified in geotechnical and geological report(s), no cut slopes should be excavated higher or steeper than that allowed by the ordinances of controlling governmental agencies. Additionally, short-term stability of temporary cut slopes is the contractor's responsibility.

Erosion control and drainage devices should be designed by the project civil engineer and should be constructed in compliance with the ordinances of the controlling governmental agencies, and/or in accordance with the recommendations of the geotechnical consultant.

COMPLETION

Observation, testing, and consultation by the geotechnical consultant should be conducted during the grading operations in order to state an opinion that all cut and fill areas are graded in accordance with the approved project specifications. After completion of grading, and after the geotechnical consultant has finished observations of the work, final reports should be submitted, and may be subject to review by the controlling governmental agencies. No further excavation or filling should be undertaken without prior notification of the geotechnical consultant or approved plans.

All finished cut and fill slopes should be protected from erosion and/or be planted in accordance with the project specifications and/or as recommended by a landscape architect. Such protection and/or planning should be undertaken as soon as practical after completion of grading.

PRELIMINARY OUTDOOR POOL/SPA DESIGN RECOMMENDATIONS

The following preliminary recommendations are provided for consideration in pool/spa design and planning. Actual recommendations should be provided by a qualified geotechnical consultant, based on site specific geotechnical conditions, including a subsurface investigation, differential settlement potential, expansive and corrosive soil potential, proximity of the proposed pool/spa to any slopes with regard to slope creep and lateral fill extension, as well as slope setbacks per code, and geometry of the proposed improvements. Recommendations for pools/spas and/or deck flatwork underlain by expansive soils, or for areas with differential settlement greater than ¼-inch over 40 feet horizontally, will be more onerous than the preliminary recommendations presented below.

The 1:1 (h:v) influence zone of any nearby retaining wall site structures should be delineated on the project civil drawings with the pool/spa. This 1:1 (h:v) zone is defined as a plane up from the lower-most heel of the retaining structure, to the daylight grade of the nearby building pad or slope. If pools/spas or associated pool/spa improvements are constructed within this zone, they should be re-positioned (horizontally or vertically) so that they are supported by earth materials that are outside or below this 1:1 plane. If this is not possible given the area of the building pad, the owner should consider eliminating these improvements or allow for increased potential for lateral/vertical deformations and associated distress that may render these improvements unusable in the future, unless they are periodically repaired and maintained. The conditions and recommendations presented herein should be disclosed to all homeowners and any interested/affected parties.

General

1. The equivalent fluid pressure to be used for the pool/spa design should be 60 pounds per cubic foot (pcf) for pool/spa walls with level backfill, and 75 pcf for a 2:1 sloped backfill condition. In addition, backdrains should be provided behind pool/spa walls subjacent to slopes.

2. Passive earth pressure may be computed as an equivalent fluid having a density of 150 pcf, to a maximum lateral earth pressure of 1,000 pounds per square foot (psf).

3. An allowable coefficient of friction between soil and concrete of 0.30 may be used with the dead load forces.

4. When combining passive pressure and frictional resistance, the passive pressure component should be reduced by one-third.

5. Where pools/spas are planned near structures, appropriate surcharge loads need to be incorporated into design and construction by the pool/spa designer. This includes, but is not limited to landscape berms, decorative walls, footings, built-in barbeques, utility poles, etc.

6. All pool/spa walls should be designed as "free standing" and be capable of supporting the water in the pool/spa without soil support. The shape of pool/spa in cross section and plan view may affect the performance of the pool, from a geotechnical standpoint. Pools and spas should also be designed in accordance with Section 1806.5 of the 1997 UBC. Minimally, the bottoms of the pools/spas, should maintain a distance H/3, where H is the height of the slope (in feet), from the slope face. This distance should not be less than 7 feet, nor need not be greater than 40 feet.

7. The soil beneath the pool/spa bottom should be uniformly moist with the same stiffness throughout. If a fill/cut transition occurs beneath the pool/spa bottom, the cut portion should be overexcavated to a minimum depth of 48 inches, and replaced with compacted fill, such that there is a uniform blanket that is a minimum of 48 inches below the pool/spa shell. If very low expansive soil is used for fill, the fill should be placed at a minimum of 95 percent relative compaction, at optimum moisture conditions. This requirement should be 90 percent relative compaction at over optimum moisture if the pool/spa is constructed within or near expansive soils. The potential for grading and/or re-grading of the pool/spa bottom, and attendant potential for shoring and/or slot excavation, needs to be considered during all aspects of pool/spa planning, design, and construction.

8. If the pool/spa is founded entirely in compacted fill placed during rough grading, the deepest portion of the pool/spa should correspond with the thickest fill on the lot.

9. Hydrostatic pressure relief valves should be incorporated into the pool and spa designs. A pool/spa under-drain system is also recommended, with an appropriate outlet for discharge.

10. All fittings and pipe joints, particularly fittings in the side of the pool or spa, should be properly sealed to prevent water from leaking into the adjacent soils materials, and be fitted with slip or expandible joints between connections transecting varying soil conditions.

11. An elastic expansion joint (flexible waterproof sealant) should be installed to prevent water from seeping into the soil at all deck joints.

12. A reinforced grade beam should be placed around skimmer inlets to provide support and mitigate cracking around the skimmer face.

13. In order to reduce unsightly cracking, deck slabs should minimally be 4 inches thick, and reinforced with No. 3 reinforcing bars at 18 inches on-center. All slab reinforcement should be supported to ensure proper mid-slab positioning during the placement of concrete. Wire mesh reinforcing is specifically not recommended. Deck slabs should not be tied to the pool/spa structure. Pre-moistening and/or pre-soaking of the slab subgrade is recommended, to a depth of 12 inches (optimum moisture content), or 18 inches (120 percent of the soil's optimum moisture content, or 3 percent over optimum moisture content, whichever is greater), for very low to low, and medium expansive soils, respectively. This moisture content should be maintained in the subgrade soils during concrete placement to promote uniform curing of the concrete and minimize the development of unsightly shrinkage cracks. Slab underlayment should consist of a 1- to 2-inch leveling course of sand (S.E.>30) and a minimum of 4 to 6 inches of Class 2 base compacted to 90 percent. Deck slabs within the H/3 zone, where H is the height of the slope (in feet), will have an increased potential for distress relative to other areas outside of the H/3 zone. If distress is undesirable,

improvements, deck slabs or flatwork should not be constructed closer than H/3 or 7 feet (whichever is greater) from the slope face, in order to reduce, but not eliminate, this potential.

14. Pool/spa bottom or deck slabs should be founded entirely on competent bedrock, or properly compacted fill. Fill should be compacted to achieve a minimum 90 percent relative compaction, as discussed above. Prior to pouring concrete, subgrade soils below the pool/spa decking should be throughly watered to achieve a moisture content that is at least 2 percent above optimum moisture content, to a depth of at least 18 inches below the bottom of slabs. This moisture content should be maintained in the subgrade soils during concrete placement to promote uniform curing of the concrete and minimize the development of unsightly shrinkage cracks.

15. In order to reduce unsightly cracking, the outer edges of pool/spa decking to be bordered by landscaping, and the edges immediately adjacent to the pool/spa, should be underlain by an 8-inch wide concrete cutoff shoulder (thickened edge) extending to a depth of at least 12 inches below the bottoms of the slabs to mitigate excessive infiltration of water under the pool/spa deck. These thickened edges should be reinforced with two No. 4 bars, one at the top and one at the bottom. Deck slabs may be minimally reinforced with No. 3 reinforcing bars placed at 18 inches on-center, in both directions. All slab reinforcement should be supported on chairs to ensure proper mid-slab positioning during the placement of concrete.

16. Surface and shrinkage cracking of the finish slab may be reduced if a low slump and water-cement ratio are maintained during concrete placement. Concrete utilized should have a minimum compressive strength of 4,000 psi. Excessive water added to concrete prior to placement is likely to cause shrinkage cracking, and should be avoided. Some concrete shrinkage cracking, however, is unavoidable.

17. Joint and sawcut locations for the pool/spa deck should be determined by the design engineer and/or contractor. However, spacings should not exceed 6 feet on center.

18. Considering the nature of the onsite earth materials, it should be anticipated that caving or sloughing could be a factor in subsurface excavations and trenching. Shoring or excavating the trench walls/backcuts at the angle of repose (typically 25 to 45 degrees), should be anticipated. All excavations should be observed by a representative of the geotechnical consultant, including the project geologist and/or geotechnical engineer, prior to workers entering the excavation or trench, and minimally conform to Cal/OSHA ("Type C" soils may be assumed), state, and local safety codes. Should adverse conditions exist, appropriate recommendations should be offered at that time by the geotechnical consultant. GSI does not consult in the area of safety engineering and the safety of the construction crew is the responsibility of the pool/spa builder.

19. It is imperative that adequate provisions for surface drainage are incorporated by the homeowners into their overall improvement scheme. Ponding water, ground saturation and flow over slope faces, are all situations which must be avoided to enhance long term performance of the pool/spa and associated improvements, and reduce the likelihood of distress.

20. Regardless of the methods employed, once the pool/spa is filled with water, should it be emptied, there exists some potential that if emptied, significant distress may occur. Accordingly, once filled, the pool/spa should not be emptied unless evaluated by the geotechnical consultant and the pool/spa builder.

21. For pools/spas built within (all or part) of the 1997 Uniform Building Code (UBC) setback and/or geotechnical setback, as indicated in the site geotechnical documents, special foundations are recommended to mitigate the affects of creep, lateral fill extension, expansive soils and settlement on the proposed pool/spa. Most municipalities or County reviewers do not consider these effects in pool/spa plan approvals. As such, where pools/spas are proposed on 20 feet or more of fill, medium or highly expansive soils, or rock fill with limited "cap soils" and built within 1997 UBC setbacks, or within the influence of the creep zone, or lateral fill extension, the following should be considered during design and construction:

    OPTION A: Shallow foundations with or without overexcavation of the pool/spa "shell," such that the pool/spa is surrounded by 5 feet of very low to low expansive soils (without irreducible particles greater that 6 inches), and the pool/spa walls closer to the slope(s) are designed to be free standing. GSI recommends a pool/spa under-drain or blanket system (see attached Typical Pool/Spa Detail). The pool/spa builders and owner in this optional construction technique should be generally satisfied with pool/spa performance under this scenario; however, some settlement, tilting, cracking, and leakage of the pool/spa is likely over the life of the project.

    OPTION B: Pier supported pool/spa foundations with or without overexcavation of the pool/spa shell such that the pool/spa is surrounded by 5 feet of very low to low expansive soils (without irreducible particles greater than 6 inches), and the pool/spa walls closer to the slope(s) are designed to be free standing. The need for a pool/spa under-drain system may be installed for leak detection purposes. Piers that support the pool/spa should be a minimum of 12 inches in diameter and at a spacing to provide vertical and lateral support of the pool/spa, in accordance with the pool/spa designers recommendations, local code, and the 1997 UBC. The pool/spa builder and owner in this second scenario construction technique should be more satisfied with pool/spa performance. This construction will reduce settlement and creep effects on the pool/spa; however, it will not eliminate these potentials, nor make the pool/spa "leak-free."

22. The temperature of the water lines for spas and pools may affect the corrosion properties of site soils, thus, a corrosion specialist should be retained to review all spa and pool plans, and provide mitigative recommendations, as warranted. Concrete mix design should be reviewed by a qualified corrosion consultant and materials engineer.

23. All pool/spa utility trenches should be compacted to 90 percent of the laboratory standard, under the full-time observation and testing of a qualified geotechnical consultant. Utility trench bottoms should be sloped away from the primary structure on the property (typically the residence).

24. Pool and spa utility lines should not cross the primary structure's utility lines (i.e., not stacked, or sharing of trenches, etc.).

25. The pool/spa or associated utilities should not intercept, interrupt, or otherwise adversely impact any area drain, roof drain, or other drainage conveyances. If it is necessary to modify, move, or disrupt existing area drains, subdrains, or tightlines, then the design civil engineer should be consulted, and mitigative measures provided. Such measures should be further reviewed and approved by the geotechnical consultant, prior to proceeding with any further construction.

26. The geotechnical consultant should review and approve all aspects of pool/spa and flatwork design prior to construction. A design civil engineer should review all aspects of such design, including drainage and setback conditions. Prior to acceptance of the pool/spa construction, the project builder, geotechnical consultant and civil designer should evaluate the performance of the area drains and other site drainage pipes, following pool/spa construction.

27. All aspects of construction should be reviewed and approved by the geotechnical consultant, including during excavation, prior to the placement of any additional fill, prior to the placement of any reinforcement or pouring of any concrete.

28. Any changes in design or location of the pool/spa should be reviewed and approved by the geotechnical and design civil engineer prior to construction. Field adjustments should not be allowed until written approval of the proposed field changes are obtained from the geotechnical and design civil engineer.

29. Disclosure should be made to homeowners and builders, contractors, and any interested/affected parties, that pools/spas built within about 15 feet of the top of a slope, and/or H/3, where H is the height of the slope (in feet), <u>will</u> experience some movement or tilting. While the pool/spa shell or coping may not necessarily crack, the levelness of the pool/spa will likely tilt toward the slope, and may not be esthetically pleasing. The same is true with decking, flatwork and other improvements in this zone.

30. Failure to adhere to the above recommendations will significantly increase the potential for distress to the pool/spa, flatwork, etc.

31. Local seismicity and/or the design earthquake will cause some distress to the pool/spa and decking or flatwork, possibly including total functional and economic loss.

32. The information and recommendations discussed above should be provided to any contractors and/or subcontractors, or homeowners, interested/affected parties, etc., that may perform or may be affected by such work.

JOB SAFETY

General

At GSI, getting the job done safely is of primary concern. The following is the company's safety considerations for use by all employees on multi-employer construction sites. On-ground personnel are at highest risk of injury, and possible fatality, on grading and construction projects. GSI recognizes that construction activities will vary on each site, and that site safety is the prime responsibility of the contractor; however, everyone must be safety conscious and responsible at all times. To achieve our goal of avoiding accidents, cooperation between the client, the contractor, and GSI personnel must be maintained.

In an effort to minimize risks associated with geotechnical testing and observation, the following precautions are to be implemented for the safety of field personnel on grading and construction projects:

Safety Meetings: GSI field personnel are directed to attend contractor's regularly scheduled and documented safety meetings.

Safety Vests: Safety vests are provided for, and are to be worn by GSI personnel, at all times, when they are working in the field.

Safety Flags: Two safety flags are provided to GSI field technicians; one is to be affixed to the vehicle when on site, the other is to be placed atop the spoil pile on all test pits.

Flashing Lights: All vehicles stationary in the grading area shall use rotating or flashing amber beacons, or strobe lights, on the vehicle during all field testing. While operating a vehicle in the grading area, the emergency flasher on the vehicle shall be activated.

In the event that the contractor's representative observes any of our personnel not following the above, we request that it be brought to the attention of our office.

Test Pits Location, Orientation, and Clearance

The technician is responsible for selecting test pit locations. A primary concern should be the technician's safety. Efforts will be made to coordinate locations with the grading contractor's authorized representative, and to select locations following or behind the established traffic pattern, preferably outside of current traffic. The contractor's authorized representative (supervisor, grade checker, dump man, operator, etc.) should direct excavation of the pit and safety during the test period. Of paramount concern should be the soil technician's safety, and obtaining enough tests to represent the fill.

Test pits should be excavated so that the spoil pile is placed away from oncoming traffic, whenever possible. The technician's vehicle is to be placed next to the test pit, opposite the spoil pile. This necessitates the fill be maintained in a driveable condition. Alternatively, the contractor may wish to park a piece of equipment in front of the test holes, particularly in small fill areas or those with limited access.

A zone of non-encroachment should be established for all test pits. No grading equipment should enter this zone during the testing procedure. The zone should extend approximately 50 feet outward from the center of the test pit. This zone is established for safety and to avoid excessive ground vibration, which typically decreases test results.

When taking slope tests, the technician should park the vehicle directly above or below the test location. If this is not possible, a prominent flag should be placed at the top of the slope. The contractor's representative should effectively keep all equipment at a safe operational distance (e.g., 50 feet) away from the slope during this testing.

The technician is directed to withdraw from the active portion of the fill as soon as possible following testing. The technician's vehicle should be parked at the perimeter of the fill in a highly visible location, well away from the equipment traffic pattern. The contractor should inform our personnel of all changes to haul roads, cut and fill areas or other factors that may affect site access and site safety.

In the event that the technician's safety is jeopardized or compromised as a result of the contractor's failure to comply with any of the above, the technician is required, by company policy, to immediately withdraw and notify his/her supervisor. The grading contractor's representative will be contacted in an effort to affect a solution. However, in the interim, no further testing will be performed until the situation is rectified. Any fill placed can be considered unacceptable and subject to reprocessing, recompaction, or removal.

In the event that the soil technician does not comply with the above or other established safety guidelines, we request that the contractor bring this to the technician's attention and notify this office. Effective communication and coordination between the contractor's representative and the soil technician is strongly encouraged in order to implement the above safety plan.

Trench and Vertical Excavation

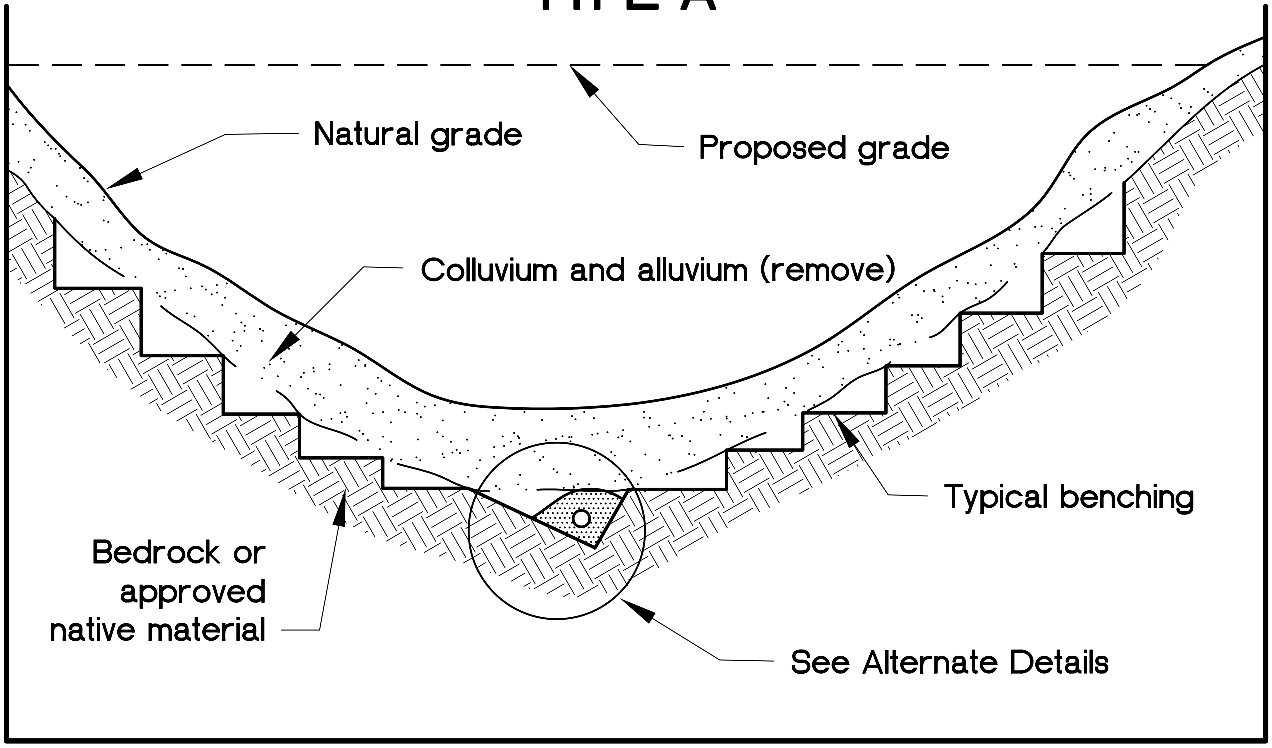
It is the contractor's responsibility to provide safe access into trenches where compaction testing is needed. Our personnel are directed not to enter any excavation or vertical cut which: 1) is 5 feet or deeper unless shored or laid back; 2) displays any evidence of instability, has any loose rock or other debris which could fall into the trench; or 3) displays any other evidence of any unsafe conditions regardless of depth.

All trench excavations or vertical cuts in excess of 5 feet deep, which any person enters, should be shored or laid back. Trench access should be provided in accordance with Cal/OSHA and/or state and local standards. Our personnel are directed not to enter any trench by being lowered or "riding down" on the equipment.

If the contractor fails to provide safe access to trenches for compaction testing, our company policy requires that the soil technician withdraw and notify his/her supervisor. The contractor's representative will be contacted in an effort to affect a solution. All backfill not tested due to safety concerns or other reasons could be subject to reprocessing and/or removal.

If GSI personnel become aware of anyone working beneath an unsafe trench wall or vertical excavation, we have a legal obligation to put the contractor and owner/developer on notice to immediately correct the situation. If corrective steps are not taken, GSI then has an obligation to notify Cal/OSHA and/or the proper controlling authorities.

TYPE A



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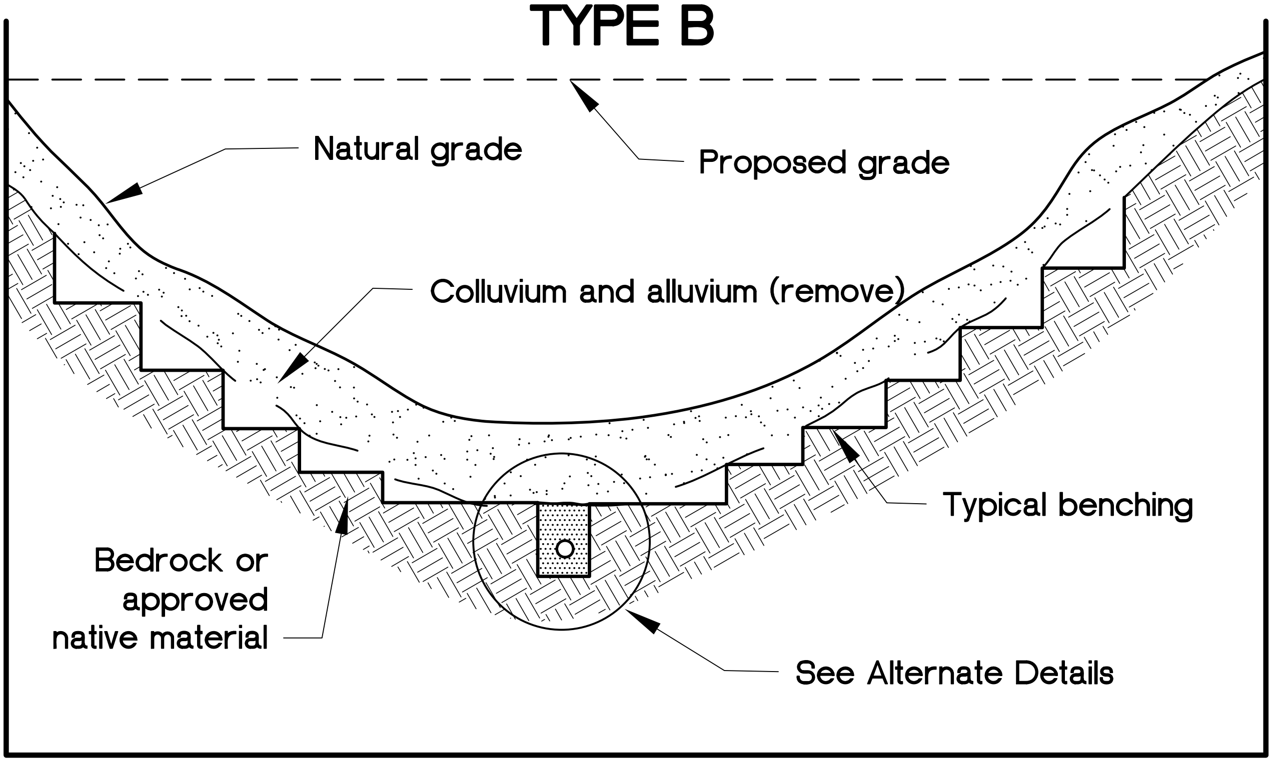
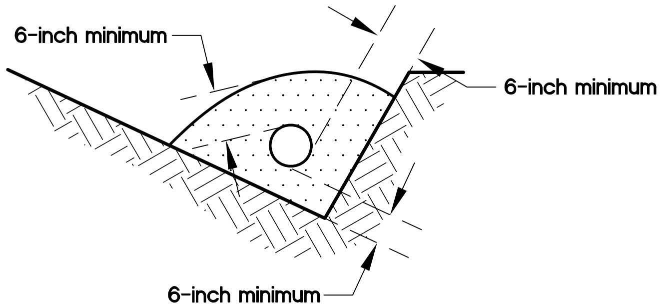
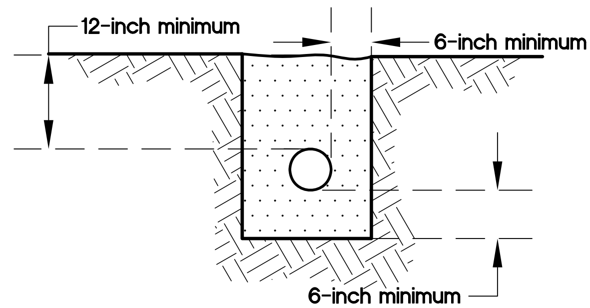


Selection of alternate subdrain details, location, and extent of subdrains should be evaluated by the geotechnical consultant during grading.

GeoSoils, Inc.	CANYON SUBDRAIN DETAIL	Plate C-1



A-1



B-1

Filter material: Minimum volume of 9 cubic feet per lineal foot of pipe.

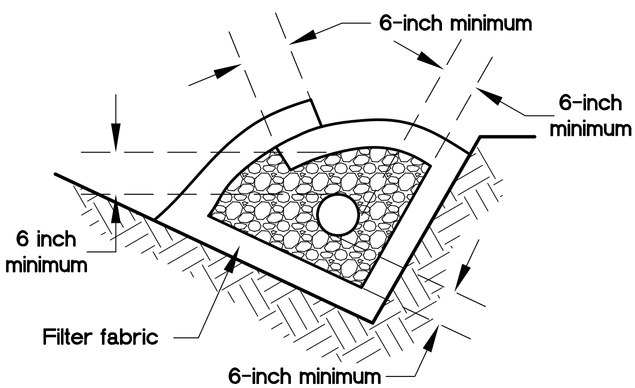
Perforated pipe: 6-inch-diameter ABS or PVC pipe or approved substitute with minimum 8 perforations ($\frac{1}{4}$-inch diameter) per lineal foot in bottom half of pipe (ASTM D-2751, SDR-35, or ASTM D-1527, Schd. 40).

For continuous run in excess of 500 feet, use 8-inch-diameter pipe (ASTM D-3034, SDR-35, or ASTM D-1785, Schd. 40).

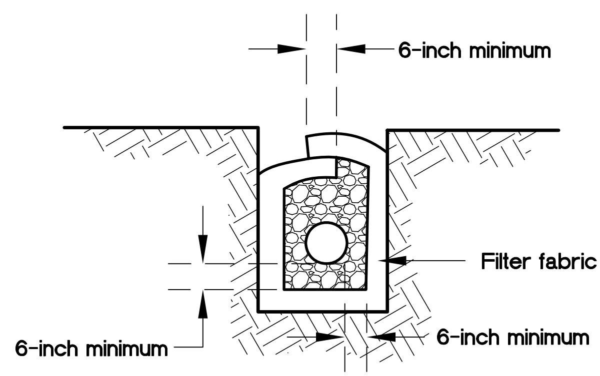
FILTER MATERIAL

Sieve Size	Percent Passing
1 inch	100
$\frac{3}{4}$ inch	90-100
$\frac{3}{8}$ inch	40-100
No. 4	25-40
No. 8	18-33
No. 30	5-15
No. 50	0-7
No. 200	0-3

ALTERNATE 1: PERFORATED PIPE AND FILTER MATERIAL



A-2

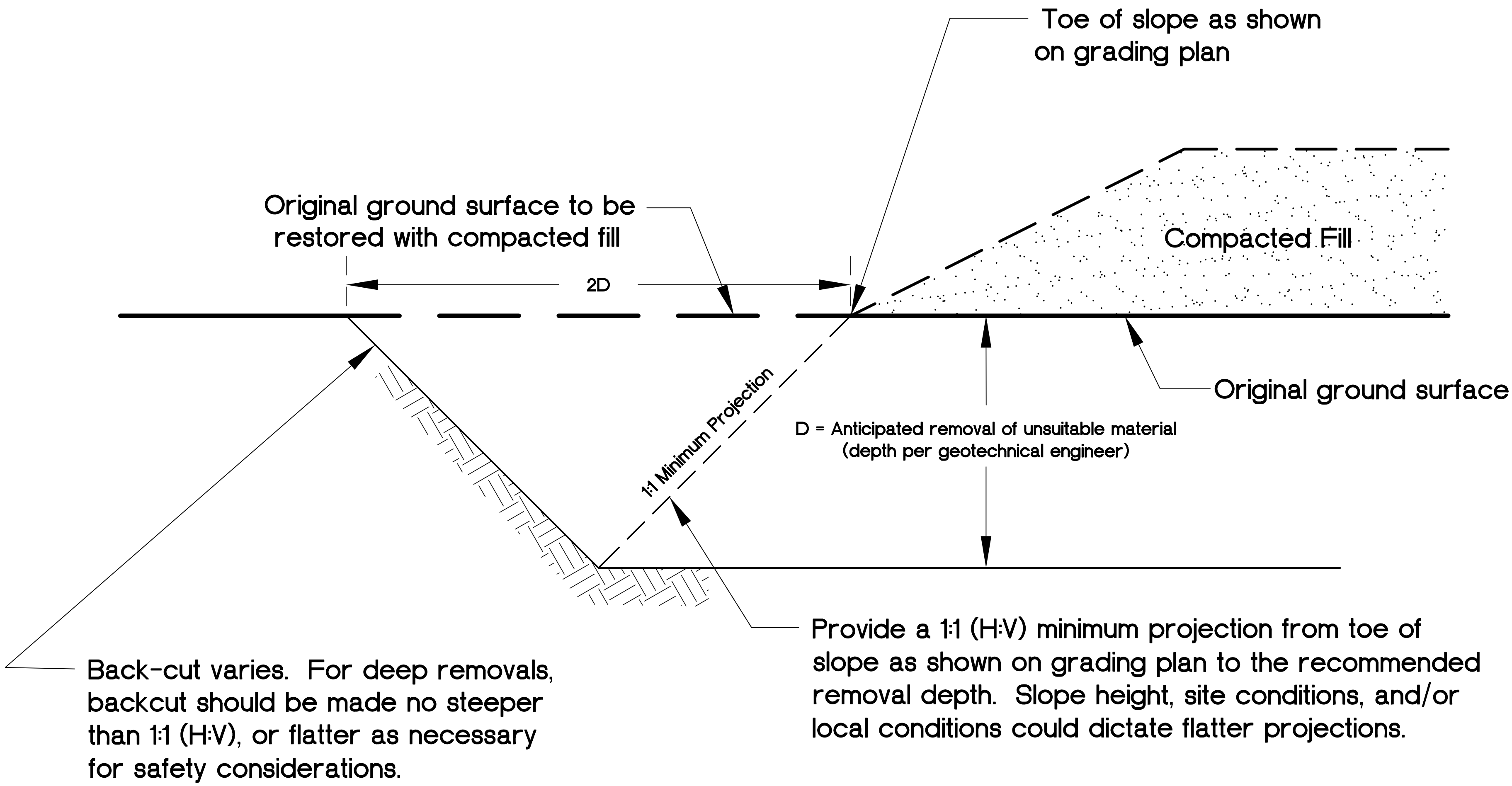


B-2

Gravel Material: 9 cubic feet per lineal foot.
Perforated Pipe: See Alternate 1
Gravel: Clean $\frac{3}{4}$-inch rock or approved substitute.
Filter Fabric: Mirafi 140 or approved substitute.

ALTERNATE 2: PERFORATED PIPE, GRAVEL, AND FILTER FABRIC

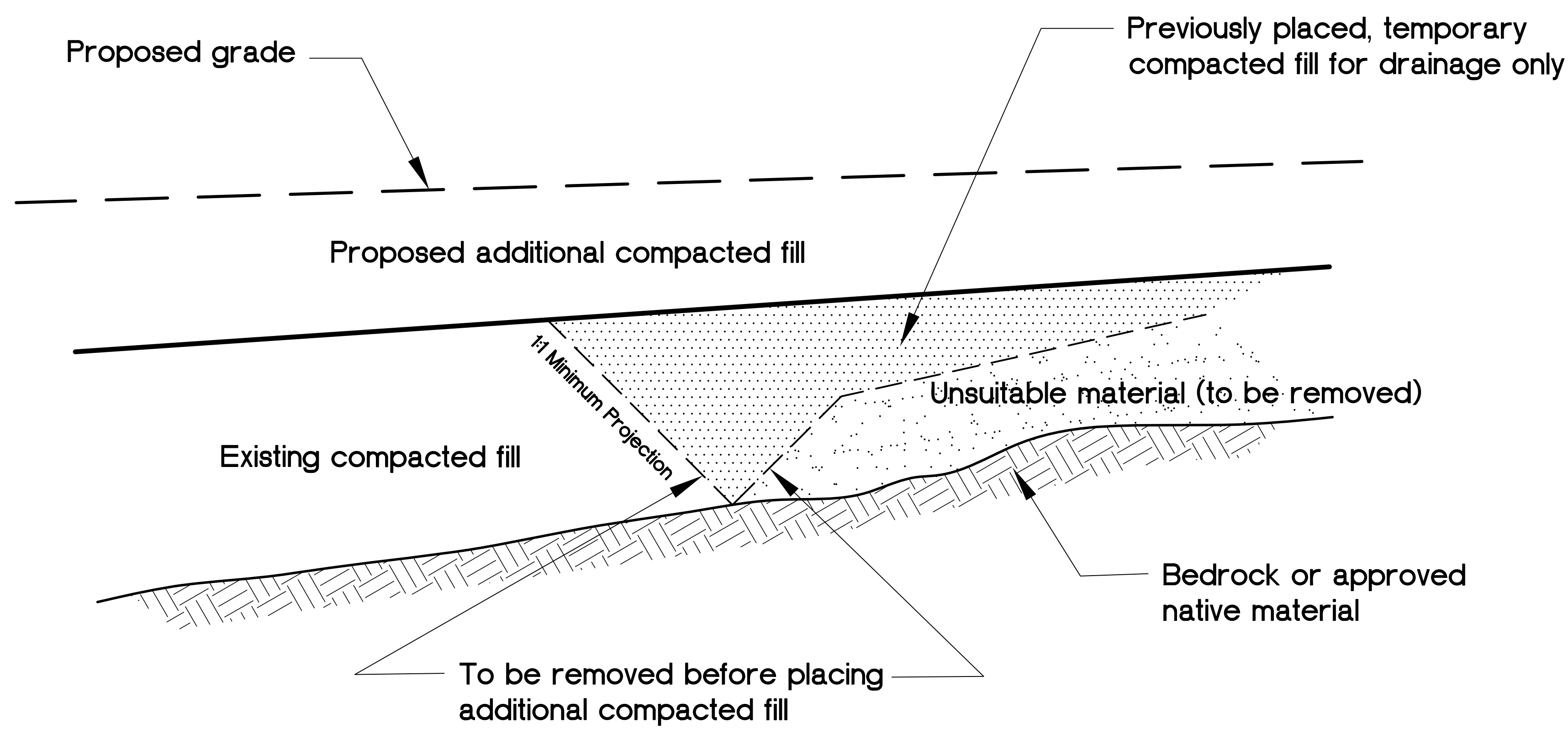
GeoSoils, Inc.	CANYON SUBDRAIN ALTERNATE DETAILS	Plate C-2



GeoSoils, Inc.

FILL SLOPE TOEING OUT ON FLAT ALLUVIATED CANYON DETAIL

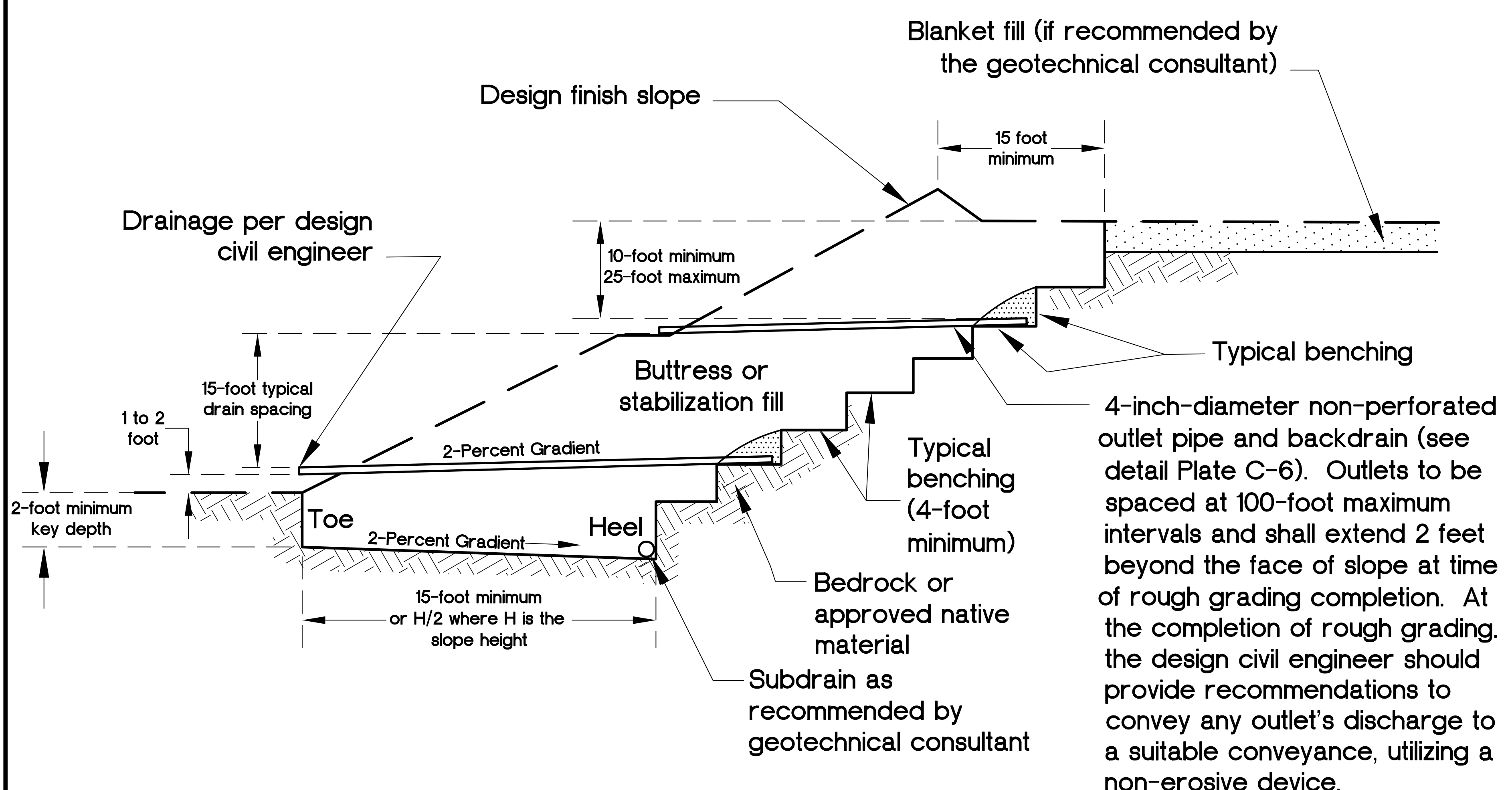
Plate C-3



GeoSoils, Inc.

REMOVAL ADJACENT TO EXISTING FILL ADJOINING CANYON FILL DETAIL

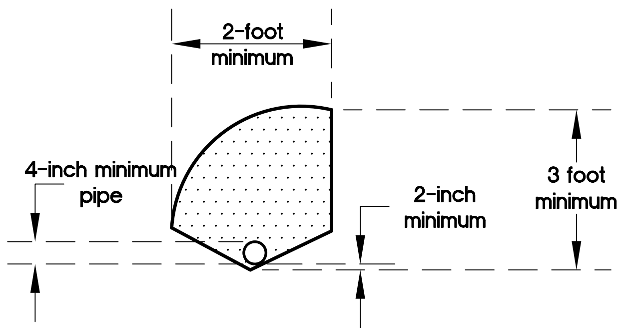
Plate C-4

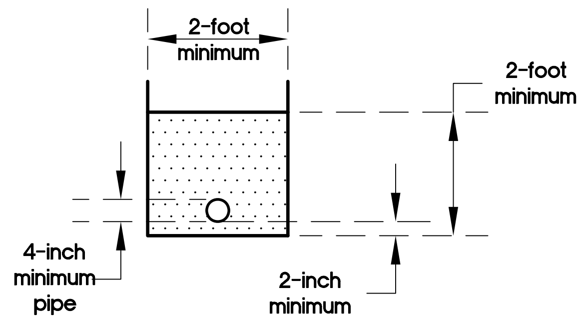


GeoSoils, Inc.

TYPICAL STABILIZATION / BUTTRESS FILL DETAIL

Plate C-5





Filter Material: Minimum of 5 cubic feet per lineal foot of pipe or 4 cubic feet per lineal feet of pipe when placed in square cut trench.

Alternative in Lieu of Filter Material: Gravel may be encased in approved filter fabric. Filter fabric shall be Mirafi 140 or equivalent. Filter fabric shall be lapped a minimum of 12 inches in all joints.

Minimum 4-Inch-Diameter Pipe: ABS-ASTM D-2751, SDR 35; or ASTM D-1527 Schedule 40, PVC-ASTM D-3034, SDR 35; or ASTM D-1785 Schedule 40 with a crushing strength of 1,000 pounds minimum, and a minimum of 8 uniformly-spaced perforations per foot of pipe. Must be installed with perforations down at bottom of pipe. Provide cap at upstream end of pipe. Slope at 2 percent to outlet pipe. Outlet pipe to be connected to subdrain pipe with tee or elbow.

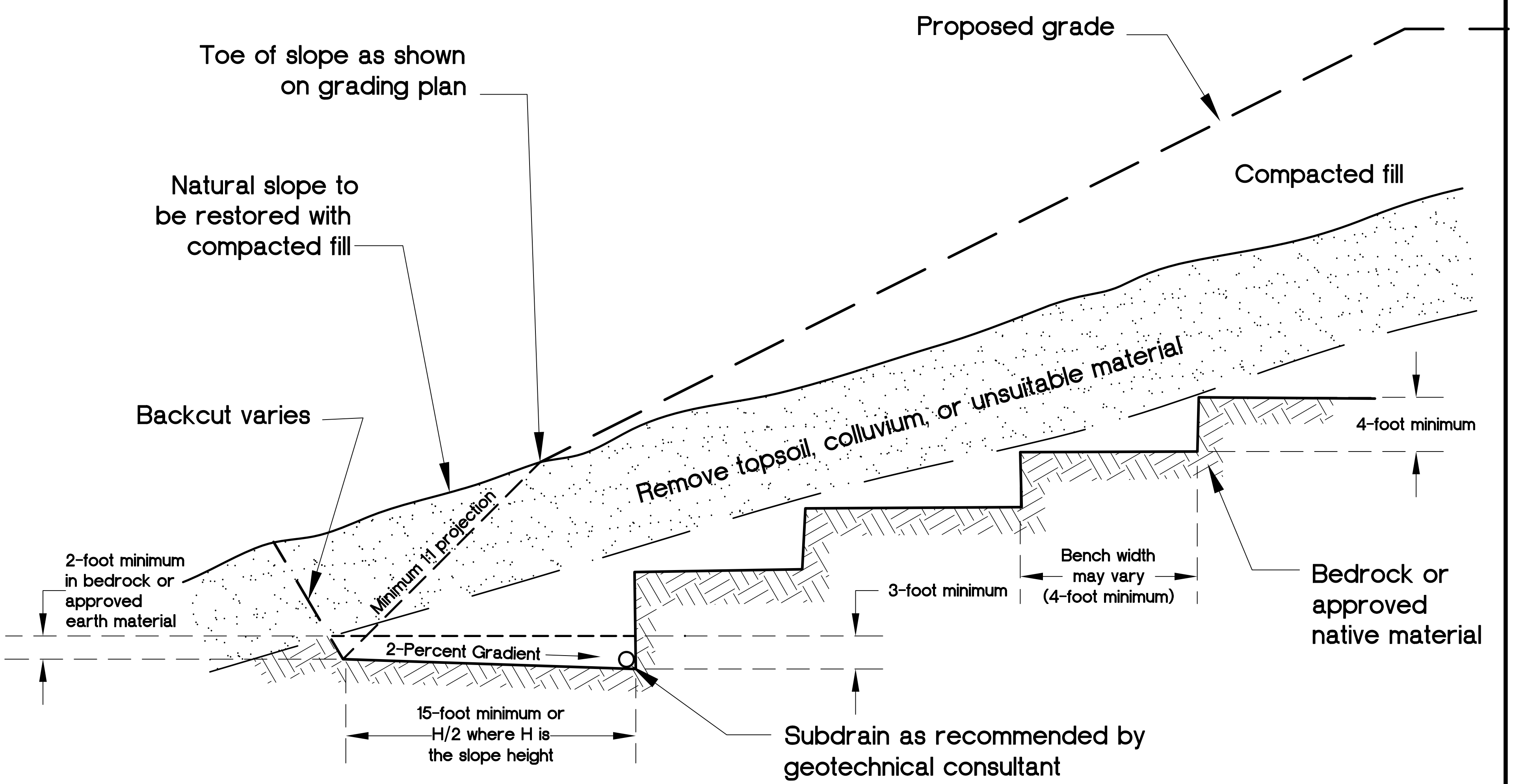
Notes:
1. Trench for outlet pipes to be backfilled and compacted with onsite soil.
2. Backdrains and lateral drains shall be located at elevation of every bench drain. First drain located at elevation just above lower lot grade. Additional drains may be required at the discretion of the geotechnical consultant.

Filter Material shall be of the following specification or an approved equivalent.

Sieve Size	Percent Passing
1 inch	100
3/4 inch	90-100
3/8 inch	40-100
No. 4	25-40
No. 8	18-33
No. 30	5-15
No. 50	0-7
No. 200	0-3

Gravel shall be of the following specification or an approved equivalent.

Sieve Size	Percent Passing
1½ inch	100
No. 4	50
No. 200	8



NOTES:

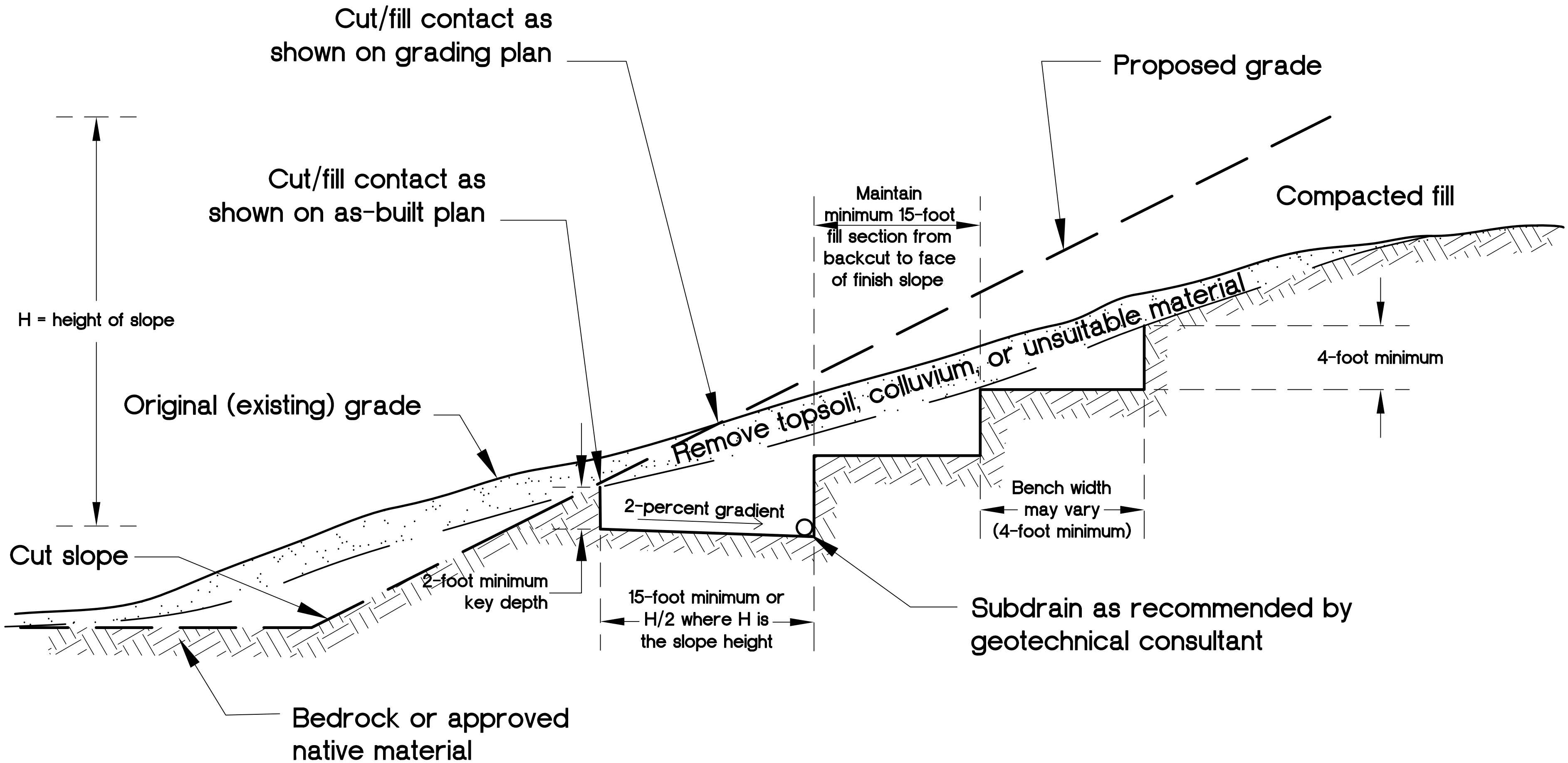
1. Where the natural slope approaches or exceeds the design slope ratio, special recommendations would be provided by the geotechnical consultant.

2. The need for and disposition of drains should be evaluated by the geotechnical consultant, based upon exposed conditions.

GeoSoils, Inc.

FILL OVER NATURAL (SIDEHILL FILL) DETAIL

Plate C-7

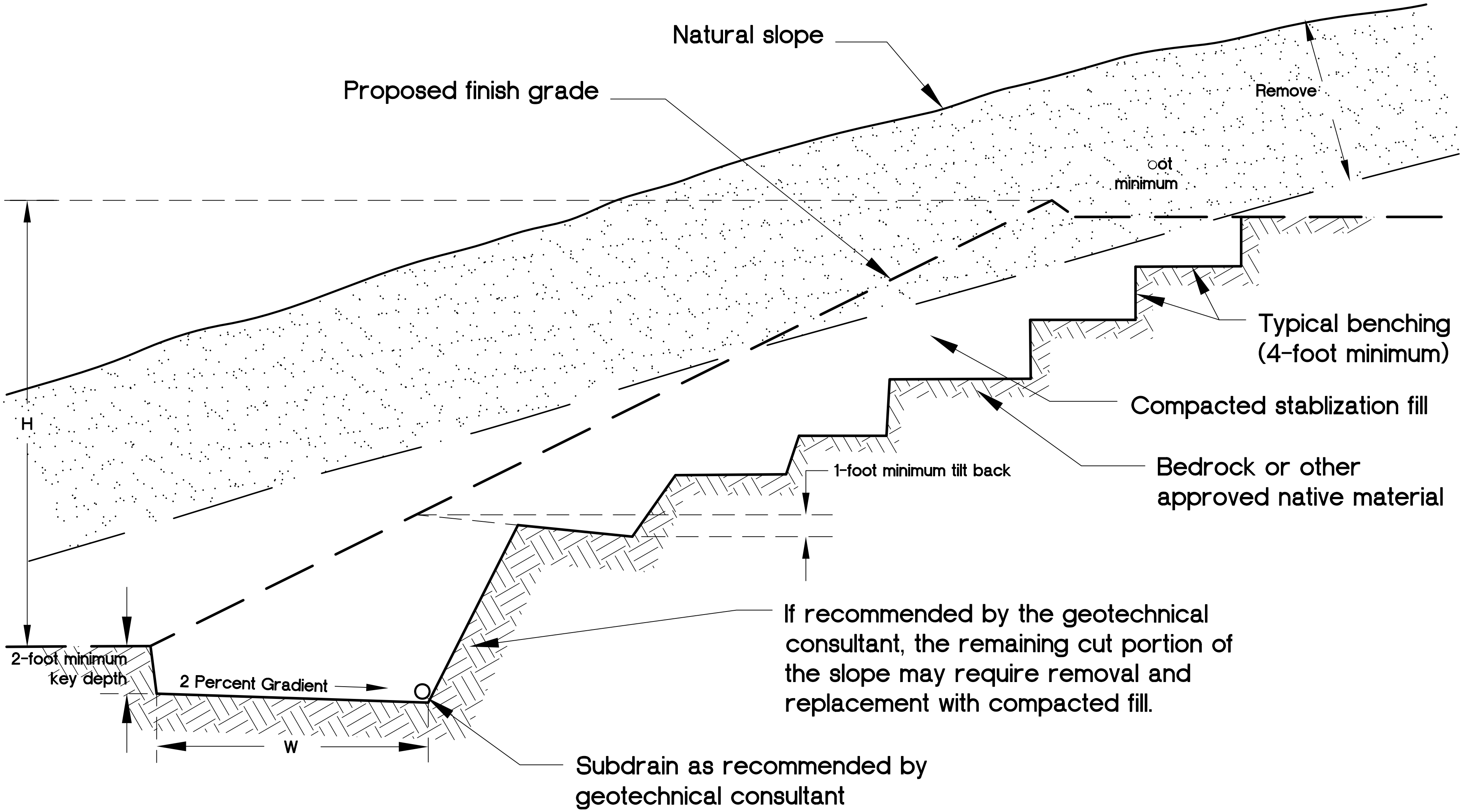


NOTE: The cut portion of the slope should be excavated and evaluated by the geotechnical consultant prior to construction of the fill portion.

GeoSoils, Inc.

FILL OVER CUT DETAIL

Plate C-8



NOTES:

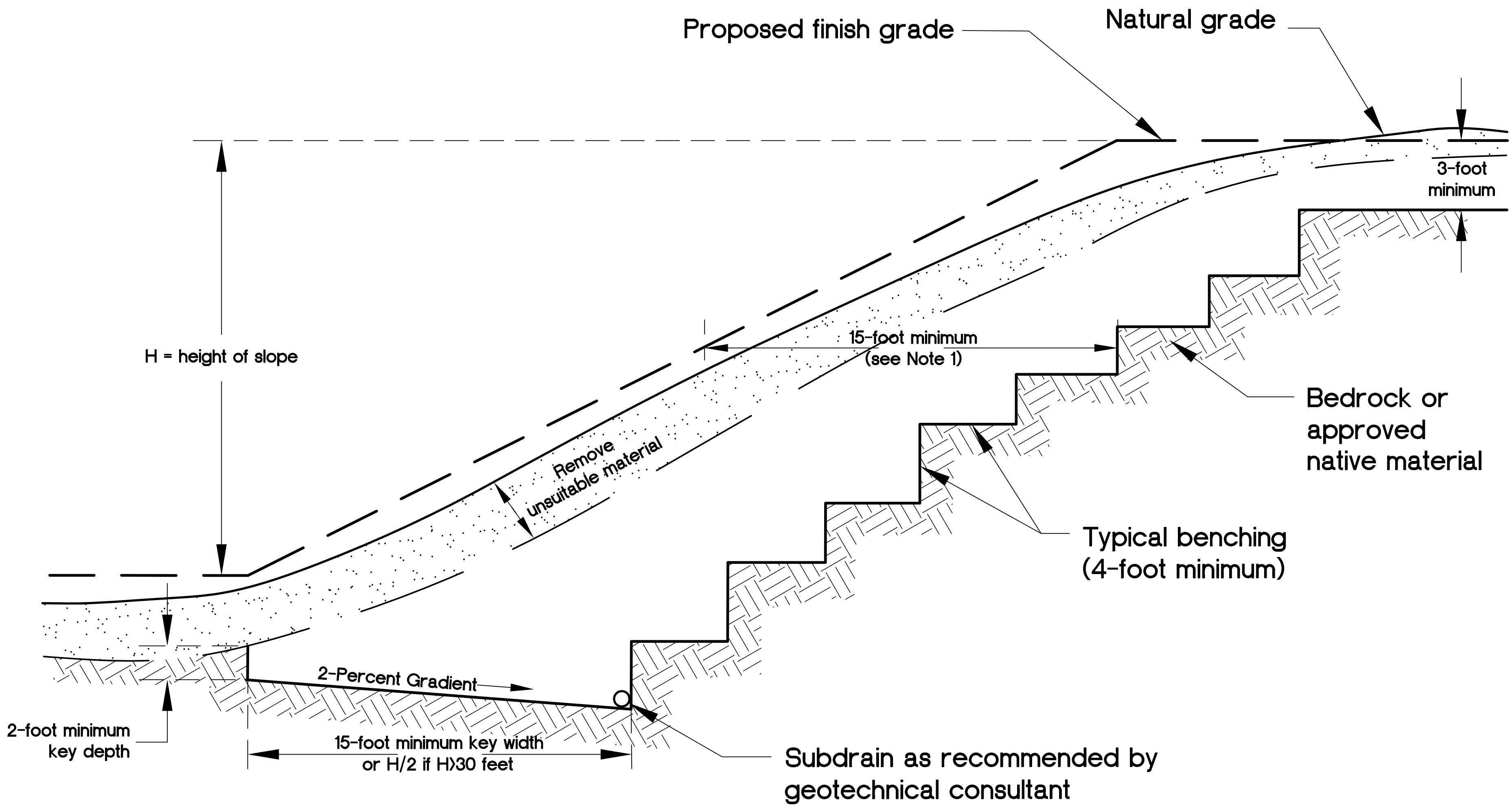
1. Subdrains may be required as specified by the geotechnical consultant.

2 W shall be equipment width (15 feet) for slope heights less than 25 feet. For slopes greater than 25 feet, W shall be evaluated by the geotechnical consultant. At no time, shall W be less than H/2, where H is the height of the slope.

GeoSoils, Inc.

STABLIZATION FILL FOR UNSTABLE MATERIAL EXPOSED IN CUT SLOPE DETAIL

Plate C–9



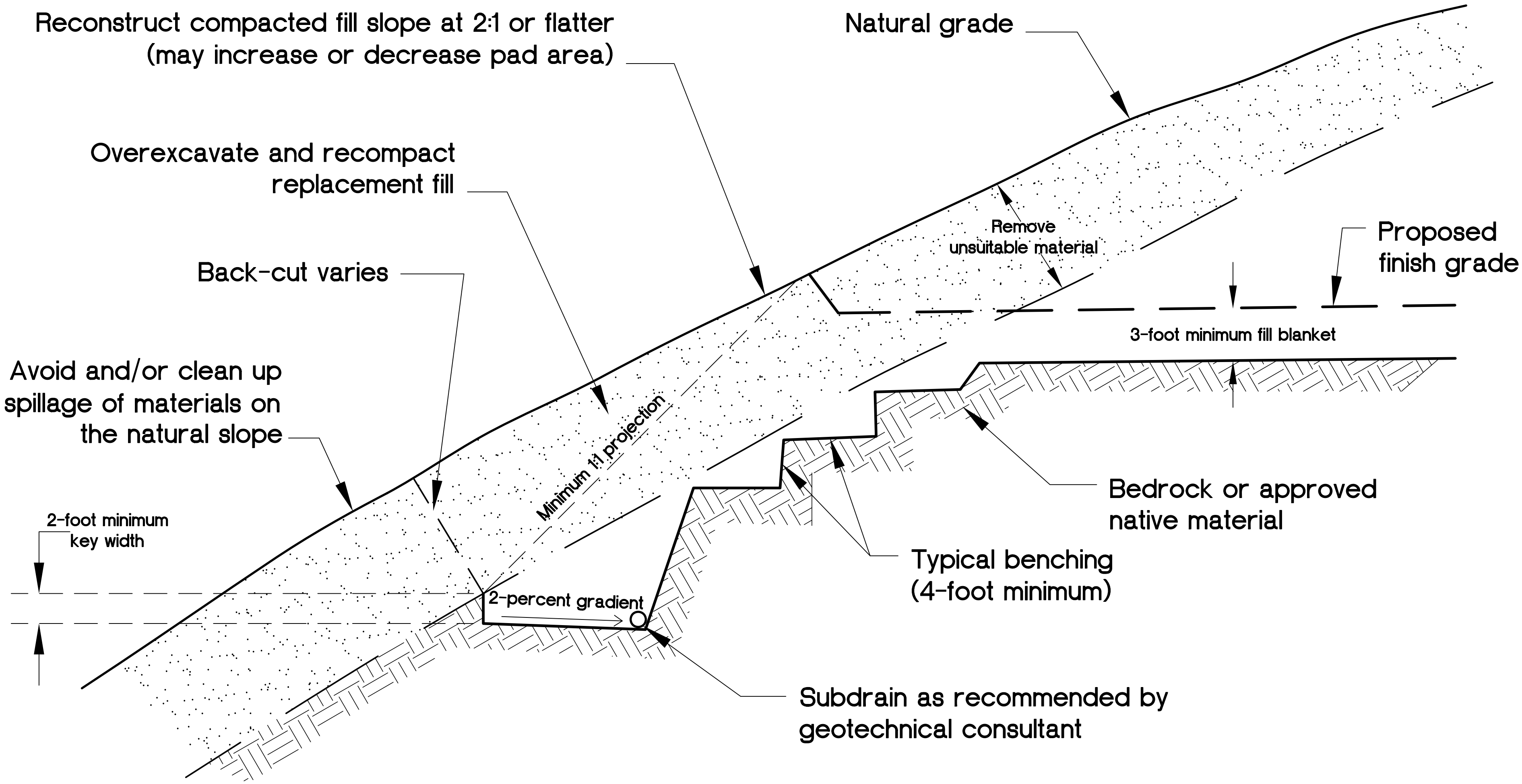
NOTES:

1. 15-foot minimum to be maintained from proposed finish slope face to backcut.
2. The need and disposition of drains will be evaluated by the geotechnical consultant based on field conditions.
3. Pad overexcavation and recompaction should be performed if evaluated to be necessary by the geotechnical consultant.

GeoSoils, Inc.

SKIN FILL OF NATURAL GROUND DETAIL

Plate C-10



NOTES:

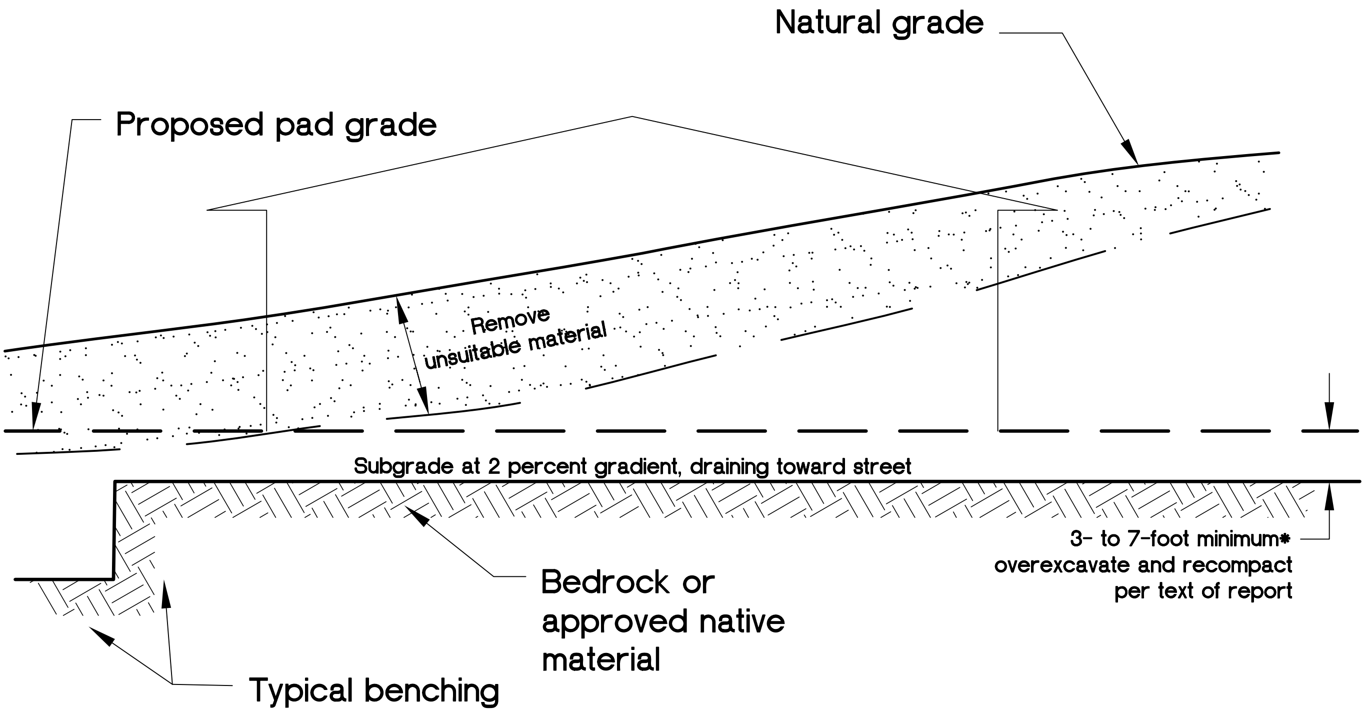
1. Subdrain and key width requirements will be evaluated based on exposed subsurface conditions and thickness of overburden.

2. Pad overexcavation and recompaction should be performed if evaluated necessary by the geotechnical consultant.

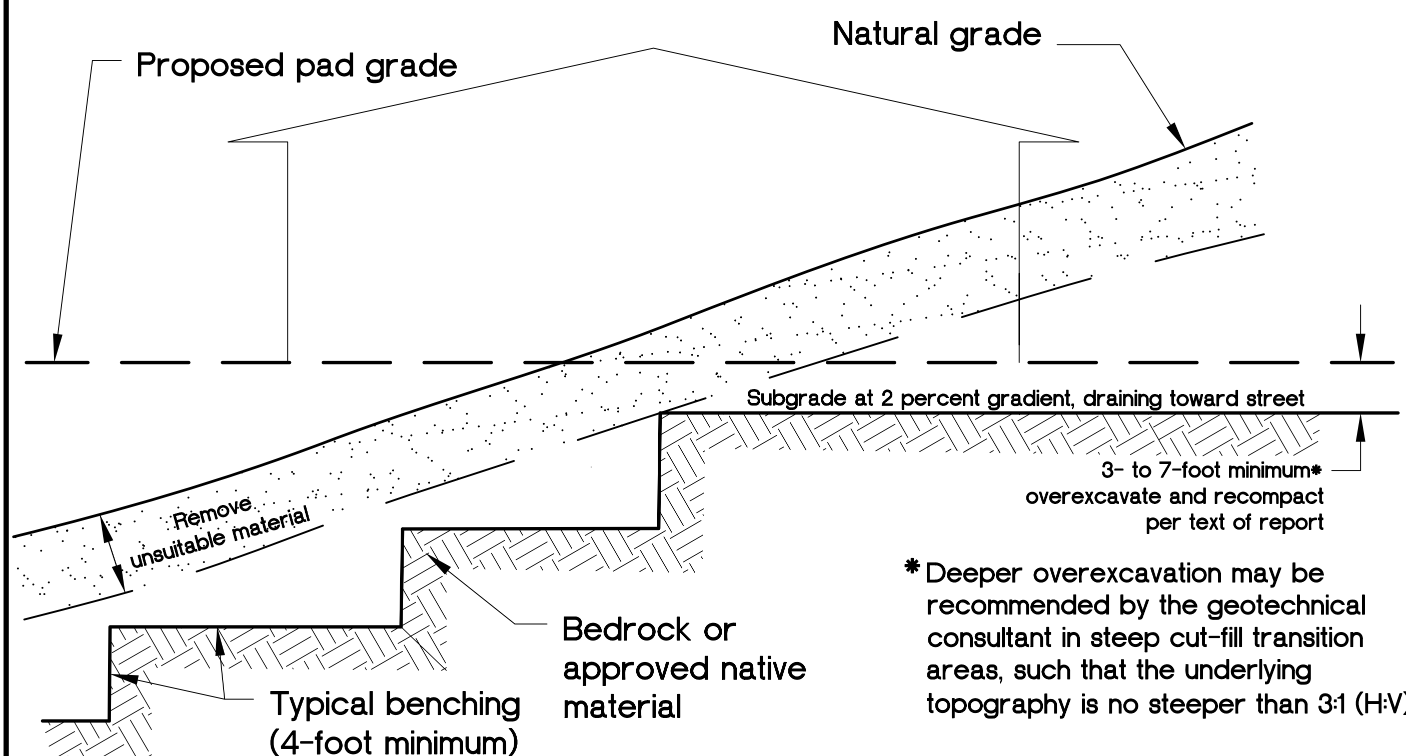
GeoSoils, Inc.

DAYLIGHT CUT LOT DETAIL

Plate C-11



CUT LOT OR MATERIAL-TYPE TRANSITION

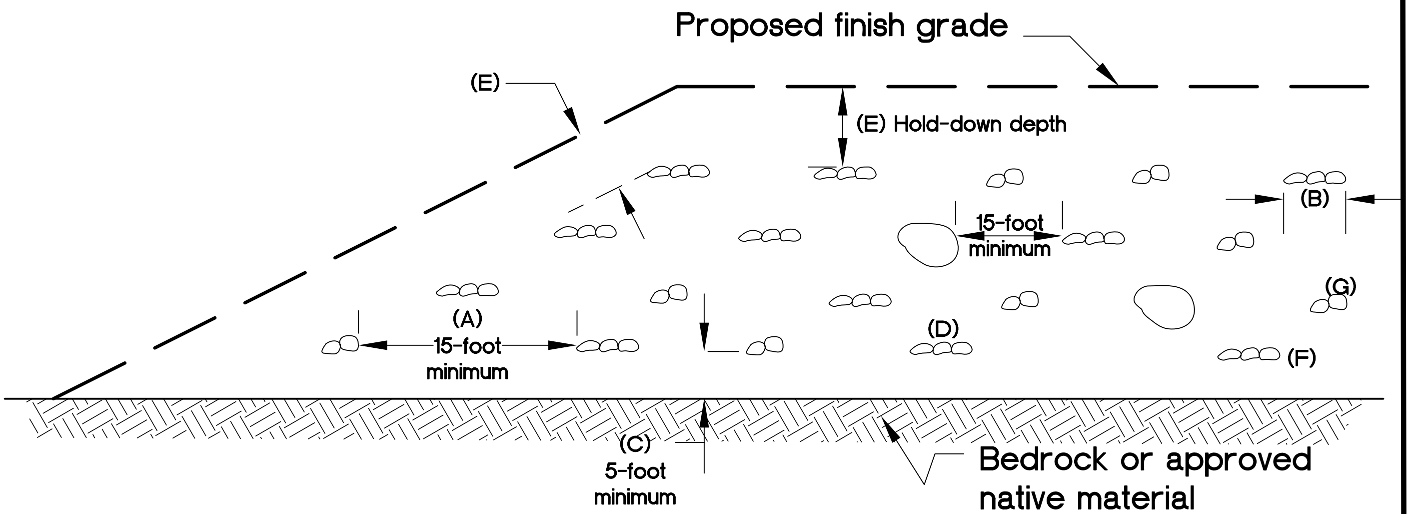


* Deeper overexcavation may be recommended by the geotechnical consultant in steep cut-fill transition areas, such that the underlying topography is no steeper than 3:1 (H:V)

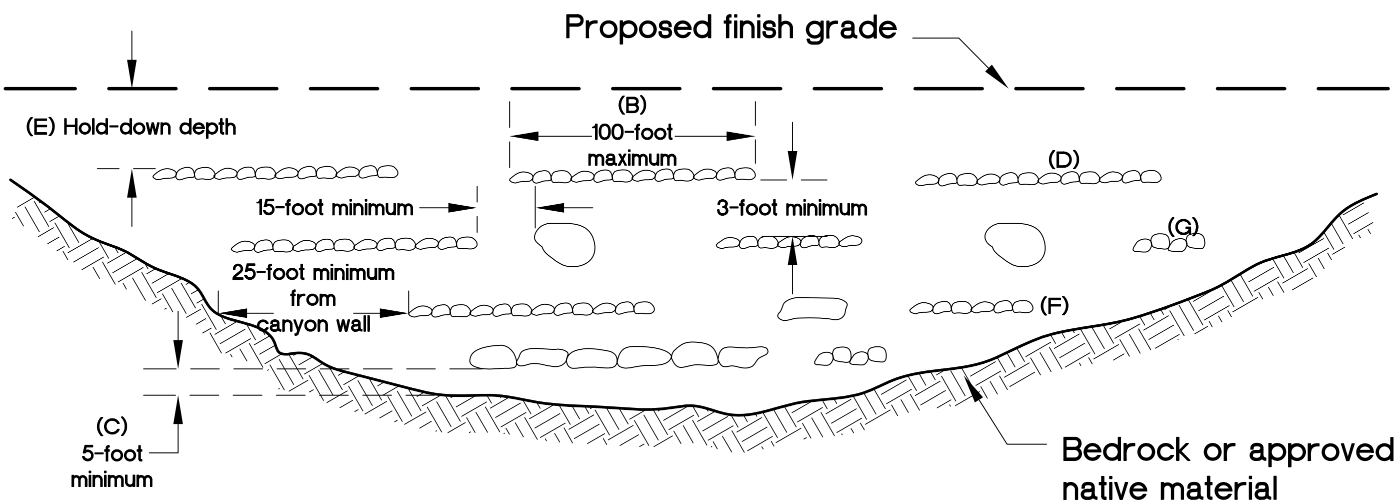
CUT-FILL LOT (DAYLIGHT TRANSITION)

GeoSoils, Inc.	TRANSITION LOT DETAILS	Plate C-12

VIEW NORMAL TO SLOPE FACE



VIEW PARALLEL TO SLOPE FACE



NOTES:

A. One equipment width or a minimum of 15 feet between rows (or windrows).

B. Height and width may vary depending on rock size and type of equipment. Length of windrow shall be no greater than 100 feet.

C. If approved by the geotechnical consultant, windrows may be placed direclty on competent material or bedrock, provided adequate space is available for compaction.

D. Orientation of windrows may vary but should be as recommended by the geotechnical engineer and/or engineering geologist. Staggering of windrows is not necessary unless recommended.

E. Clear area for utility trenches, foundations, and swimming pools; Hold-down depth as specified in text of report, subject to governing agency approval.

F. All fill over and around rock windrow shall be compacted to at least 90 percent relative compaction or as recommended.

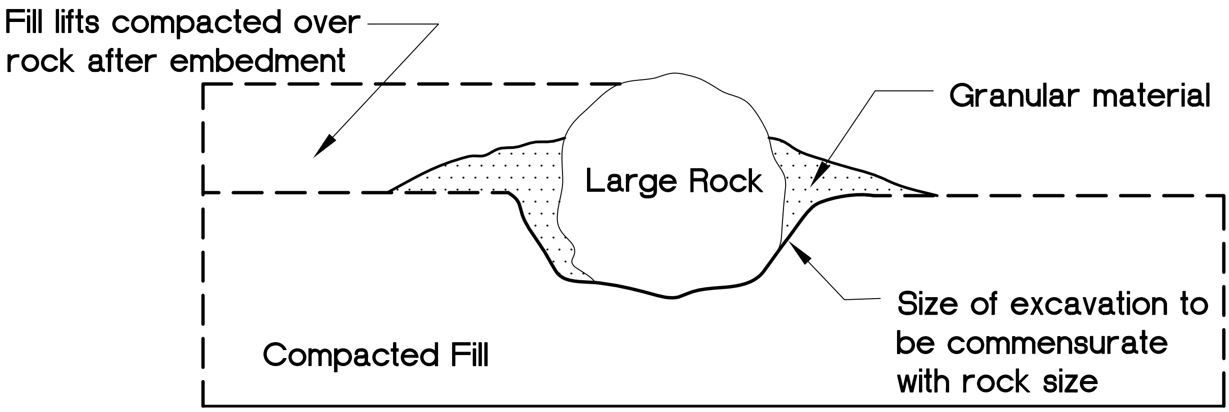
G. After fill between windrows is placed and compacted, with the lift of fill covering windrow, windrow should be proof rolled with a D-9 dozer or equivalent.

VIEWS ARE DIAGRAMMATIC ONLY AND MAY BE SUPERSEDED BY REPORT RECOMMENDATIONS OR CODE

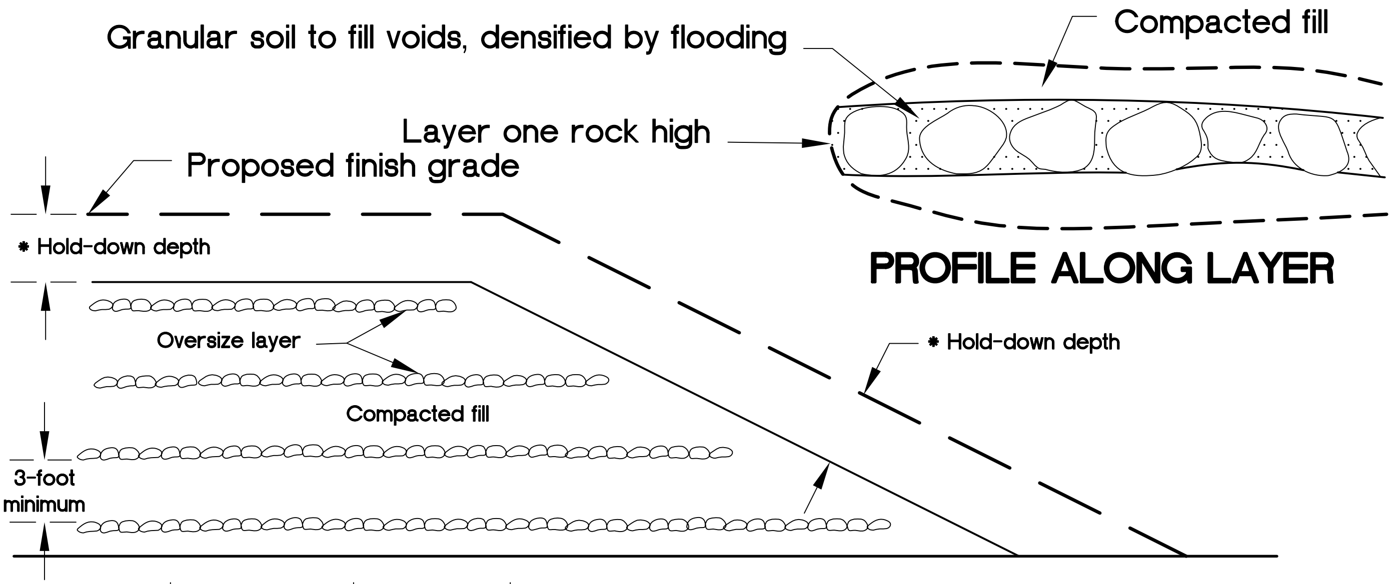
ROCK SHOULD NOT TOUCH AND VOIDS SHOULD BE COMPLETELY FILLED

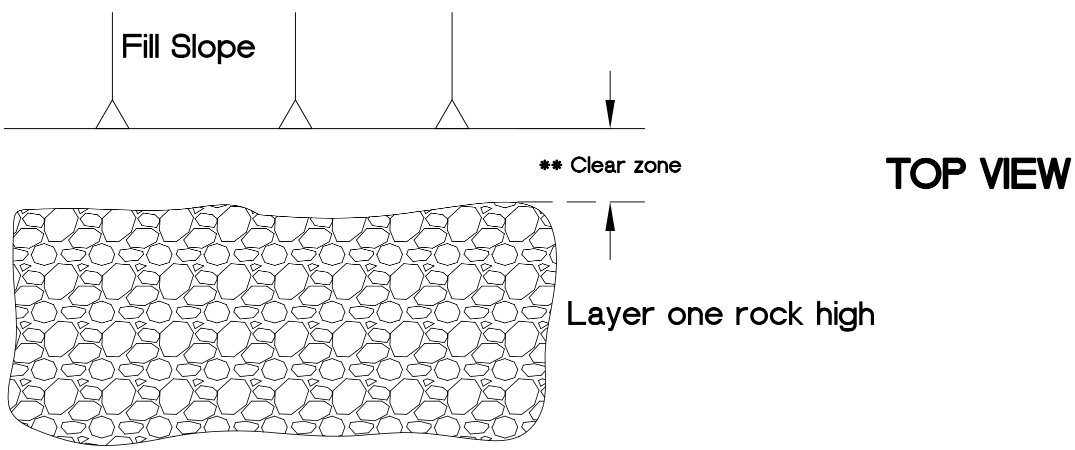
GeoSoils, Inc.	OVERSIZE ROCK DISPOSAL DETAIL	Plate C-13

ROCK DISPOSAL PITS



ROCK DISPOSAL LAYERS





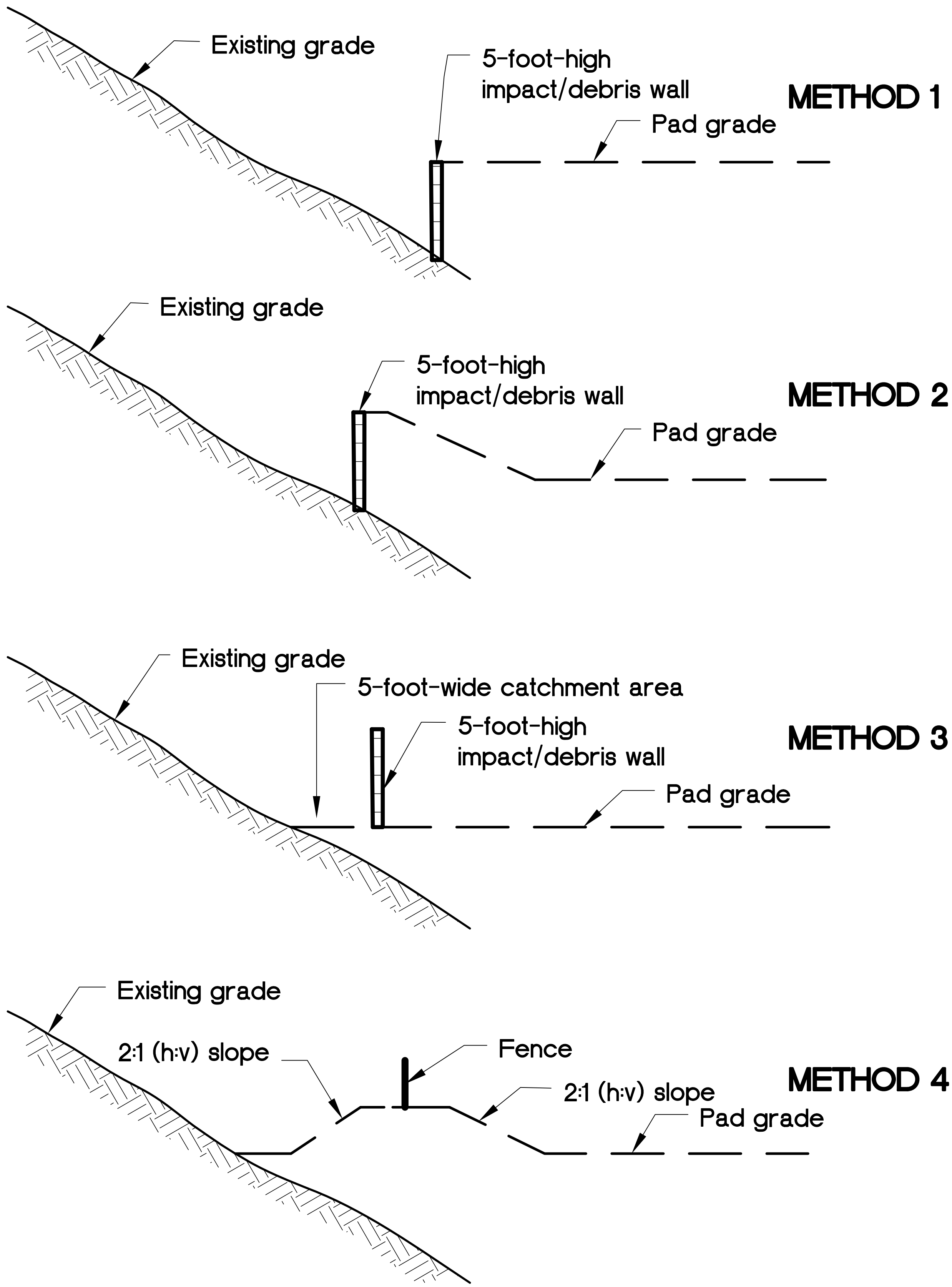
* Hold-down depth or below lowest utility as specified in text of report, subject to governing agency approval.

** Clear zone for utility trenches, foundations, and swimming pools, as specified in text of report.

VIEWS ARE DIAGRAMMATIC ONLY AND MAY BE SUPERSEDED BY REPORT RECOMMENDATIONS OR CODE

ROCK SHOULD NOT TOUCH AND VOIDS SHOULD BE COMPLETELY FILLED IN

GeoSoils, Inc.	ROCK DISPOSAL DETAIL	Plate C-14

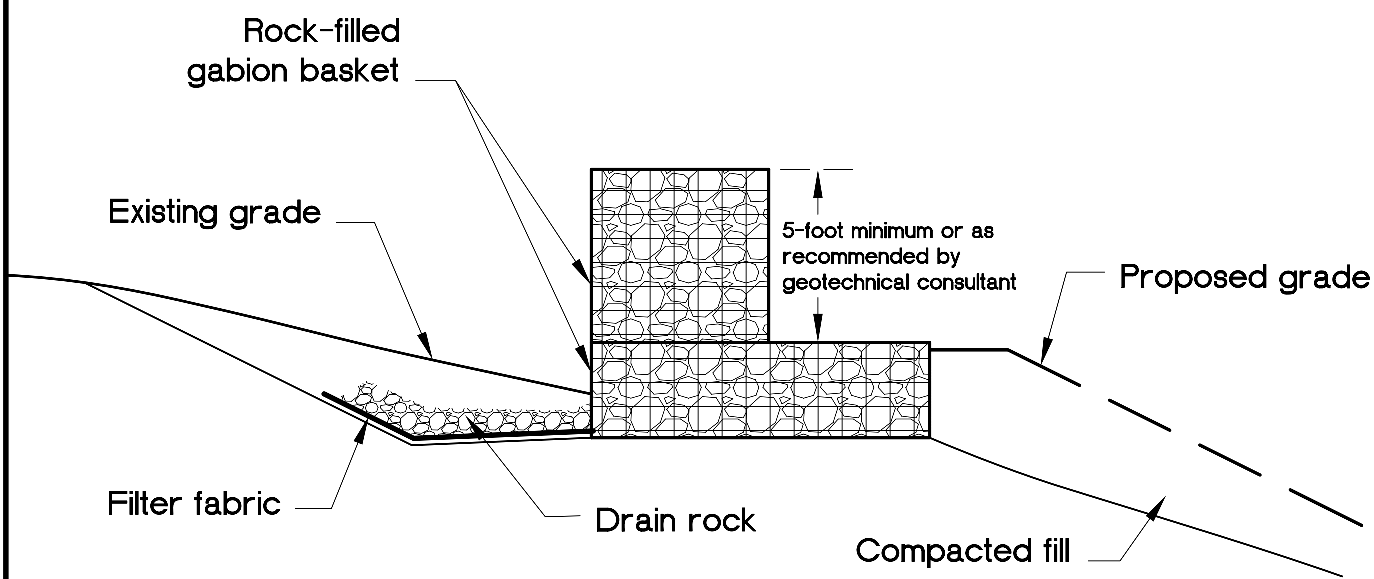


NOT TO SCALE

GeoSoils, Inc.

DEBRIS DEVICE CONTROL METHODS DETAIL

Plate C-15

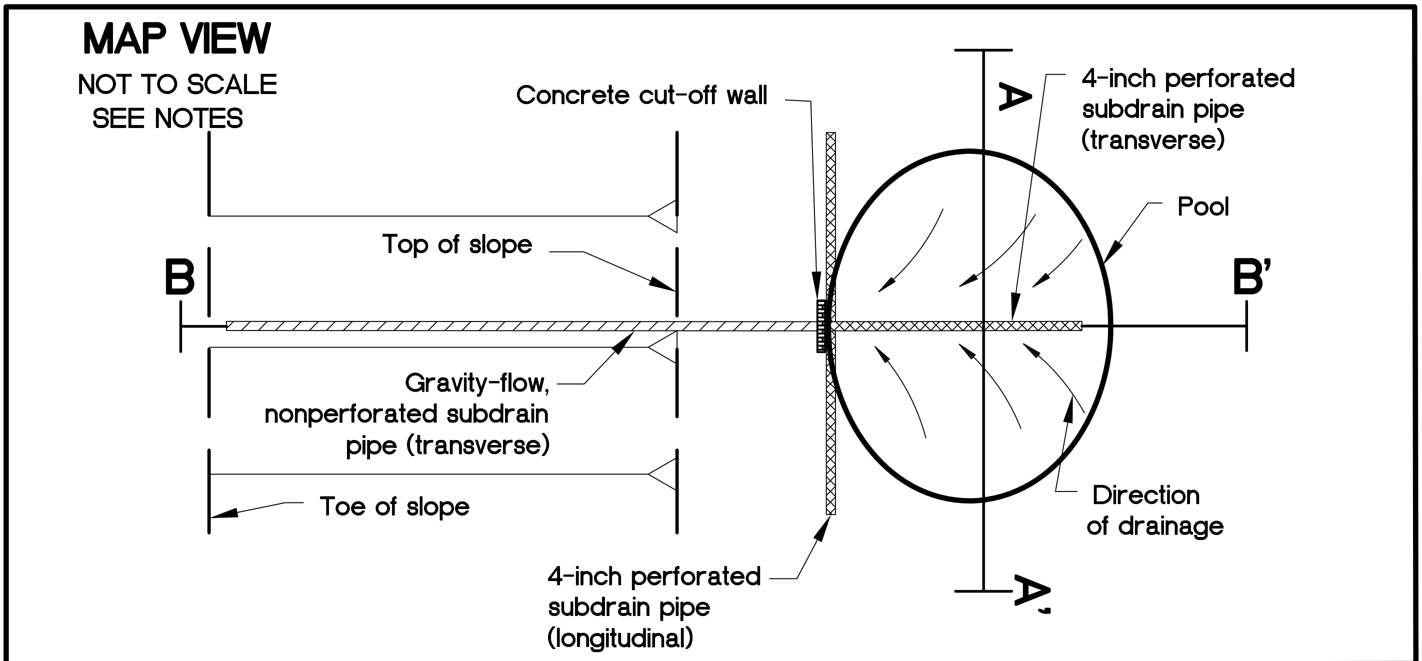


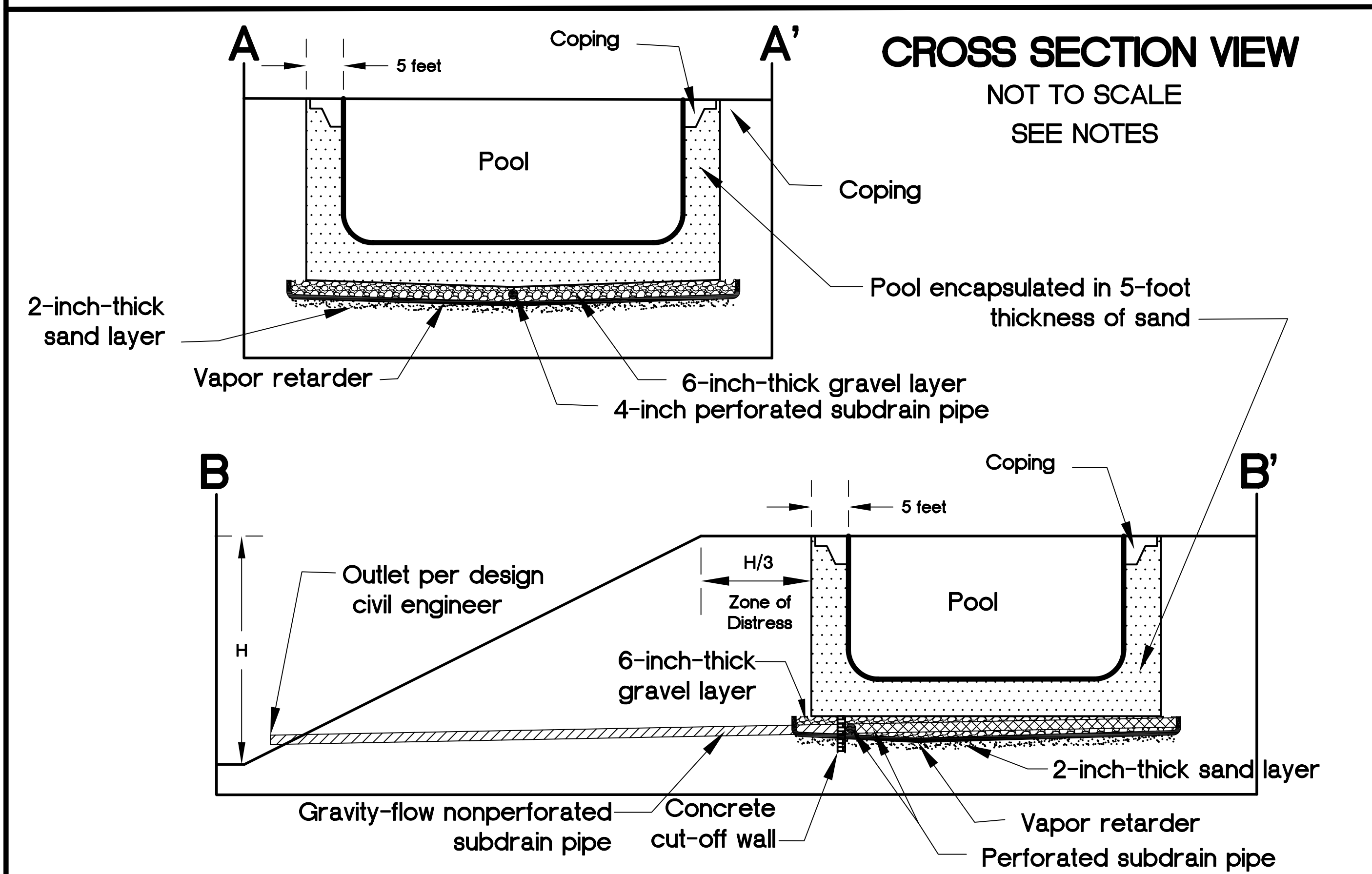
Gabion impact or diversion wall should be constructed at the base of the ascending slope subject to rock fall. Walls need to be constructed with high segments that sustain impact and mitigate potential for overtopping, and low segment that provides channelization of sediments and debris to desired depositional area for subsequent clean-out. Additional subdrain may be recommended by geotechnical consultant.

From GSA, 1987

GeoSoils, Inc.

ROCK FALL MITIGATION DETAIL

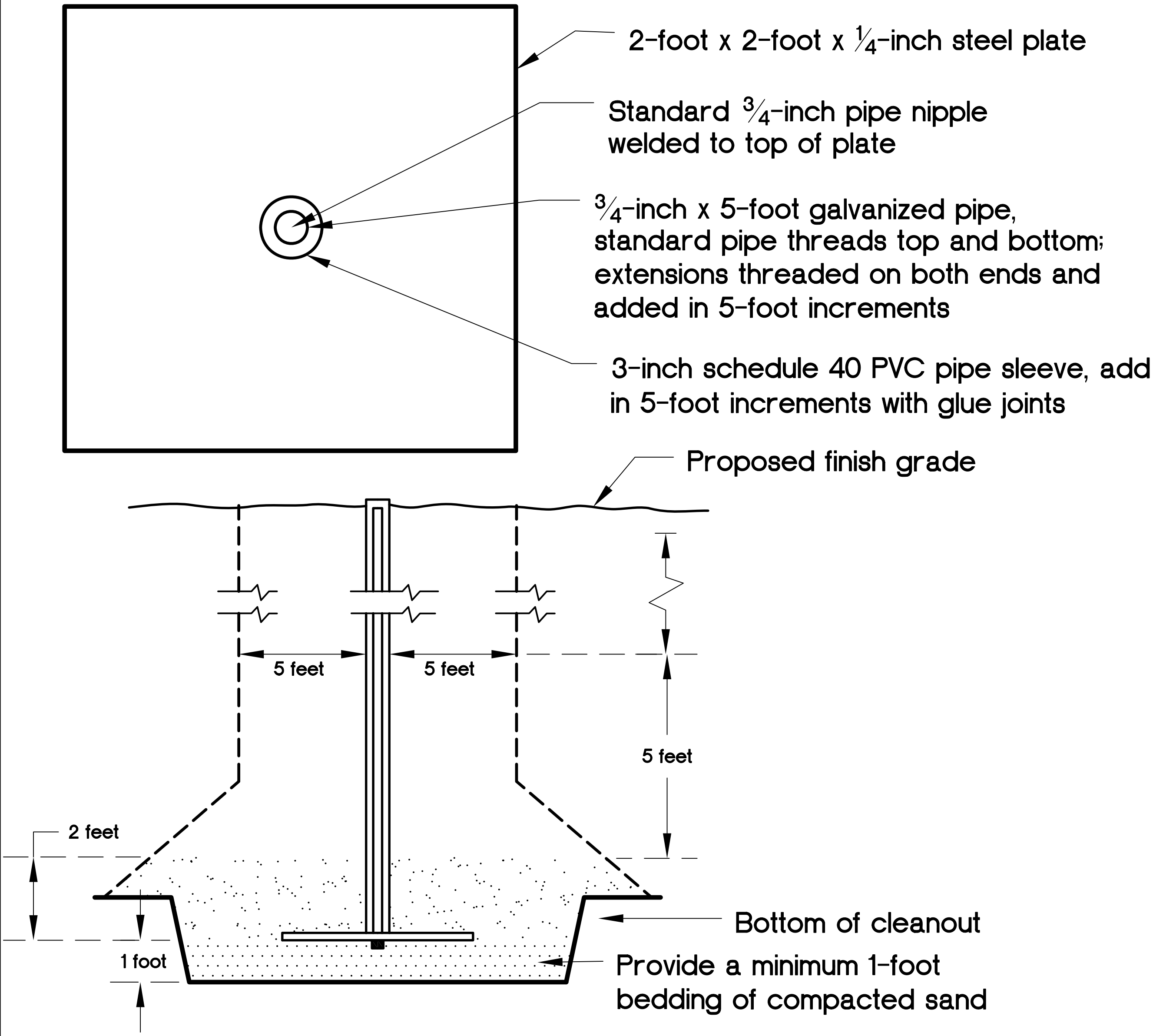




NOTES:

1. 6-inch-thick, clean gravel (¾ to 1½ inch) sub-base encapsulated in Mirafi 140N or equivalent, underlain by a 15-mil vapor retarder, with 4-inch-diameter perforated pipe longitudinal connected to 4-inch-diameter perforated pipe transverse. Connect transverse pipe to 4-inch-diameter nonperforated pipe at low point and outlet or to sump pump area.
2. Pools on fills thicker than 20 feet should be constructed on deep foundations; otherwise, distress (tilting, cracking, etc.) should be expected.
3. Design does not apply to infinity-edge pools/spas.

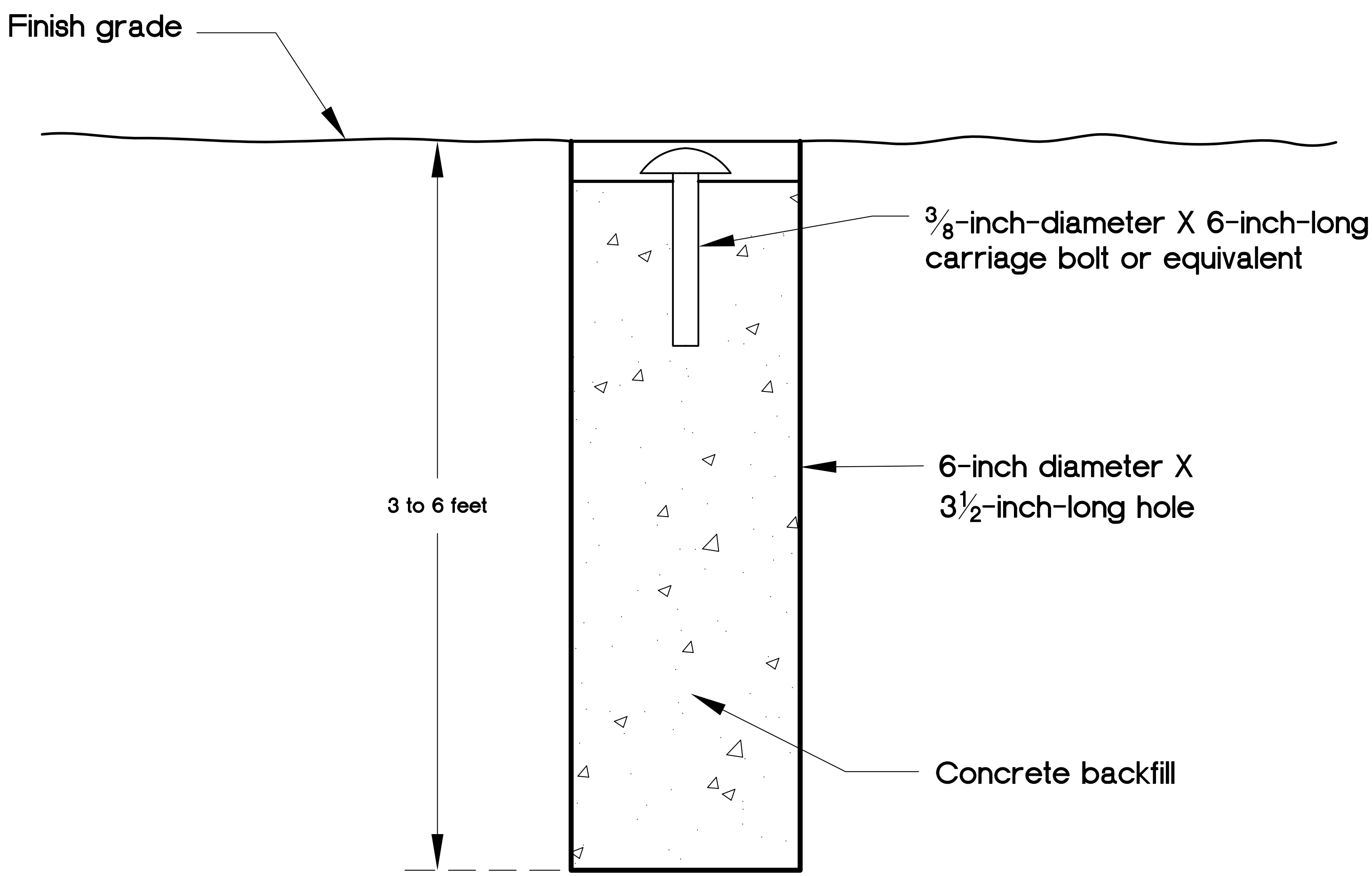
GeoSoils, Inc.	TYPICAL POOL/SPA DETAIL	Plate C-17



NOTES:

1. Locations of settlement plates should be clearly marked and readily visible (red flagged) to equipment operators.
2. Contractor should maintain clearance of a 5-foot radius of plate base and withiin 5 feet (vertical) for heavy equipment. Fill within clearance area should be hand compacted to project specifications or compacted by alternative approved method by the geotechnical consultant (in writing, prior to construction).
3. After 5 feet (vertical) of fill is in place, contractor should maintain a 5-foot radius equipment clearance from riser.
4. Place and mechanically hand compact initial 2 feet of fill prior to establishing the initial reading.
5. In the event of damage to the settlement plate or extension resulting from equipment operating within the specified clearance area, contractor should immediately notify the geotechnical consultant and should be responsible for restoring the settlement plates to working order.
6. An alternate design and method of installation may be provided at the discretion of the geotechnical consultant.

GeoSoils, Inc.	SETTLEMENT PLATE AND RISER DETAIL	Plate C-18

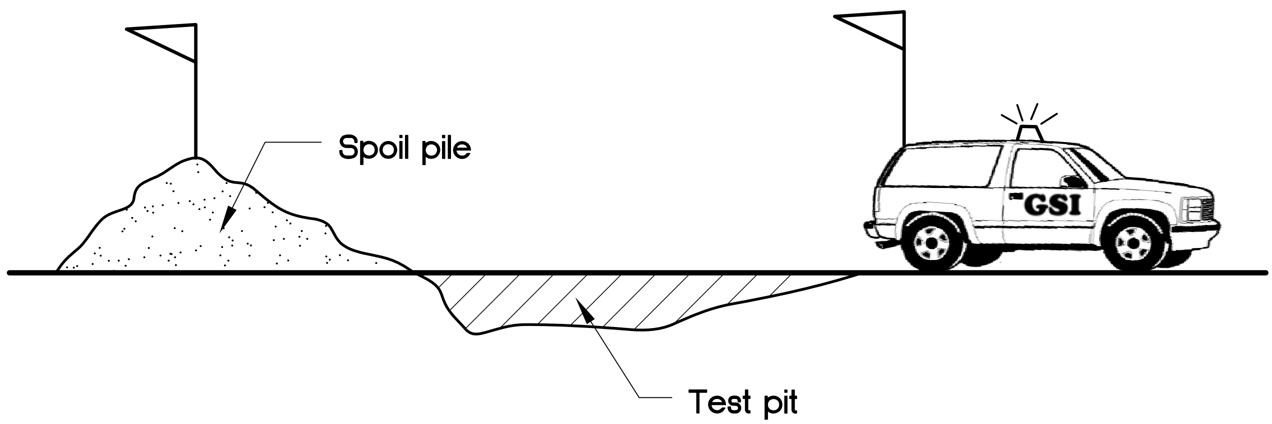


GeoSoils, Inc.

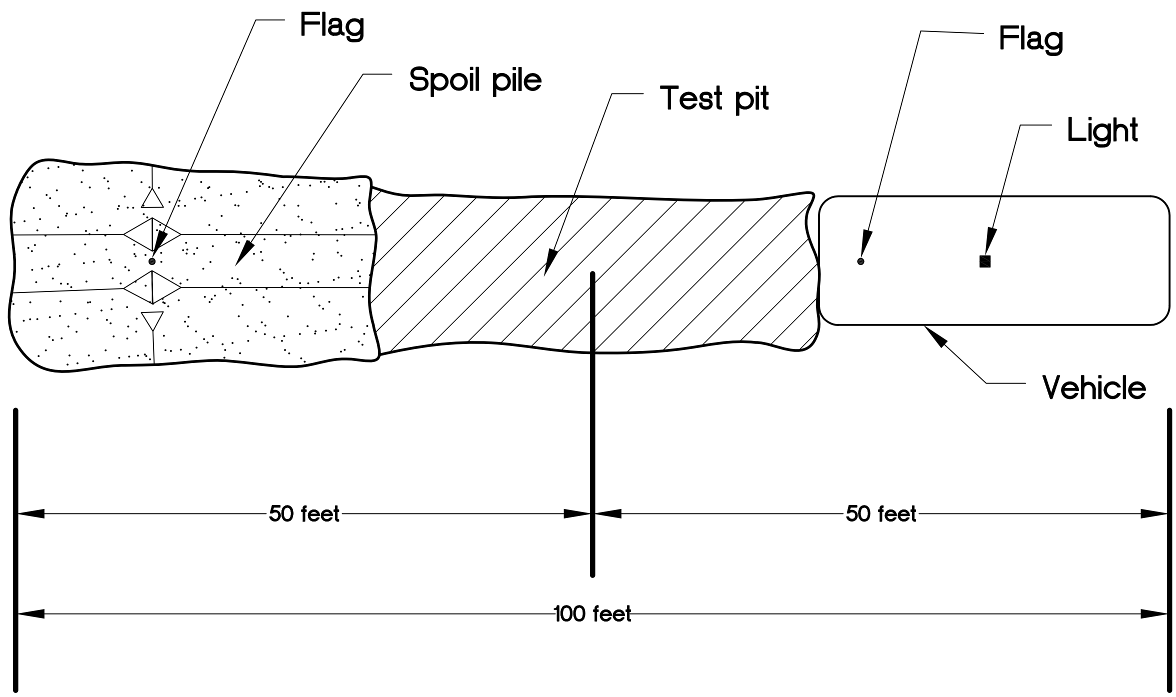
TYPICAL SURFACE SETTLEMENT MONUMENT

Plate C-19

SIDE VIEW



TOP VIEW



GeoSoils, Inc.	TEST PIT SAFETY DIAGRAM	Plate C-20

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Appendix III-A-E

GeoSoils, Inc.
Addendum to
"Supplemental Fault and Seismic Investigation Lytle Creek Ranch Neighborhood 1 Sycamore Canyon Area Rialto, San Bernardino County California, dated February 13, 2007 by GeoSoils, Inc."
revised August 27, 2007

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GeoSoils, Inc.
Geotechnical • Coastal • Geologic • Environmental
26590 Madison Avenue • Murrieta, California 92562 • (951) 677-9651 • FAX (951) 677-9301

August 27, 2007

W.O. 5278-A-SC

Lytle Development Company
3281 E. Guasti Road, Suite 330
Ontario, CA 91761

Attention: Mr. Ron Pharris and Mr. Jan Dabney

Subject: Addendum to "Supplemental Fault and Seismic Investigation, Lytle Creek Ranch, Neighborhood 1, Sycamore Canyon Area, Rialto, San Bernardino County, California, dated February 13, 2007, W.O. 5278-A-SC, by GeoSoils, Inc."

Dear Mr. Pharris and Mr. Dabney:

In accordance with your request and authorization, GeoSoils, Inc. (GSI), and as a result of our meeting last week, GSI is providing this Fault Setback Map (Exhibit 1), which shows all of the explorations in Neighborhood I, for the Sycamore Flat and Sycamore Canyon areas, in order to expedite review. All trench logs shown are either included in the subject report, or as pdf documents in Appendix A. Unless specifically superceded herein, the conclusions and recommendations contained in the subject report remain pertinent and applicable.

The opportunity to be of service is sincerely appreciated. If you should have any questions, please do not hesitate to contact the undersigned.

Respectfully submitted,

GeoSoils, Inc.

PROFESSIONAL GEOLOGIST JOHN P. FRANKLIN No. 1340 Certified Engineering Geologist STATE OF CALIFORNIA

John P. Franklin
Engineering Geologist, CEG 1340

PROFESSIONAL GEOLOGIST PAUL L. McCLAY No. 1117 Certified Engineering Geologist STATE OF CALIFORNIA

Paul L. McClay
Engineering Geologist, CEG 1117

JPF/PLM/jk

Attachment: Exhibit 1 - Fault Setback Map

Distribution: (5) Addressee
(1) Dr. Roy J. Shlemon (CD Only)
(1) Pacific Soil Engineering, Inc., Attention: Mr. Michael Mills

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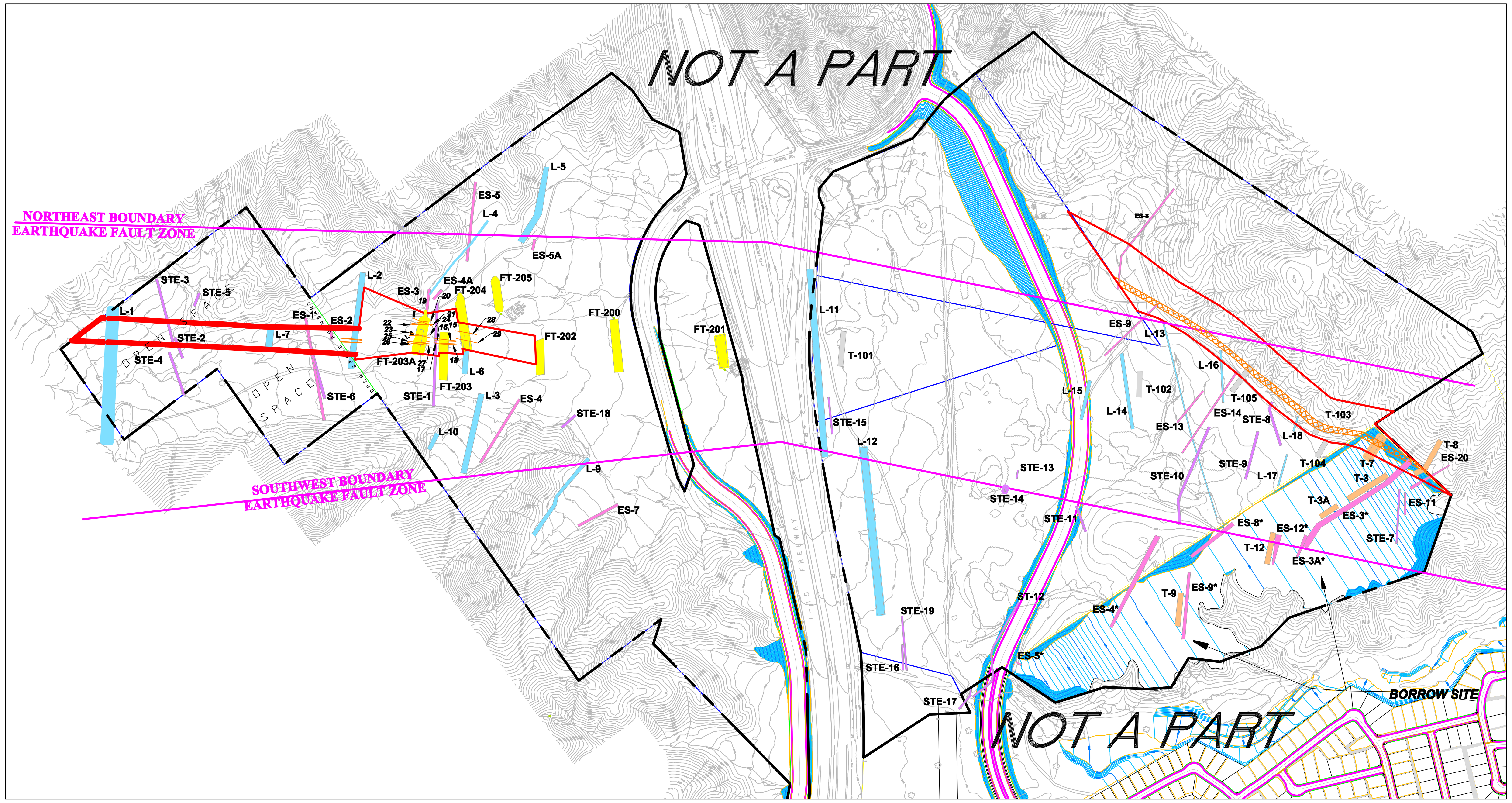
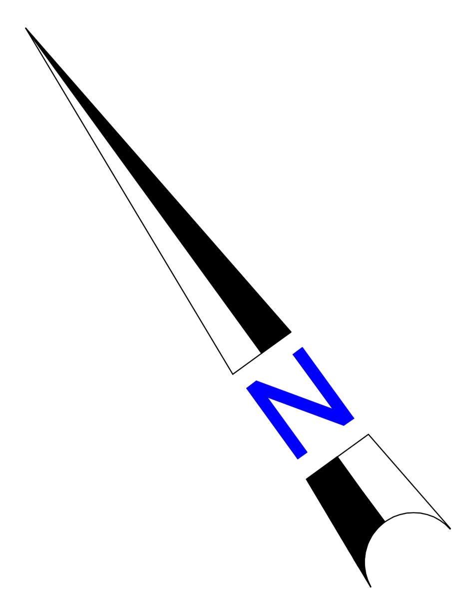


LEGEND

Symbol	Description
14	Approximate location of plotted fault (GSI, 2007a; 2006a)
	Approximate location of fault zone (GSI, 1999b; 1994)
	Approximate location of setback limit for habitable structures (GSI, 2007a, 2006a, 1999b; 1994)
	Approximate location of setback limit for habitable structures (LOR Geotechnical Group, Inc., 1994b; Gary S. Rasmussen and Associates, Inc., 1994a)
FT-205	Approximate location of fault-locating trench (GSI, 2007a, 2006a)
T-105	Approximate location of fault-locating trench (GSI, 1999b)
T-9	Approximate location of fault-locating trench (GSI, 1994)
L-18	Approximate location of fault-locating trench (LOR Geotechnical Group, Inc., 1994b)
ES-20	Approximate location of fault-locating trench (Eberhart and Stone, Inc., 1990-1993, unpublished, adapted from LOR Geotechnical Group, Inc., 1994b; GSI, 1994)
ES-12*	Approximate location of fault-locating trench (Eberhart and Stone, Inc., 1990-1993, unpublished, adapted from GSI, 1994), trench logs provided in GSI (1994)
STE-19	Approximate location of fault-locating trench (Soil Testing and Engineers, Inc., 1988)



ALL LOCATIONS, NORTH ARROW, AND SCALE ARE APPROXIMATE

Partial Base Map Provided by Otte-Burkley Group Inc., August 16, 2006. Scale and north arrow were inferred by GSI.

GeoSoils, Inc.

RIVERSIDE CO.
ORANGE CO.
SAN DIEGO CO.

FAULT SETBACK MAP

Exhibit 1

W.O. 5278-A-SC	DATE 08/07	SCALE 1"=400'

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Appendix III-A-F

GeoSoils, Inc.
Supplemental
Fault and Seismic Investigation
Lytle Creek Ranch
Neighborhoods I
Sycamore Canyon Area
Rialto, San Bernardino
County, California
February 13, 2007

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SUPPLEMENTAL FAULT AND SEISMIC INVESTIGATION
LYTLE CREEK RANCH, NEIGHBORHOOD 1
SYCAMORE CANYON AREA, RIALTO
SAN BERNARDINO COUNTY, CALIFORNIA

FOR

LYTLE DEVELOPMENT COMPANY
3281 E. GUASTI ROAD, SUITE 330
ONTARIO, CALIFORNIA 91761

W.O. 5278-A-SC FEBRUARY 13, 2007

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GeoSoils, Inc.

Geotechnical • Coastal • Geologic • Environmental

26590 Madison Avenue • Murrieta, California 92562 • (951) 677-9651 • FAX (951) 677-9301

February 13, 2007

W.O. 5278-A-SC

Lytle Development Company
3281 E. Guasti Road, Suite 330
Ontario, CA 91761

Attention: Mr. Ron Pharris and Mr. Jan Dabney

Subject: Supplemental Fault and Seismic Investigation, Lytle Creek Ranch, Neighborhood 1, Sycamore Canyon Area, Rialto, San Bernardino County, California

Dear Mr. Pharris and Mr. Dabney:

In accordance with your request and authorization, GeoSoils, Inc. (GSI), summarizes herein our supplemental fault and seismic investigation of the subject property. Most of the site lies within an Alquist-Priolo Earthquake Fault Zone (APEFZ). Accordingly, this update evaluates onsite geologic conditions as they pertain to active faulting and their effects on the proposed development. The APEFZ Act requires that the State establish APEFZ's along well-located, active ("sufficiently active and well-defined") faults, and that local building officials shall not issue development permits for sites within the APEFZ until geologic investigations demonstrate that the sites are not likely adversely affected by surface displacements from future faulting. Typically, "sufficiently active" refers to faults that show evidence of surface displacement within about the last 11,000 years (Holocene Epoch). In addition, current professional standards-of-practice require identification and investigation of photo-lineaments or other geomorphic or geologic features reasonably suggestive of active faulting, whether they be within or outside of existing APEFZ's.

Numerous investigators have previously performed fault studies within the site. However, the LOR Geotechnical, Inc. (LOR, 1994a) study within the Sycamore Canyon area and the adjacent Sycamore Flat area, is the only investigation submitted to the County and State. More recent investigations by GSI (1999a, 1999b, and 2003), in Sycamore Flat indicate that the projected trend of LOR's fault is not justified, for active faulting was demonstrably <u>not</u> identified in LOR's mapped fault zone. Accordingly, there was uncertainty about the location of the LOR fault in Sycamore Canyon. Thus, GSI updates fault/seismic investigations in order to evaluate the LOR-mapped fault in the Sycamore Canyon area.

This investigation is based on geologic data from published technical documents and reports, prior fault investigations, stereoscopic aerial-photograph reviews (Appendix A), and independent photo-lineament analyses. Electronic copies of available, prior fault and geotechnical investigations are also included on a compact disk (CD) enclosed in Appendix A. GSI retained Dr. Roy J. Shlemon, as an independent geologic consultant to date soils (pedogenic profiles) exposed in the trenches, as well as to provide guidance for the investigation (Appendix B). Mr. Michael Mills of Pacific Soils Engineering, Inc. (PSE), provided independent third-party review for the governing agency. Mr. Mills attended field meetings and reviewed site trenches and geomorphology. Trench logging and trench/fault survey locations have been incorporated into this report. Site geologic units are presented on Plate 1 (Geologic Units Map). Trench locations from this and previous investigations, and faults are shown on Plate 2 (Supplemental Fault Setback Map). Both plates have been modified from the 200-scale topographic base map provided by Dawson Surveying, Inc. Trench logs are also included as Plates 3 through 12.

EXECUTIVE SUMMARY

Based on our current geologic analyses, the proposed project is feasible for its intended use, provided the recommendations in this report are properly implemented during planning, design, and construction. The most significant elements of our investigation are summarized below:

1. The site lies within a region of faults known as the San Jacinto fault zone (SJFZ), which is active (i.e., movement within the Holocene Epoch), according to the State of California (Hart and Bryant, 1997). Holocene faults were identified in some trench exposures during our investigation. Habitable structures will require setbacks from active faults, as shown on Plate 2 (Fault Setback Map). We understand that the Client is relying on the LOR (1994a) data in areas of proposed development not investigated by GSI.

2. Joints and dry sand settlement cracks (i.e., no offset or displacement), presumably associated with near-field seismic activity, were documented in a few trenches; however, these features likely can be reasonably mitigated by properly designed, post-tensioned or mat foundations and/or other engineering design.

3. The site is in an area of potentially high seismic activity and horizontal seismic accelerations are anticipated to be near 1g, should the design earthquake occur. Therefore, there is a potential for more onerous, near-field seismic effects (based on the type and size of the seismic source, distance, and geological aspects), and therefore appropriate mitigation, should take place.

4. Historic well-water data (California Department of Water Resources [CDWR], 2006) indicate that regional groundwater depths, recorded between 1919 and 2000 in a well near the study area, have fluctuated between ±19 and ±108 feet below the

surface. Perched water has been observed at the site by other investigators. We also note that perched water may also occur, during and after development, owing to a combination of high rainfall, rapid snowmelt, irrigation runoff and seepage, broken utilities, improper drainage, and relatively impermeable subsoils.

5. We observed local paleoliquefaction features in mid-Holocene and younger sediments, indicating that liquefaction and possible ground deformation has previously occurred onsite. We therefore recommend that additional, site-specific investigations evaluate liquefaction potential, dry sand settlement, as well as other typical geotechnical conditions, such as remedial-removal depths, settlement, engineered and natural slope stability, and design criteria. In view of the site seismic setting and the potential for seismic settlement, post-tensioned and/or mat foundations appear particularly appropriate for this project.

6. Based on our current geological assessments, and excluding proposed setback zones, GSI concludes that active faults (i.e., "sufficiently active" and "well-defined") likely do not exist within the remainder of the property. If present, however, they are of such small displacement to be reasonably mitigated by appropriate engineering design.

7. Major underground or above-ground utility lines should cross active faults at high angles approaching perpendicular. Cut-off valves should be located on both sides of active fault zones to facilitate repair.

8. As a result of strong ground shaking, seiching (periodic oscillation of an enclosed body of water) may occur in any planned lakes (if proposed), potentially topping the confining sides of the lake. Additionally, during a seiche, flooding adjacent to and down-gradient of the lakes (if proposed) may occur.

9. Flooding may also occur during periods of heavy precipitation. The mid- to late-Holocene alluvial sediments at the site were primarily deposited by debris flows emanating from the up-gradient canyon. Therefore, the potential for flooding should be evaluated by the design civil engineer and mitigation should be provided by the design civil engineer and geotechnical consultant, as warranted.

10. Owing to the relatively steep walls of Sycamore Canyon, there is potential for local landslides and rockfalls. Therefore, these potential hazards should be appropriately mitigated.

The opportunity to be of service is sincerely appreciated. If you should have any questions, please do not hesitate to contact the undersigned.

Respectfully submitted,

GeoSoils, Inc.

Ryan Boehmer
Staff Geologist

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RB/JPF/PLM/jk

Distribution: (5) Addressee
(1) Dr. Roy J. Shlemon (CD Only)
(1) Pacific Soil Engineering, Inc., Attention: Mr. Michael Mills

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SUPPLEMENTAL FAULT AND SEISMIC INVESTIGATION
LYTLE CREEK RANCH, NEIGHBORHOOD 1
SYCAMORE CANYON AREA, RIALTO
SAN BERNARDINO COUNTY, CALIFORNIA

SCOPE OF SERVICES

The primary purpose of this fault and seismic investigation was to confirm or refute the existence and accuracy of the approved fault zones mapped by LOR (1994a), in accordance with current techniques accepted by State and County guidelines (Hart and Bryant, 1997; and County of San Bernardino, 1984). The scope of our services included the following:

1. Review existing, site-specific and regional geologic data (Appendix A), including stereoscopic "false-color" infrared and black-and-white aerial photographs, and analyze associated photo-lineaments. Pertinent available reports by GSI and other investigators, within and adjacent to the site, are provided on the CD in Appendix A.

2. Geologic and geomorphic site reconnaissance. Site geologic units are presented on Plate 1 (Geologic Units Map). Exploratory trenches by GSI and others, faults, recommended fault setback zones, and aerial-photographic lineaments are presented on Plate 2 (Supplemental Fault Setback Map).

3. Subsurface exploration consisting of geologic logging of seven fault-finding/dating and/or locating trenches totaling approximately 1,780 linear feet. Trenches by GSI and previous investigators are shown on the Supplemental Fault Setback Map (Plate 2). The logs of the GSI trenches are included as Plates 3 through 12.

4. Attending field meetings and reviewing site geologic and geomorphic conditions with the Quality Assurance Reviewer, Dr. Roy J. Shlemon and independent third-party reviewer, Mr. Michael Mills of PSE. A general geomorphic and soil-stratigraphy report by Dr. Shlemon is provided as Appendix B, as are radiometric dates.

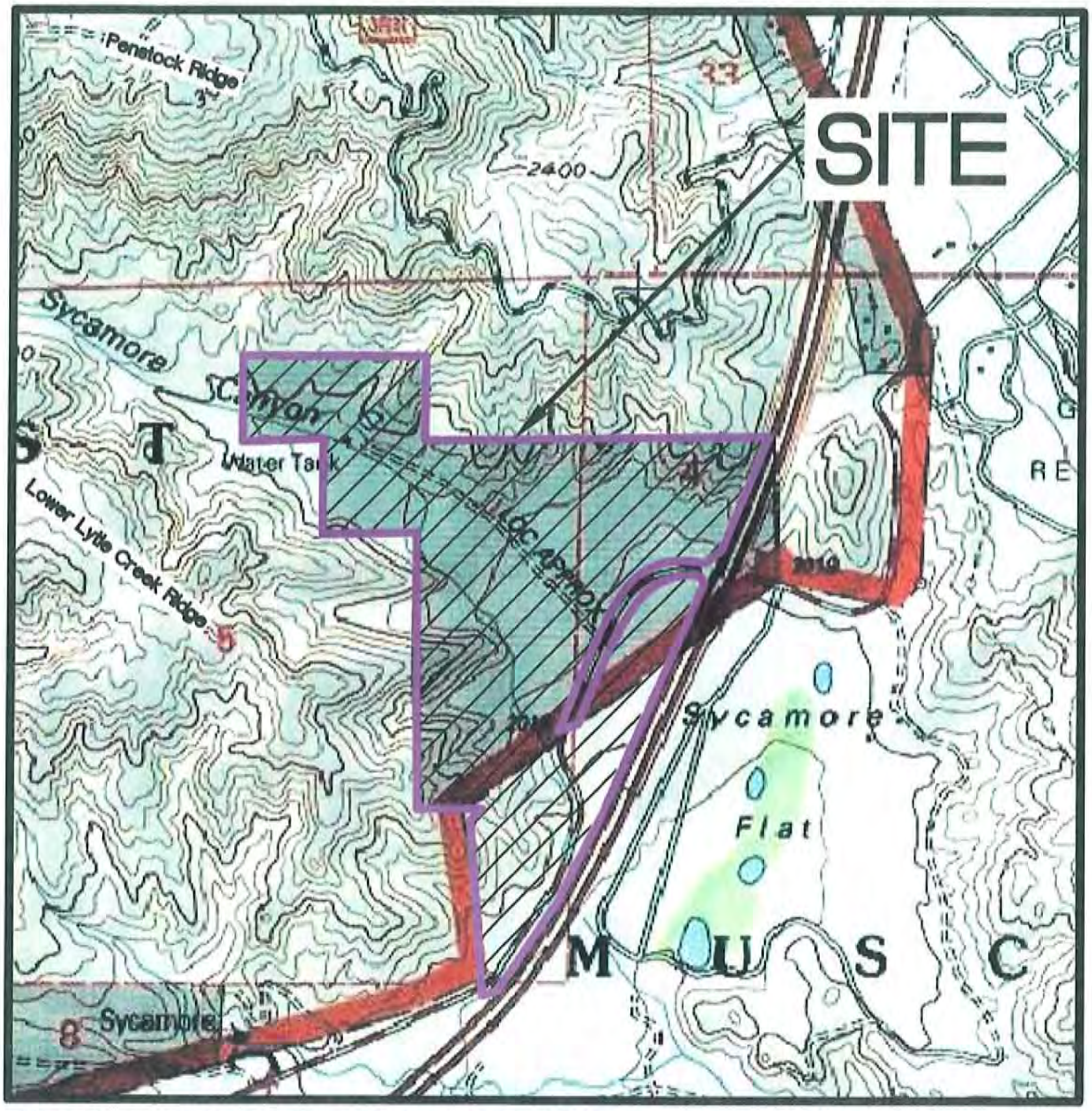
5. Deterministic, historical and probabilistic seismic analyses (Appendix C).

6. Geologic and geomorphic analysis of the data collected.

7. Preparation of this report and accompanying documents.

SITE DESCRIPTION AND CONDITIONS

The site is located within the Sycamore Canyon area of Neighborhood 1 is part of the "Lytle Creek Ranch"Project. It is irregularly-shaped, totaling ±146 acres in the Rialto area of San Bernardino County, California (see the Site Location Map, Figure 1). The project area occupies a portion of Sycamore Canyon and adjacent of Sycamore Flat, located



Base Map from U.S.G.S., dated 1997, current 1999, ©2005.

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SITE LOCATION MAP

Figure 1

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generally west of Interstate 15. Sycamore Canyon is located between Lytle Creek Ridge and Penstock Ridge (Figure 1). The project area is characterized by relatively steep hillsides with gradients of ~1.5:1 horizontal:vertical (h:v), or flatter, that descend into a southeastern-sloping, canyon floor with gradients less than about 3:1 h:v. An abandoned water tank was observed along the north wall of the canyon near the northwestern property boundary.

Site drainage is accommodated by sheetflow along hillsides directed toward tributary canyons that empty into emphermal drainages and ultimately discharge into Lytle Creek Wash to the southeast. Overall drainage of the site is predominately northwest to southeast.

Site elevations range from about 2,330 feet, in the northern portion of the site to about 1,968 feet, in the southern part, for an overall relief of about 362 feet. Vegetation consists of low growth weeds, grasses, bushes, and a few trees.

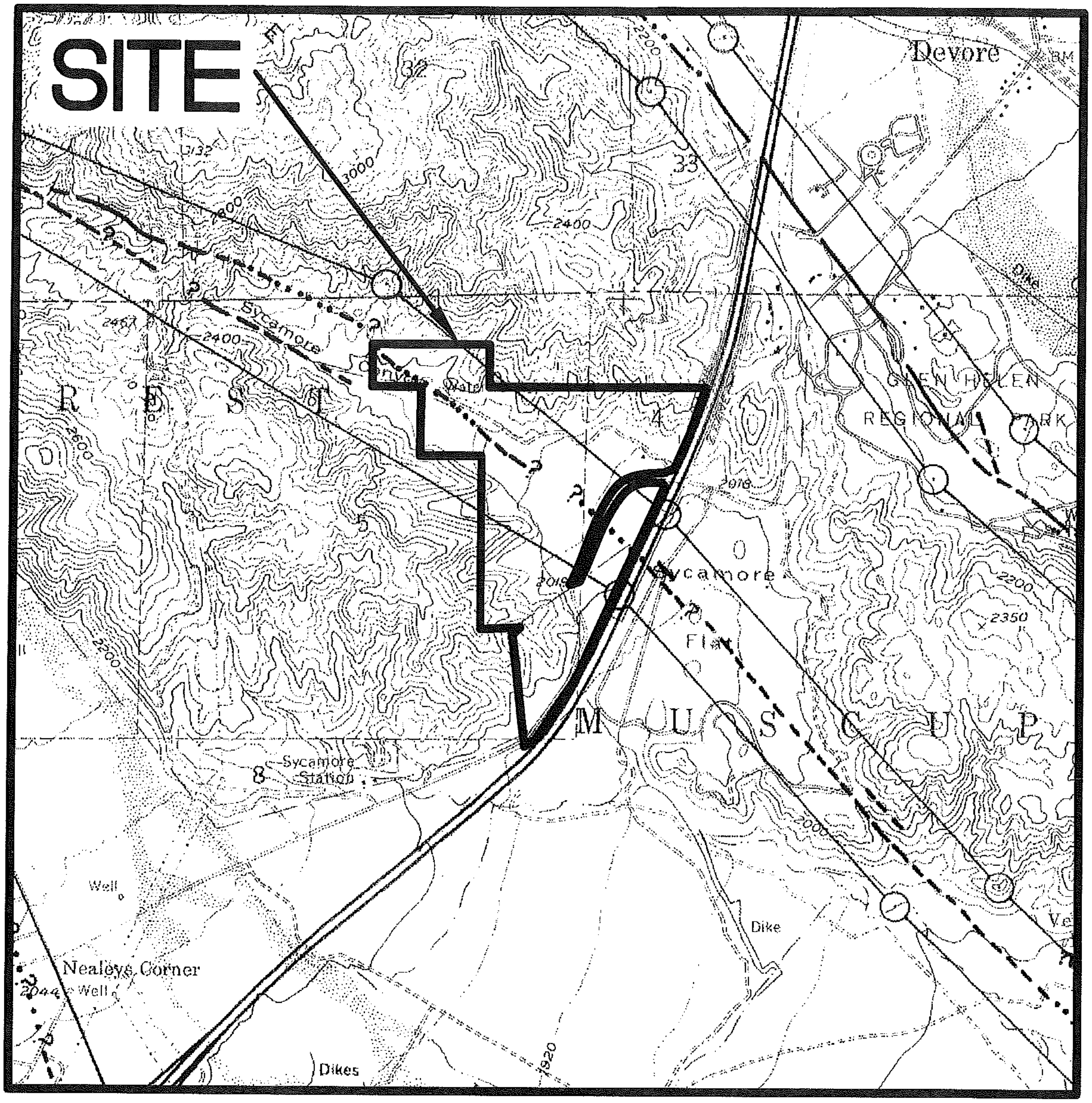
PROPOSED DEVELOPMENT

Preliminary conceptual land use plans by EDAW/AECOM (400-scale plans dated December 11, 2006), indicate that proposed site development is a combination of residential, mixed-use, and open-space applications. Of the 146 total acres, 50 will be devoted to residential development and 12 to mixed-use development. The remaining 84 acres will be open-space. Based upon our review of the preliminary conceptual land use plans, hillside development is not anticipated at this time. If any changes are made to this plan, additional geologic review may be necessary.

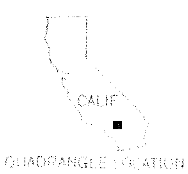
We understand that proposed buildings will be one- and/or two-story residential and commercial structures, utilizing typical wood-frame and/or tilt-up construction with slabs-on-grade and continuous footings and/or post-tension/structural mat slabs. Building loads are assumed to be typical for this type of relatively light construction. Sewage disposal is assumed to be accommodated by tying into the regional municipal system. The need for import soils is presently unknown.

DEFINITIONS

Portions of the site lie in an Alquist-Priolo Earthquake Fault Zone (Special Publication 42 [see Figure 2]), and pertinent definitions are appropriate. Special Publication 42 (Hart and Bryant, 1997), state: "A *fault* is defined as a fracture or zone of closely associated fractures along which rocks on one side have been displaced with respect to those on the other side." Hart and Bryant (1997) also indicate that: "an *active fault* is defined by the State Mining and Geology Board as one which has 'had surface displacement within Holocene time (about the last 11,000 years).'" Similarly, Neuendorf, *et al.* (2005) define a *fault* as: "A



Base Map from State of California, 1995.



2000 FEET

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GeoSoils, Inc.		RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.
EARTHQUAKE FAULT ZONE MAP		
		Figure 2
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discrete surface or zone of discrete surfaces separating two rock masses across which one mass has slid past the other." Accordingly, the key criterion for determining whether a feature is a fault, is shear displacement. Fractures (including joints and cracks) with no shear displacement, are therefore, by definition, not classified as faults. Neuendorf, *et al.* (2005) also define a *joint* as: "A planar fracture, crack, or parting in a rock, without shear displacement...." A *crack* is defined by Neuendorf, *et al.* (2005) as: "A parting with crack-normal motion."

Further, for purposes of State definitions, faults should be "sufficiently active" and "well-defined" (Hart and Bryant, 1997). As summarized by Hart and Bryant (1997), "the more recent the faulting, the greater the probability for future faulting." The State also notes that, "A fault is deemed sufficiently active if there is evidence of Holocene surface displacement along one or more of its segments or branches....." and "A fault is considered well-defined if its trace is clearly detectable by a trained geologist as a physical feature at or just below the ground surface." Surface is defined by Neuendorf, *et al.* (2005) as: "... top of the ground...." The critical consideration by the State is that the fault, or some part of it, can be located in the field with sufficient accuracy and confidence to indicate that the required site-specific investigations would meet with some success.

If a fault that clearly demonstrates Holocene activity crosses an area proposed for human occupancy, the State of California requires an appropriate setback distance. This distance depends on uncertainty in fault character and trend. Thus, several closely spaced, well-documented trenches, may provide sufficient geologic information to reduce setbacks to ~10 feet. In contrast, faults that step, flower upward or have other "uncertain" characteristics, require a greater setback distance. The setback distance is therefore determined by the geologist based mainly on site-specific data and sound professional judgement. A *structure for human occupancy* is defined by Hart and Bryant (1997) "as any structure used or intended for supporting or sheltering any use or occupancy, which is expected to have a human occupancy rate of more than 2,000 person-hours per year."

FIELD STUDIES AND INVESTIGATIVE PROCEDURES

Consistent with present, professional standards-of-practice, our field studies consisted of the following:

1. Geologic and geomorphic site reconnaissance.

2. Review of pertinent literature.

3. Aerial-photographic lineament analysis.

4. Subsurface exploration consisting of the geologic logging of seven fault-finding/dating and/or locating trenches totaling approximately 1,780 linear feet. Trench locations and controlling faults, and faults exhibiting the largest vertical displacements in each trench were surveyed. The trenches have been backfilled with compacted fills in accordance with industry guidelines (GSI, 2007).

5. Field meetings and assessment of site geologic and geomorphic conditions with Dr. Shlemon and the independent third-party reviewer, Mr. Michael Mills of PSE.

The GSI fault trenches were logged by geologists from our firm. The trench locations and fault setback zones are indicated on Plate 2. Logs of the GSI trenches are presented as Plates 3 through 12. Dr. Shlemon's soil age-dating report as well as radiocarbon data by Beta Analytic, Inc. are provided as Appendix B.

Geologic and Geomorphic Site Reconnaissance

Prior to commencing field work, we reconnoitered general site geologic and geomorphic conditions. This reconnaissace noted features possibly indicative of faulting that warranted placement of trenches.

Review of Pertinent Literature

Readily available soils, geologic (including previous fault investigations performed at the site), hydrogeologic, and related literature were reviewed to evaluate prior work that could bear on proposed explorations. Cited references are listed in Appendix A. A compact disk, including available geologic reports by GSI and other investigators that pertain to this investigation, is provided in Appendix A.

Aerial-Photographic Lineament Analysis

A lineament analysis identified possible unmapped faults and evaluated topographic expressions of published fault traces. Stereoscopic "false-color," infrared aerial photographs at a scale of approximately 1:40,000 and stereoscopic black-and-white aerial photographs at a scale ranging from approximately 1:12,000 to 1:24,000 were utilized for the analysis.

We classified lineaments as strong, moderate, or weak. A strong lineament is a well defined feature that is traceable from several hundred to a few thousand feet. A moderate lineament is less well defined, somewhat discontinuous, and can be traced for only a few hundred feet. A weak lineament is discontinuous, poorly defined, and can be traced for less than a few hundred feet.

Several weak to strong photo-lineaments were observed within the study area and are indicated on Plate 2. The trends of these photo-lineaments are sub-parallel with the SJFZ and therefore, were previously investigated by LOR (1994a) or by our new trenches. Where intercepted by our trenches and the LOR (1994a) trenches, these lineaments were not associated with any active faulting. Rather, unbroken sediments were documented. Owing to the young, low-lying near-surface alluvial sediments in this particular area, the lineaments in this terrain most likely reflect Holocene and historic flooding channels, and thus are not indicators of active faults.

Subsurface Exploration

Based on review of LOR (1994a) and aerial-photographic lineament analysis, initial fault-finding trenches covered the mapped zone of faulting. Based on the trench exposures, additional trenches were subsequently excavated. Trench spacing and geologic extrapolation of data (see Plate 2), generally conformed with the criteria of the County of San Bernardino (1984). A photograph of a typical trench is attached as Figure 3. The type of excavating equipment used for this investigation is displayed in Figure 4. The trench locations are shown on Plate 2, and logs of the GSI exploratory trenches are provided as Plates 3 through 12.

Outside Consultation

The trenches were observed by Dr. Shlemon who provided independent geologic consultation and guidance for investigative techniques. Although not requested to provide detailed soil-stratigraphic measurements and documentation, Dr. Shlemon observed the general stratigraphy, identified the relative development of buried paleosols, and provided estimates of sediment age, which were later corroborated by radiocarbon assay. A quality assurance assessment report by Dr. Shlemon, including the radiocarbon dating test results, is provided in Appendix B.

Sediment Dating

Relative age-dates of alluvial soils exposed in our trenches were initially obtained in the field based on soil-stratigraphic assesements. Our exploratory trenches exposed "slightly developed" buried paleosols, typically identified by a slight change in color (Bw; cambic horizons), that truncated underlying stratified deposits. Often four to five soil-stratigraphic markers were present. Based on the grain size (relative permeability) of the sediments and probable soil climate, Dr. Shlemon estimated each Bw horizon represents no more than approximately 1,500 to 2,000 years of weathering. Thus, from a relative dating standpoint, the ~25-foot deep trenches exposing multiple paleosols suggest that trench sediments are not likely older than mid-Holocene.

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Typical fault trench for this investigation (FT-201, view is to the southwest [see Plate 2]). Bench heights are about 5 feet.

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SITE PHOTOGRAPH

Figure 3

DATE 2/2007 | W.O. NO. 5278-A-SC

Geotechnical · Geologic · Coastal · Environmental

Excavating equipment used for this investigation (HITACHI 450).

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SITE PHOTOGRAPH

Figure 4

DATE 2/2007	W.O. NO. 5278-A-SC

Geotechnical · Geologic · Coastal · Environmental

After initial soil-stratigraphic age assessments, we obtained charred wood fragments from Trench FT-202 (Plates 2 and 6). Sample 2, collected at Station No. 136, approximately 24½ feet below the surface (or about 1 foot above the trench bottom), yielded an uncorrected radiocarbon date of 4,560 ±40 years before present (Appendix B). Because all trenches were excavated to similar depths and the alluvial stratigraphy readily correlated between trenches, the age of the exposed sediments is no older than mid-Holocene.

REGIONAL GEOLOGIC SETTING

General

Sycamore Canyon is located near the southeast corner of the Transverse Ranges Geomorphic Province. This province is characterized by a conspicuous east-west alignment of steep mountain ranges and valleys that contrast in trend, to most mountain ranges in North America (Norris and Webb, 1990). Characteristics of the Transverse Ranges Geomorphic Province include major mountain ranges with intervening alluviated, broadly synclinal valleys and narrow stream canyons. It is bounded by the Mojave Desert Geomorphic Province to the north and northeast, by the Coast Ranges Geomorphic Province to the north and northwest, by the Colorado Desert Geomorphic Province to the southeast, by the Peninsular Ranges Geomorphic Province to the south and by the Continental Borderlands Geomorphic Province to the west. The Transverse Ranges extend about 320 miles (520 kilometers) from Point Arguello and San Miguel Island on the west to the mountains of Joshua Tree National Forest on the east. At its widest point, the province is about 60 miles (96 kilometers) across. Intense north-south compression has resulted in rapid uplift of this region (California Geological Survey [CGS], 2002).

The province subdivides into several individual ranges with intervening valleys. The major subdivisions are generally divided into the Santa Ynez Mountains, Central Ventura County Mountains, Santa Ana Mountains, Ventura/Soledad Basin, Ridge Basin, San Gabriel Mountains, Los Angeles Basin, San Bernardino Mountains, and the Eastern Boundary Ranges. The site is located within the San Gabriel Mountains subdivision; a high rugged block located between the Los Angeles Basin and the Mojave Desert (Norris and Webb, 1990). This block is bounded on the east by the San Andreas fault as it traverses through Cajon Pass, by the Sierra Madre and Cucamonga faults to the south, by the Soledad Basin to the west, and by the San Fernando Valley to west. This range forms a 60-mile (96-km) long by 24-mile (39-km) wide, continuous feature. Because the San Gabriel Mountains have undergone considerable uplift in recent geologic time, they have become a deeply dissected, rugged horst (Norris and Webb, 1990) with deep, steep-sided stream canyons, high peaks (up to 10,080 feet), and steep flanks. A regional geologic map has been adopted from Morton and Matti (2001), and is provided as Figure 5.

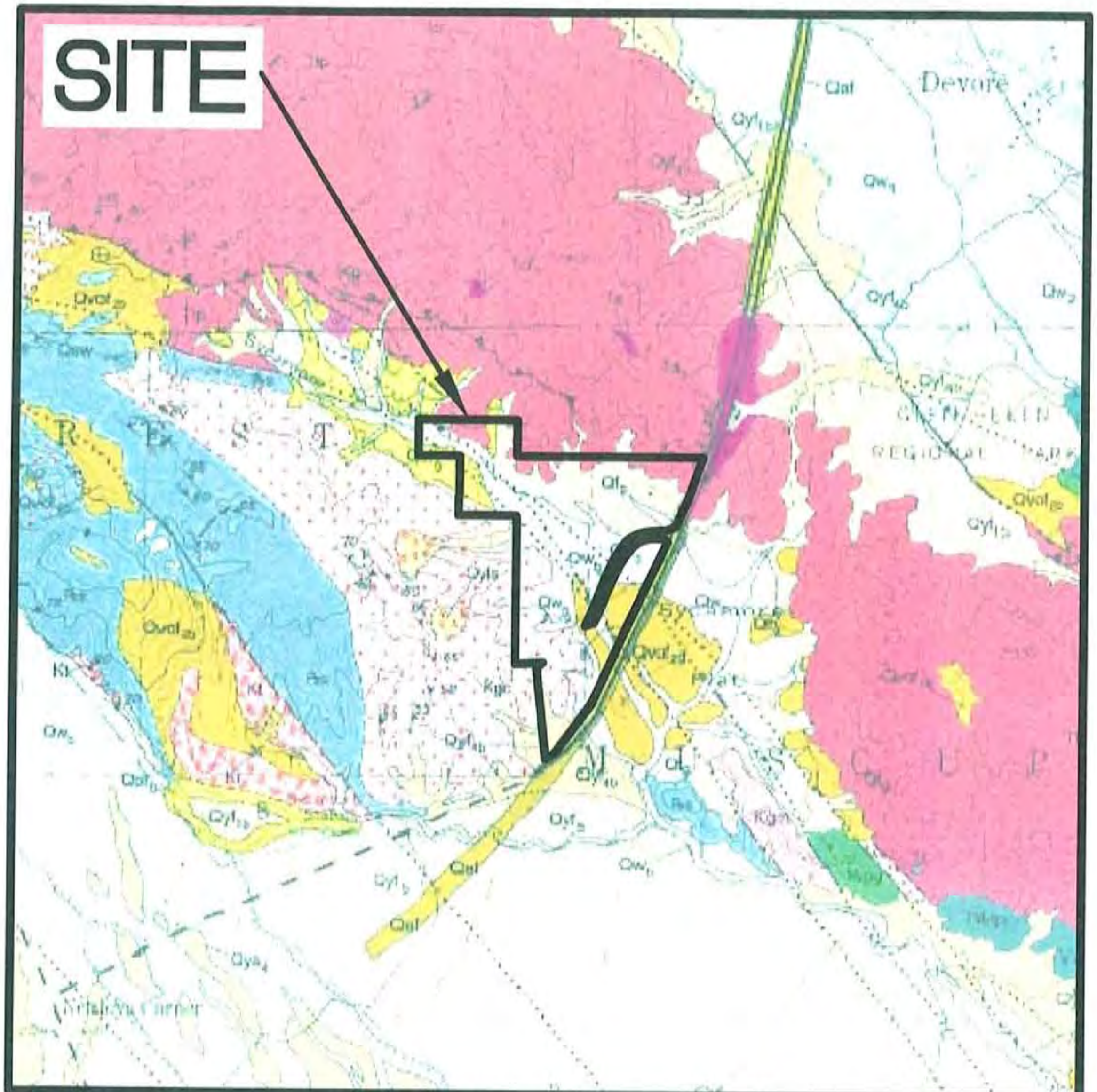
Basement Rocks

Basement rocks in the vicinity of the site include those of the Peninsular Ranges, San Gabriel Mountains, and San Bernardino Mountains types. These rocks vary in composition, age, and deformational styles.

Matti and Morton (1993) describe basement rocks of the Peninsular Ranges as Jurassic and Cretaceous granitoid rocks (granodiorite, quartz diorite, tonalite, gabbro) that have intruded prebatholithic metasedimentary rocks (pelitic schist, metaquartzite, marble, quartzofeldspathic gneiss, and schist). The Peninsular Ranges block is bordered by a mylonitic belt of ductile deformation, along its north and northeast margins, that separates lower plate Peninsular Ranges plutonic and metasedimentary rocks from broadly similar upper plate rocks.

Basement rocks of the San Gabriel Mountains consist of an eastward-elongated, parallelogram-shaped area of crystalline basement rocks. In the late Cenozoic, these rocks were elevated between the San Andreas and related faults, along its northern margin, and against the Mojave Desert, the San Gabriel Mountains, and related faults on its southern margin (adjacent the coastal lowlands of the Los Angeles area). The greatest amount of uplift was by northward tilt on the north-dipping reverse faults, along its southern margin (Dibblee, 1982b). As discussed by Matti, *et al.* (1992), basement rocks of the San Gabriel Mountains type include of two crustal layers separated by the Vincent thrust fault. The upper plate contains Mesozoic plutons of various compositions, ages, and deformational styles that have intruded prebatholithic crystalline rocks. The lower plate of the Vincent thrust consists of the Pelona Schist (late Mesozoic quartzofeldspathic sandstone and siltstone, limestone, quartzite, chert, and mafic volcanic rocks) that have been metamorphosed to greenschist and lower amphibolite facies, presumably during late Mesozoic to early Tertiary emplacement of the upper plate.

Basement rocks of the San Bernardino Mountains type are similar to those in the Mojave Desert Geomorphic Province: mainly Triassic through Cretaceous granitoid rocks of various compositions that have intruded prebatholithic orthogneiss and metasedimentary rocks. Similar to rocks in the San Gabriel Mountains, those of the San Bernardino Mountains may be a layered terrane with upper plate, batholithic and prebatholithic rocks separated from lower plate, Pelona Schist by a low-angle fault comparable to the Vincent thrust (Matti and Morton, 1993). A map of Geologic Terranes is provided as Figure 6 from Matti, *et al.* (1992).



Base Map from Morton and Matti, 2001, scale 1:24,000.

LEGEND

Symbol	Description
Qw2	Quaternary modern wash deposits - Unit 2
Qf1	Quaternary modern alluvial fan deposits - Unit 1
Qyf4	Quaternary young alluvial fan deposits - Unit 4
Qof3	Quaternary old alluvial fan deposits - Unit 3
Qvof2	Quaternary very old alluvial fan deposits - Unit 2
Ttp	Tertiary Granodiorite of Telegraph Peak
Kgl	Cretaceous mylonitic leucogranite

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REGIONAL GEOLOGIC MAP

Figure 5

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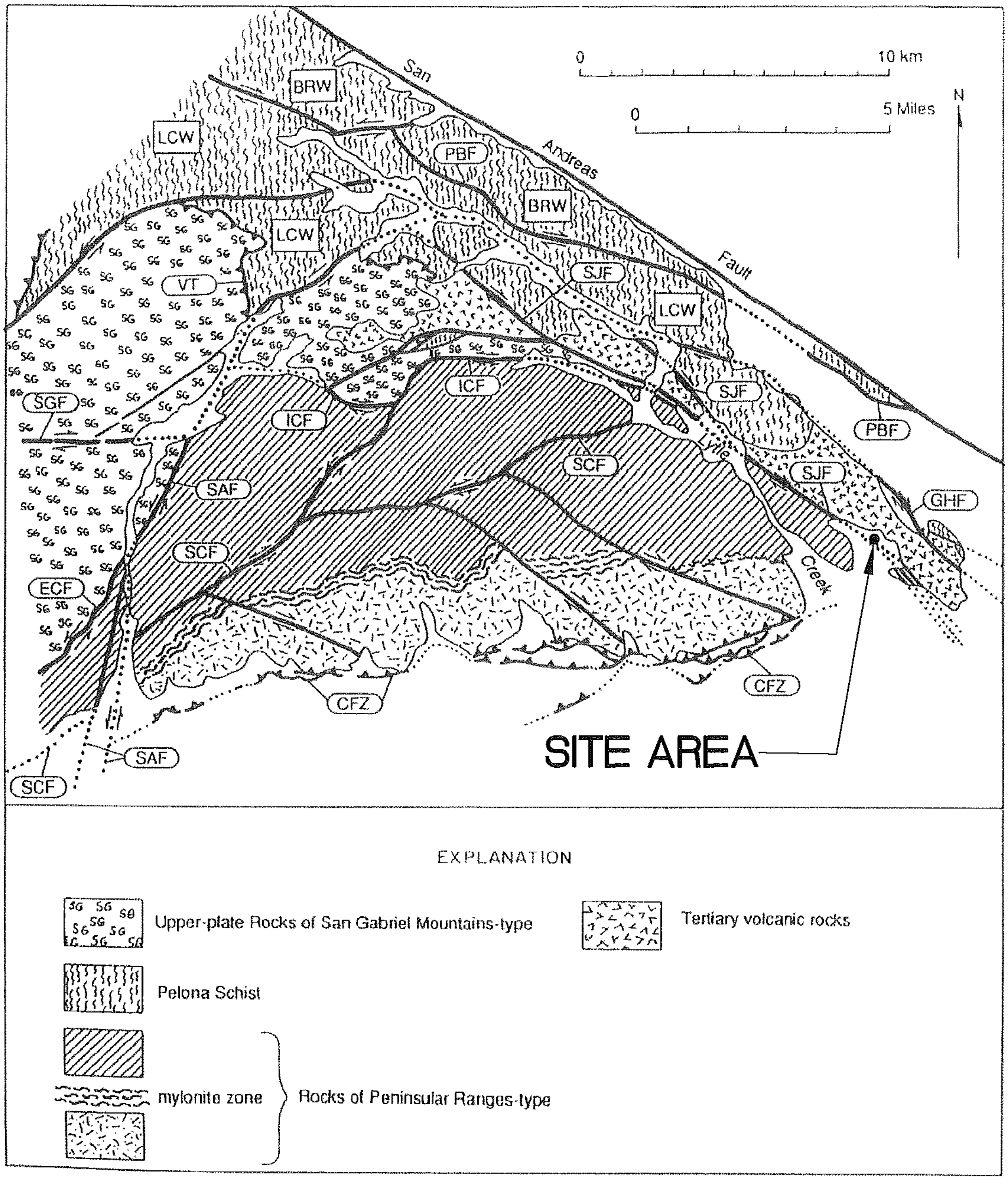

Distribution, geologic relations, and nomenclature of geologic terranes and Neogene faults in the southeastern San Gabriel Mountains (modified from Morton, 1975a, figs. 1,2). BRW, Blue Ridge Window of Pelona Schist; CFZ, Cucamonga fault zone; ECF, Evey Canyon fault; GHF, Glen Helen fault; ICF, Icehouse Canyon fault; LCW, Lytle Creek window of Pelona Schist; PBF, Punchbowl fault; SAF, San Antonio fault; SCF, Stoddard Canyon fault (includes San Gabriel fault [south branch] west of the San Antonio fault); SGF, San Gabriel fault (north branch); SJF, faults traditionally referred to the San Jacinto fault; VT, Vincent thrust.

Base Map from Matti et al., 1992.

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GEOLOGIC TERRANES MAP		
		Figure 6
W.O. 5278-A-SC	DATE 02/07	SCALE Bar Scale

SITE TECTONIC FRAMEWORK

The San Andreas Fault Zone

The Sycamore Canyon area of the proposed Neighborhood 1 lies within the San Jacinto fault zone; a major active component of the San Andreas fault system. The SAFZ extends into California at Point Arena, north of San Francisco, southeast through and along the Coast Ranges to the Transverse Ranges where it bends obliquely across the Cajon Pass-San Gorgonio Pass region. Southward, north and south branches along with the Banning fault, diverge southeast into the Salton trough (Sharp, 1975), as illustrated on the California Fault Map (Figure 7).

The SAFZ is relatively straight and continuous throughout much of its length in California, and these characteristics are hallmarks of steeply dipping strike-slip faults throughout the world. The San Jacinto fault, part of the San Andreas transform-fault system, trends southeastward to the Gulf of California from the nearby Cajon Pass area (Crowell, 1975). Matching displaced rocks on the sides of the combined faults indicates that right slip began in the Miocene, about 12 million years ago. Other studies (Matti, *et al.*, 1992) indicate the inception of the modern San Andreas fault occurred 4 or 5 million years ago in latest Miocene to early Pliocene time. Movement on the San Andreas fault zone continues to the present. As summarized by Matti, *et al.* (1992), the traces of most recent movement on the San Andreas fault are commonly along discontinuous en-echelon strands.

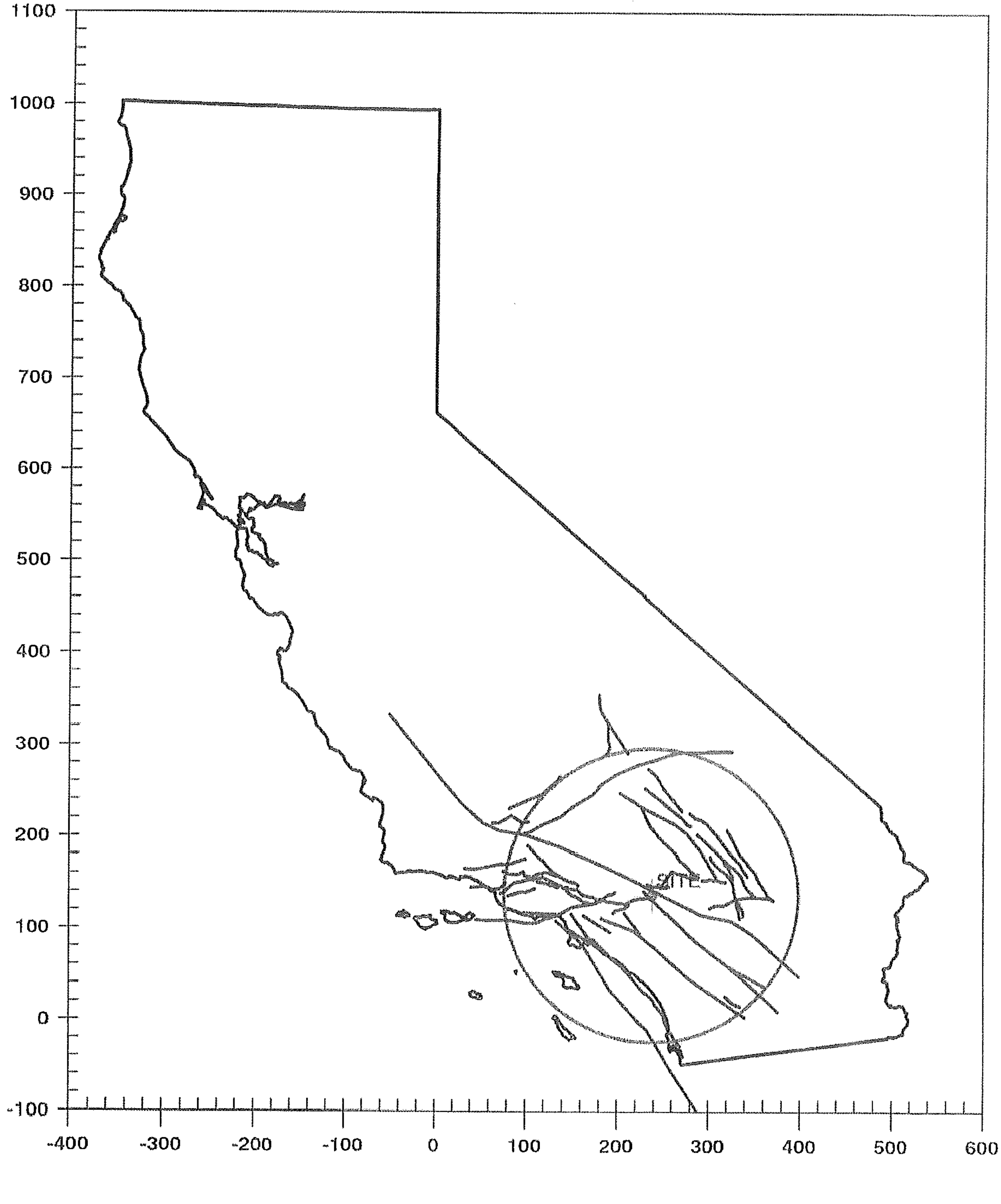
Matti, *et al.* (1992), also note that in central California, displacement is mainly along the San Andreas fault proper. In southern California, however, the total displacement is taken up by several discrete fault strands, including the San Andreas, San Jacinto, Punchbowl, San Gabriel, and Banning faults, as well as other structures (Matti and Morton, 1993). The average slip rate on the SAFZ in the general region has been about 15 mm/yr. In contrast, the southern branch (Coachella segment) of the SAFZ has an average slip rate of 23 to 35 mm/yr near Indio, and 5 to 14 mm/yr on the southern-most SAFZ (Keller, *et al.*, 1982; Shifflett, *et al.*, 2002). The Mojave segment has an average slip rate of about 35 mm/yr.

The California Geological Survey ([CGS], 1996 and 2003) judge the slip rate on the San Bernardino segment of the San Andreas fault, near the site, is about 24 mm/yr. Recurrence intervals for large earthquakes of about ~M7.0 to M8.0 generating surface rupture average are about 433 years for this San Bernardino segment (CGS, 1996). Historical records do not indicate any ~M7.0 to M8.0 earthquakes on this strand.

Matti, *et al.* (1992) view the Quaternary tectonic framework of the central Transverse Ranges north of the site as responding to an evolving left step in the San Andreas transform-fault system. During latest Quaternary time, right-slip on the SAFZ stepped left from the northern Coachella Valley segment, west to the Banning fault and thence into San Gorgonio Pass, where right-slip is absorbed by convergence with the San Gorgonio Pass

CALIFORNIA FAULT MAP

LYTLE DEVELOPMENT COMPANY



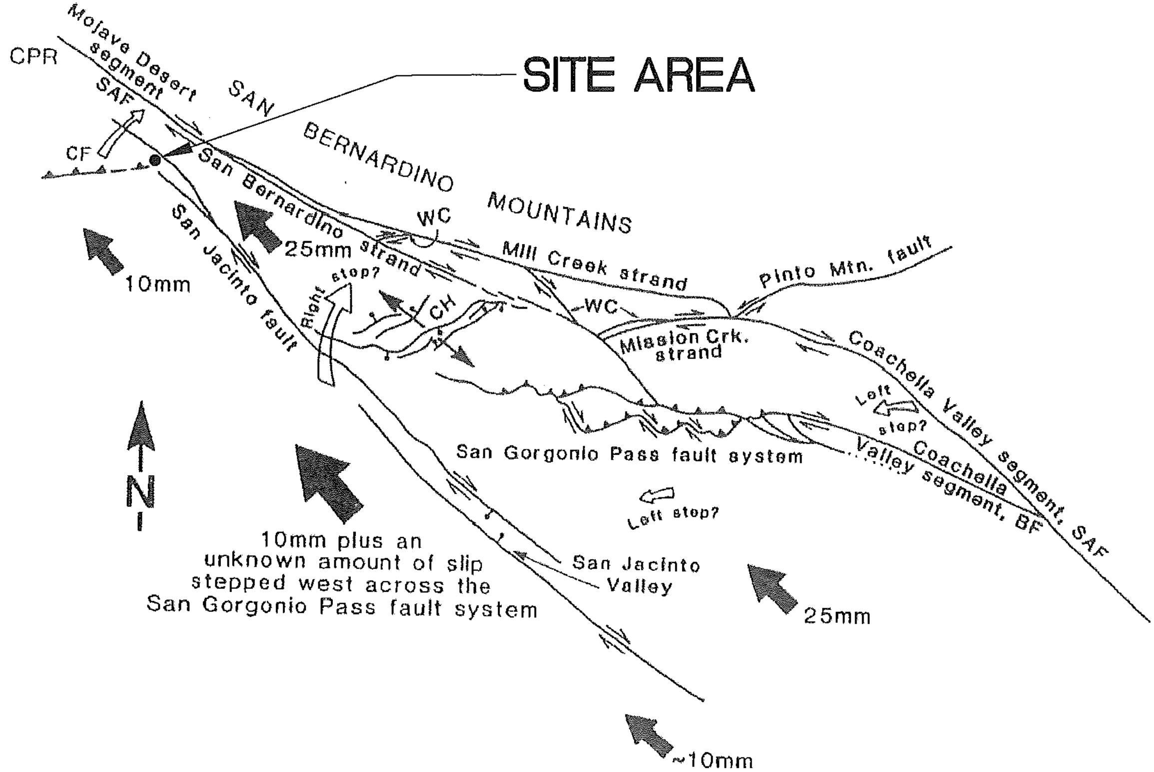
fault zone. Some slip may step farther west to the San Jacinto fault zone near the San Jacinto Valley, where accelerated right-slip may have contributed to subsidence of the San Jacinto graben. Ultimately, slip steps back from the San Jacinto fault to the modern San Andreas fault, giving rise to the San Bernardino strand by reactivation of the Mission Creek fault. This right step has created a right-lateral shear couple and extensional strain field in the greater San Bernardino Valley, where extension gives rise to normal dip-slip faults as in the Crafton Hills horst-and-graben complex (Matti, *et al.* 1992). This is illustrated on Figure 8, "Relations between Faults and Crustal Blocks."

San Jacinto Fault Zone

The San Jacinto fault zone (SJFZ) forms several en-echelon faults among its member strands. The Glen Helen-Claremont and Claremont-Casa Loma fault pairs (Figure 9) probably define zones of shallow crustal extension or elongation beneath San Bernardino and San Jacinto, respectively (Sharp, 1975). The San Jacinto fault zone contrasts strongly with the SAFZ with respect to the continuity of its strands, even though the zone as a whole is mostly linear. Not only are en-echelon fault relations more numerous along the San Jacinto fault zone, but also the length of individual strands, in en-echelon pairs, and the distance between the overlapping elements are both much larger than those described along the San Andreas (Sharp, 1975), possibly indicating a higher level of activity.

The Claremont fault is clearly the dominant trace of the San Jacinto fault zone immediately southeast of San Bernardino Valley (Figure 9). At the north edge of the valley, the zone includes two major strands, one nearly on line with the Claremont fault, and the other, called the Glen Helen fault (Sharp, 1975). Between the San Jacinto Valley and the San Gabriel Mountains, the San Jacinto fault zone traverses Quaternary alluvial units and sedimentary rocks. The Glen Helen fault has scarps and sag ponds in young Holocene alluvium at the northern edge of the valley whereas, the Claremont fault does not. This suggests that transfer of displacement by crustal extension between en-echelon fault pairs might be occurring (Sharp, 1975). Southeast of San Bernardino, the main trace displaces Quaternary units, but southeast and northwest of this break the youngest floodplain deposits of the Santa Ana River and Cajon and Lytle Creeks are not broken (Matti, *et al.*, 1992).

Matti, *et al.* (1992) indicated the name "San Jacinto" traditionally has been applied to a northwest-oriented fault zone developed in crystalline rocks east of the mouth of Lytle Creek canyon (Figures 5 and 6). There, the zone consists of two or more, vertically oriented, closely spaced faults with shear zones in crystalline bedrock up to 300 meters wide. These however, do not displace Quaternary deposits (Morton and Matti, 1987). Eastward (Figure 9), the Glen Helen fault forms scarps and sag ponds in probable Holocene alluvial deposits (Sharp, 1975; Matti and Morton, 1993). To the west, the Lytle Creek fault forms a scarp in latest Pleistocene alluvium (Morton and Matti, 1987). Metzger and Weldon (1983) indicated a late Quaternary right-slip rate of about 2 mm/yr for the Lytle Creek fault. Matti, *et al.* (1992), postulate that the Glen Helen fault is probably the active strand of the SJFZ in the San Gabriel Mountain region.



Schematic diagram illustrating relations between faults and crustal blocks in the vicinity of the south-central Transverse Ranges. Large solid arrows indicate the relative motion of crustal blocks; large hollow arrows indicate lateral transfer of slip. Small solid arrows indicate crustal extension in the Crafton Hills horst-and-graben complex. BF, Banning fault; CF, Cucamonga fault; CH, Crafton Hills; CPR, Cajon Pass region; SAF, San Sandreas fault; WC, Wilson Creek strand, San Andreas fault. Ten millimeters of annual slip on the San Jacinto fault is assumed from data of Sharp (1981).

Base Map from Matti et al., 1992.

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RELATIONS BETWEEN FAULTS AND CRUSTAL BLOCKS		
		Figure 8
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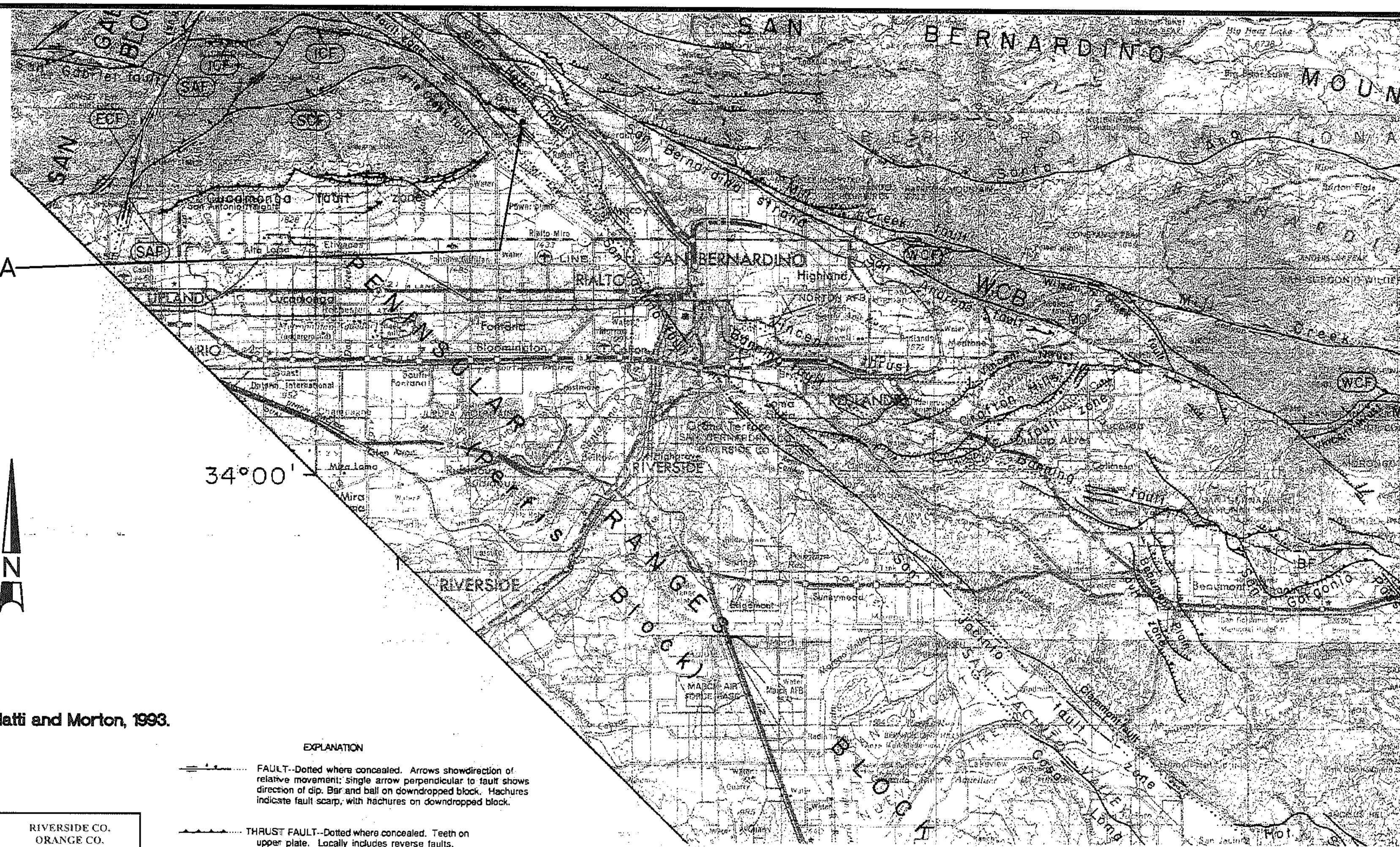


Base Map from Matti and Morton, 1993.

EXPLANATION

FAULT--Dotted where concealed. Arrows showdirection of relative movement; single arrow perpendicular to fault shows direction of dip. Bar and ball on downdropped block. Hachures indicate fault scarp, with hachures on downdropped block.

THRUST FAULT--Dotted where concealed. Teeth on upper plate. Locally includes reverse faults.

BF	Banning fault	SCF	Stoddard Canyon fault
ECF	Evey Canyon fault	SPF	Squaw Peak fault
ICF	Icehouse Canyon fault	WCB	Wilson Creek block
MC	Mill Creek	WCF	Wilson Creek fault
SAF	San Antonio fault	VT	Vincent thrust

Scale 1:250,000

5 0 5 10 15 20 Statute Miles

5 0 5 10 15 20 25 30 Kilometers

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS
TRANSVERSE MERCATOR PROJECTION

GeoSoils, Inc. RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.

DISTRIBUTION AND GEOLOGIC RELATIONS OF FAULT SYSTEMS IN THE VICINITY OF THE CENTRAL TRANSVERSE RANGES, SOUTHERN CALIFORNIA

Figure 9

W.O. 5278-A-SC	DATE 02/07	SCALE Bar Scale

Morton and Matti (1987) also concluded that the San Jacinto fault cannot be mapped into either the Punchbowl or San Andreas faults; instead, faults attributed to the San Jacinto fault zone splay into several branches that curve west into the San Gabriel Mountains without joining the San Andreas fault at the surface (Matti, *et al.*, 1992). Matti, *et al.* (1992) proposed that the east- to northeast-oriented Evey Canyon, Icehouse Canyon, and Stoddard Canyon faults (Figure 9) are segments of through-going structures that were regionally connected in the past, namely the middle Miocene, left-lateral Malibu Coast-Raymond-Banning fault and the late Miocene San Gabriel-Banning fault. They further believe that these older faults separate rocks of San Gabriel Mountains-type on the west, north, and east from rocks of Peninsular Ranges type on the south. These structures trend essentially eastward until they enter the Lytle Creek drainage, where they converge and trend southeastward down Lytle Creek Canyon. There, they are represented by the fault zone that occurs east of the mouth of Lytle Creek Canyon. They also concluded that the name "San Jacinto fault" in Lytle Creek Canyon has been applied to an ancient fault zone that has witnessed multiple episodes of strike-slip faulting, only the latest of which can be attributed to the so-called "San Jacinto" that traverses the Peninsular Ranges Province to the southeast (Matti, *et al.*, 1992). Matti and Morton (1993) proposed that the "San Jacinto fault" in Lytle Creek Canyon was once part of the previously discussed middle Miocene left lateral Malibu Coast-Raymond-Banning fault and the late Miocene San Gabriel-Banning fault. Here these faults shared their sequential left- and right-slip histories, in addition to episodes of Quaternary right slip related to the San Jacinto fault farther south in the Peninsular Ranges.

The "San Jacinto fault zone," where it penetrates the southeastern corner of the San Gabriel Mountains near the mouth of Lytle Creek, consists of three near vertical faults (Matti and Morton, 1993). Soils offset by the Lytle Creek fault are reportedly in the 50,000 to 60,000 years old range (Metzger and Weldon, 1983).

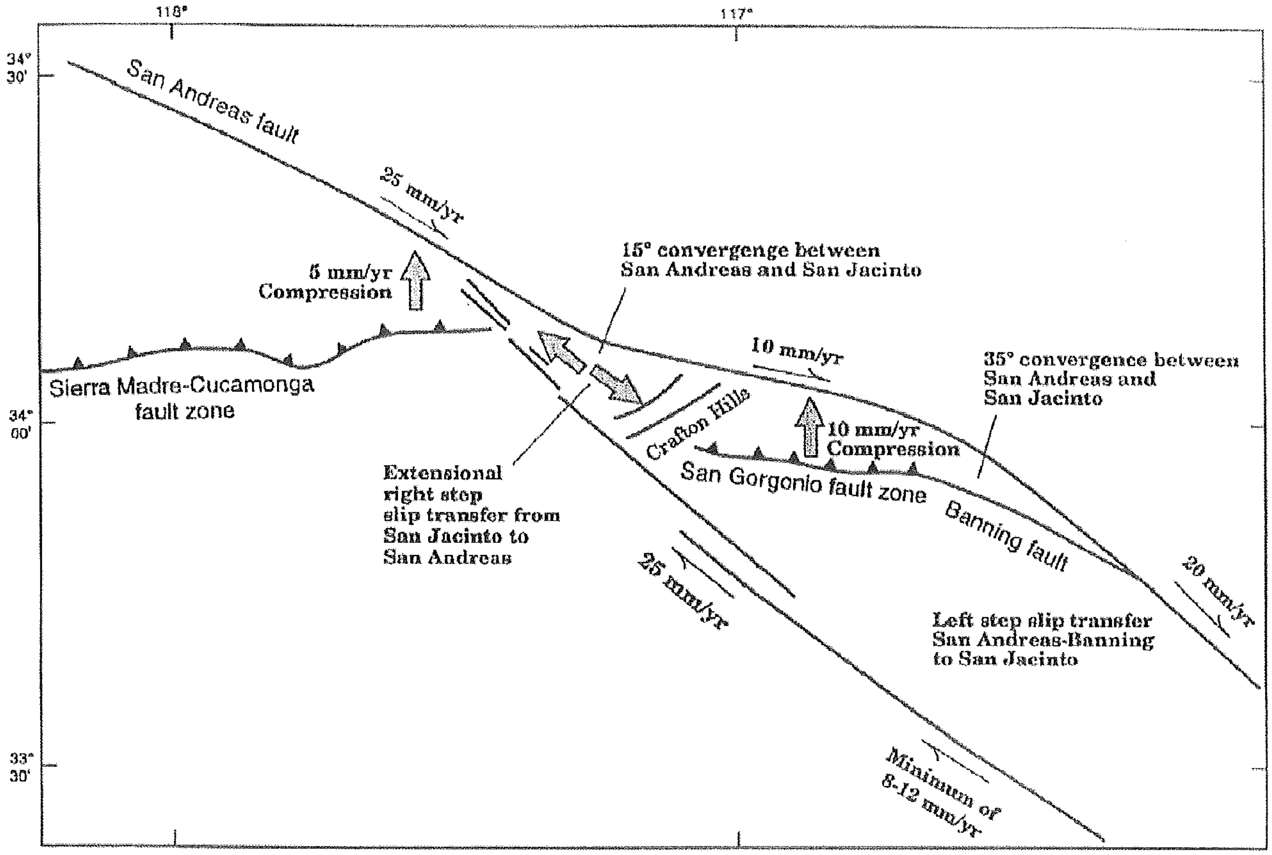
A variety of slip rates have been estimated for the SJFZ. Morton and Matti (1993) inferred ~10 to 20 mm/yr for the Glen Helen and Claremont segments. The Southern California Earthquake Center (SCEC, 2006a) postulate a 7 to 17mm/yr slip rate, and Kendrick, *et al.* (2002) suggested slip may be greater than 20 mm/year. According to Bennet, *et al.* (2004), San Jacinto fault slip alternates from about 0 to 26 ±4 mm/year since its inception about 1.5 million years ago; and that the current slip is about 9 ±2 mm/year. Bennet, *et al.* (2004) also concluded that the change in slip on the San Jacinto fault is matched by an equal and opposite change on the San Andreas fault. The SCEC (2006a) indicates that surface rupture recurrence is between 100 and 300 years, per segment for earthquake magnitudes between M6.5 and M7.5. Kendrick and Fumal (2005) reported recurrence of approximately 100 and 266 years, respectively, for the San Jacinto fault zone near Colton and San Bernardino, California. Matti and Morton (1993) point out that the San Andreas system between Cajon Pass and Coachella Valley is characterized by complex fault strand development, by strand switching and by strand abandonment related to formation of a structural knot in San Gorgonio Pass. Two major structural features resulted from progressive development of the structural knot. For the SAFZ, this is manifest by an apparent lack of a through-going surface fault. The SJFZ is the most recent tectonic feature and simply has bypassed the San Gorgonio knot since its inception about 2.5 to 1.5 ma. In the convergence area between the San Andreas and San Jacinto faults, the Glen Helen fault is the northernmost characteristic of faulting within the SJFZ in the Peninsular Ranges (Matti and Morton, 1993). Contraction and uplift occurring in the eastern San Gabriel Mountains, between the Cucamonga fault zone and the San Andreas fault is interpreted as strain accumulation because of slip transfer between the San Jacinto and San Andreas fault zones. This relationship is indicated on Figure 10.

Cucamonga Fault Zone

The Cucamonga fault is discussed for context only. Our review and prior work indicates that the Cucamonga fault is not expressed on the site at, or near, the surface. However, the trend of the Cucamonga fault, and its associated AP zone project toward Sycamore Canyon, and the ICBO (1998) indicates that portions of Sycamore Canyon lie with the Cucamonga fault near-source zone.

The Cucamonga fault defines the southern margin of the eastern San Gabriel Mountains and marks the eastern end of the frontal fault system of the San Gabriel Mountains (Matti and Morton, 1993). The Cucamonga fault is a compressional zone of Quaternary reverse thrust faults that separates crystalline rocks of the San Gabriel Mountains from alluviated lowlands of the upper Santa Ana River valley (Morton; 1975a, 1975b, 1976a, 1976b; Morton and Matti, 1987), as well as thrust faults entirely within alluvium (Morton and Matti, 1987). The Cucamonga fault zone (CFZ) consists of several anastomosing east-striking and north-dipping thrust faults. Matti and Morton (1993) projected the Cucamonga fault zone down-dip 13 km to merge with the San Andreas fault. They also conclude that the Cucamonga fault zone has been displaced 5 km farther north than the San Gabriel mountain front to the west of San Antonio Canyon.

Geologic investigations and mapping by Morton (1976a and 1976b) show the Cucamonga as a system of fault scarps between Lytle Creek and San Antonio Canyons. Holocene surface rupture has only been established west of Lytle Creek Canyon (Morton and Matti, 1987). Epicenters of microseismic activity do fall near the surface trace of the Cucamonga fault, but their focal depths (6 to 12 km) are too deep for this activity to be on the Cucamonga fault (Cramer and Harrington, 1987). Cramer and Harrington (1987) further conclude that internal deformation is occurring within the Cucamonga block. In the western part, deformation is largely vertical, while in the eastern part, it is largely horizontal shearing under the influence of the San Jacinto fault system. Morton and Matti (1987) suggest that faulting within the Cucamonga fault zone may have migrated southward during late Pleistocene and Holocene time. The average north-south convergence across the Cucamonga fault zone is an estimated 3 mm (Weldon, 1986) to 6 mm/year (Matti, *et al.*, 1985; Morton and Matti, 1987). Latest episodes of strain release may have occurred mainly in the eastern 15 km of the fault zone and not throughout its entire 25-km length (Matti, *et al.*, 1992).



Schematic map (modified from Matti and others, 1985) showing interpretation of slip transfer between some of the faults in the area of the San Bernardino basin and southeastern San Gabriel Mountains.

Base Map from Morton and Matti, 1993.

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SLIP TRANSFER SCHEMATIC		Figure 10
W.O. 5278-A-SC	DATE 02/07	SCALE NTS

The intervals between major ruptures are about 600 to 700 years (SCEC, 2006b). Matti, *et al.* (1992) concluded that major earthquakes with vertical displacement of about 2 meters had an average recurrence of about 625 years. Minor or ambiguous evidence of present day seismicity is documented (Morton and Yerkes, 1987).

PERTINENT SITE AND NEAR-SITE GEOLOGIC INVESTIGATIONS

1. **State of California**

   Much of the original, overall Lytle Creek Ranch project area including Sycamore Canyon was encompassed by Alquist-Priolo Earthquake Fault Zones (APEFZ), established by the State of California (1974a and 1974b) as shown on the Devore and San Bernardino North 7.5 minute Quadrangles. This included postulated traces of active faults associated with the San Jacinto and Cucamonga fault zones.

2. **Gary S. Rasmussen and Associates, Inc., "Preliminary Engineering Geology Investigation of the Lytle Creek Development, Approximately 3,600 Acres, Lytle Creek and Interstate 15, North of Rialto, California"**

   A preliminary engineering geology investigation for the entire Lytle Creek Ranch project area, including Sycamore Canyon, was previously performed by Gary S. Rasmussen & Associates (Rasmussen) in 1988. That study concluded that a large portion of the overall project could be developed if appropriate mitigation were developed for possible faulting and floods, severe seismic shaking and surface ground rupture. Rasmussen (1988) also concluded that the potential for liquefaction was low, owing to the coarseness of onsite sediments and depth to groundwater. Additionally, Rasmussen (1988) recommended subsurface geologic investigations, including trenching of aerial-photographic lineaments.

3. **Soil and Testing Engineers, Inc., "Alquist-Priolo Geologic Investigation of Portions of Section 4 and 5, T1N, R5W, Sycamore Flat[s], San Bernardino, California"**

   Soil and Testing Engineers, Inc. (STE, 1988) studied the geology of Sycamore Canyon and the adjacent Sycamore Flat area (STE, 1988). STE excavated 19 exploratory trenches (totaling 4,850 feet in length) to a maximum depth of ±16 feet below existing grades. STE also conducted six seismic traverses within Sycamore Canyon and Sycamore Flat to evaluate possible extensions of the San Jacinto fault identified by the Southern California Gas Company. Although unequivocal evidence of Holocene faulting was apparent in only one of their trenches (T-6), as indicated on graphic logs, STE recommended a "No Human Occupancy Structures" zone based on "sand boil or shear alignment in alluvium being on the main fault trace." According to STE (1988), "exposures in Trench

No. 7 were the most definitive with respect to determining the main trace of the fault and secondary shear features and permitted determining the width of the San Jacinto Fault Zone on-site." We understand that the County reviewed and rejected the STE (1988) report for it apparently was inadequate to satisfy the APEFZ Act (then referred as the Special Studies Act) and the County guidelines for fault rupture-hazard investigations. Because the STE (1988) report was rejected, GSI did not rely on the data for this investigation. Nevertheless, for context, the STE trench locations are shown on Plate 2, and the entire STE report is provided on the CD in Appendix A.

4. **Eberhart and Stone, Inc., Unpublished Geologic Investigation**

As summarized by LOR Geotechnical Group Inc. ([LOR], 1994a), in the spring of 1990, Eberhart and Stone (E&S) investigated on-site faulting by excavating 26 exploratory trenches (totaling approximately 7,700 linear feet), by geologic site mapping, by soil stratigraphy and age-dating analysis, and by a seismic refraction study. However owing to a lack of funding, the investigation was halted and abandoned in 1993. E&S's preliminary data were never made available. E&S's trench locations are presented on Plate 2, as indicated in LOR (1994a)

5. **LOR Geotechnical Group, Inc., "Geologic Fault Investigation, Sycamore Flat[s] Area, San Bernardino County, California"**

LOR Geotechnical Group, Inc. (LOR) undertook a third fault investigation of the subject property and the adjacent Sycamore Flat property between April and September 1994 in order to satisfy requirements of the Alquist-Priolo Earthquake Fault Zoning Act. LOR was the lead consultant with further technical expertise provided by Donn Schwartzkopf (Terra Geosciences), and Dr. Tom Rockwell (California State University, San Diego; now referred to as San Diego State University). LOR reviewed pertinent publications, reports, and maps; analyzed aerial photographs and lineaments; excavated and logged 18 exploratory trenches up to 31 feet in depth and totaling 8,200 linear feet in length (nine of which are located within Sycamore Canyon); dated soils using soil stratigraphic and radiocarbon age-dating techniques; mapped the site geologically; surveyed trench and fault locations; and prepared a final report (LOR, 1994a). LOR (1994a) identified Holocene faulting within Sycamore Canyon in exploratory trenches T-1, T-2, T-7, and T-8 where "the active trace of the [San Jacinto] fault exists as numerous individual fractures constrained within a well defined zone ranging from 30 to 100 feet in width. The trend of this portion of the fault ranges from N50°W to N55°W." Based on radiocarbon dating analysis of charred wood fragments in the oldest unfaulted and youngest faulted units in Trench T-2, LOR determined that the last seismic event for the zone was bracketed to a 95 percent probability, to have occurred between "AD 1380" and "AD 1810." LOR (1994a) stated that "the surficial extent of the active fault trace is less distinct" on the southeastern portion of the property, southeast of Interstate 15 (Sycamore Flat). Within Sycamore Flat, LOR identified disrupted and sheared alluvial deposits in exploratory trench T-14 and T-16 "in line with the fault on the northwestern portion of the site [Sycamore Canyon]. This would indicate that the active trace crosses the southeastern portion of the site at roughly the same trend as in Sycamore Canyon, N50°-60°W." However, LOR also pointed out that fault activity on the [southwest] portion of the site within this narrow zone was difficult to assess because of less relative fault movement than observed in Sycamore Canyon; because of the absence of datable sediments above disrupted, older alluvial units with no distinct fault zones; and because of shallow groundwater in exploratory trenches that precluded the origin of a lineament. LOR therefore concluded that Holocene faulting occurs at the site and provided setbacks for structures for human occupancy. LOR's setback zone transected portions of the property (Sycamore Canyon and Sycamore Flat) from the northwest to the southeast.

The County of San Bernardino (1994a), reviewed the LOR (1994a) report and required LOR to address four issues for possible County approval. The County also noted that because development was not yet proposed, LOR may have to update their report when development plans became available. Additionally, the County of San Bernardino (1994a) pointed out that not all LOR trenches exposed pre-Holocene sediments nor were likely to do so given the thickness of alluvium in the area. The County thus suggested that a risk analysis may be necessary for the proposed development.

Subsequent to the County's initial review, LOR (1994b) acknowledged and addressed the County's comments. LOR (1994a) was then granted approval from the County as indicated in County of San Bernardino (1994b). The County then forwarded LOR (1994a and 1994b) and County of San Bernardino (1994a and 1994b) to the California Division of Mines and Geology (CDMG). In a letter to the County, the CDMG states that LOR (1994a and 1994b) has been placed in an open file and substantiates CDMG zoning recommendations dated December 1, 1994. LOR (1994a and 1994b) and County of San Bernardino (1994a and 1994b) are provided in its entirety on the CD data disk in Appendix A.

6. GeoSoils, Inc., Preliminary Geologic Investigation, "The Villages"

In addition to the Rasmussen and LOR investigations, GSI preliminarily evaluated the proposed master plan development for "The Villages at Lytle Creek" (GSI, 1994). This study included almost all the currently proposed development excepting Sycamore Flat and the El Rancho Verde Golf Course which are now a part of the overall plan. However, much of the central portion of Sycamore Flat (Tract 15900 and other open space) is now not a part of the current development area and Sycamore Flat and the El Rancho Verde Golf Course are not included in the current fault study (Figure 1). GSI (1994) subsurface investigations included geologic logging of approximately 19,840 linear feet of exposures in open pit mines, eight exploratory trenches totaling approximately 3,855 linear feet, and one calibration test pit. In addition, unpublished trenches (approximately 2,775 linear feet) previously excavated on the site by Eberhart & Stone (E&S), were evaluated by emplacing another 785 linear feet of trenches.

GSI (1994) concluded that, in general, project development was feasible from a geologic and geotechnical viewpoint. That study also indicated that faulting along the northeast margin of the original site is active (i.e., movement within the Holocene epoch, or last ±11,000 years) and that structural setbacks are warranted. However, this area is either deemed open-space or no longer part of the current development plan and such setbacks are considered irrelevant to the currently proposed development.

GSI (1994) did not observe strong photolineaments and/or geomorphic or geologic features, indicative of active faulting, except for the extreme northeast corner of the site (i.e., south of Sycamore Flat). The GSI data therefore supports the model for slip transfer between the San Jacinto and San Andreas fault zones proposed by Matti, *et al.* (1992), and Matti and Morton (1993).

No evidence of faulting was encountered in the remainder of the site, including South Village, East Village, and the majority of North Village (PBR, 1994). Neither observed in the field or on the aerial photographs were on-site groundwater barriers. The GSI report concluded that no active faults likely exist within the remainder of the property, and that the then-current State APEFZ were now largely unwarranted and probably should be removed.

GSI (1994) indicated that severe seismic shaking and possible ground lurching may occur throughout the site should an earthquake occur on one of the nearby active faults. Mitigation in accordance with the recommendations of the project geotechnical engineer were therefore needed. Also requiring evaluation was flooding potential during periods of heavy precipitation. Similarly, hydrocollapse and liquefaction needed site-specific evaluation by the project geotechnical engineer, should groundwater levels rise as a result of urbanization or other natural means. Any subsidence in the study area, would likely be associated with active faults within the APEFZ northeast of the site and would be mitigated via recommended setbacks. GSI also concluded that it was imperative that utilities crossing the fault zone be constructed at high angles to the fault trace in order to minimize damage. Appropriately, up- and down-gradient cut-off valves for utilities, to facilitate repair, would need to be considered. Any proposed slopes greater than 30 feet high and constructed at 2:1 h:v gradients, would need evaluation by the project geotechnical engineer and engineering geologist.

After reviewing the GSI (1994) report, California Division of Mines and Geology (CDMG) published revised earthquake fault zones for the Devore Quadrangle (State of California, 1995), largely based on Fault Evaluation Report No. 240 and its supplements (CDMG, 1994, 1995a, and 1995b). Supplement No. 1 (CDMG, 1995b) specifically reviewed and commented on the GSI (1994) data and conclusions. The revised APEFZ mapping significantly reduced fault zones across the project area. The entire GSI (1994) report is included on the CD in Appendix A.

7. San Bernardino County Review and Response Report by GSI

The County of San Bernardino Reviewing Geologist, Mr. Wessly A. Reeder (County of San Bernardino, 1995a) raised several issues that were clarified by GSI (1995). Mr. Reeder then indicated that, "the response report and initial report appear to be adequate as a general feasibility investigation" (County of San Bernardino, 1995b). Mr. Reeder and GSI recognized the need for additional site-specific geotechnical studies, including slope stability and liquefaction evaluations, and supplemental fault investigations for portions of the site remaining within APEFZ's. The County of San Bernardino (1995a), is included in GSI (1995). The County of San Bernardino approval (1995b) and GSI (1995) are included on the CD in Appendix A.

8. GeoSoils, Inc., Supplemental Alquist-Priolo Earthquake Fault Zone Investigation, Sycamore Flat

In 1999, GSI performed a supplemental APEFZ investigation within Sycamore Flat (Tract 15900) in order to re-evaluate and correlate the existing, approved Alquist-Priolo report for the site (LOR Geotechnical, 1994a); to reconcile apparently equivocal data from that study with well documented soil-stratigraphy and age-dating obtained during GSI (1994) on the adjoining "The Villages of Lytle Creek" property; and to integrate all of the previous investigations into a regional, local and site geomorphic/geologic context. The GSI (1999a) study did not include the Sycamore Canyon area owing to Client cost concerns.

According to CDMG (1995b), "Evidence of Holocene faulting in the southeastern part of Sycamore Flat is more equivocal in the LOR trenches as the area has a higher water table, thinner Holocene units, and has been extensively graded." Based on the State's and our review of LOR's data, there was reasonable doubt that the LOR fault was through-going. To verify this, we emplaced five trenches (T-101 through T-105) within Sycamore Flat. Trenches T-101 and T-102 were excavated perpendicularly across the LOR zone. In those particular trenches, GSI identified unbroken Holocene stratigraphy and/or pre-Holocene paleosols. GSI also placed two trenches across a strong photolineament (T-103 and T-105) and another outside of the lineament where the undifferentiated slopewash, colluvium, and fill had been stripped (T-104). These soils were also absent from T-105. The photolineament generally coincided with apparently right-lateral offset drainage and alluvial fans on the site, topographic saddles to the southwest, a break-in-slope, and a recently incised drainage swale that was cut-off from a source area (GSI, 1994).

Active faulting appears to be reflected by a tectonic graben with the down-dropped and vertical displacement of the youngest alluvial units in the Trench T-103. In Trench T-105, the development of the graben was less defined, suggesting that the fault may be dying out, or right-stepping to the Glen Helen fault. According to GSI (1999a), "The appearance and width of the grabens noted in GSI's trenches on the offsite Lytle Creek property, T-7 and T-8 (GSI, 1994), and in T-103, this study, and closely associated topographic break and lineament, also strongly suggest that the fault is active."

Based on site-specific observations, regional geologic setting, and temporal step-over of the San Jacinto fault to the Glen Helen fault and in turn to the San Andreas fault, GSI (1999a) concluded that the LOR, Holocene-faults in Sycamore Flat, were paleoliquefaction features. Additionally, other factors suggest their equivocal data are better attributed to an older, non-seismogenic fault which may exist on the site and possibly has experienced sympathetic movement as a result of nearby seismic activity. GSI (1999a) reported that the LOR fault was not through-going, and the projected fault trend was incorrect. GSI (1999a) also pointed out that a graben structure, presence of a strong aerial-photographic lineament, and topographic break-in-slope all indicated an active fault along the eastern part of the property. The GSI (1999a) report is included on the CD in Appendix A.

9. **GeoSoils, Inc., Compilation Reports, Tract 15900**

GSI (1999b and 2003) compiled geologic and geotechnical reports for Tract 15900 (previously "North Village"). These two reports are similar in scope and content: the latter updated seismic parameters and conclusions and recommendations for future tract development. In addition, the GSI (1999b) investigation included excavation of 30 test pits for evaluation of near-surface geotechnical conditions.

GSI (2003) concluded that Tract No. 15900 was compatible and favorable with respect to the geologic constraints onsite. That study showed that the San Jacinto fault in the northeastern portion of the site (adjacent to Sycamore Flat) is active. Structural setbacks are therefore warranted should habitable structures be proposed for this area. Subsidence would be inherently mitigated by the recommended setbacks. GSI concluded that active faults do not likely exist elsewhere in that property. Additional GSI studies on the Sycamore Flat property north of Tract No. 15900 (GSI, 1999a) and an independent evaluation by the State (CDMG, 1995b) generally corroborated these conclusions. The GSI (2003 and 1999b) reports are provided on the CD in Appendix A.

10. **Hilltop Geotechnical, Inc., Updated Geotechnical Study**

Hilltop Geotechnical, Inc. ([HGI], 2004) updated a geotechnical investigation for proposed single-family residential development for the property located north of Lytle Creek and South of Sycamore Flats (i.e., southeast of the subject site). GSI believes that this investigation has no pertinent information to active faulting within Sycamore Canyon based on the GSI (1999a) conclusion that active faulting does not exist in this area.

11. **Petra Geotechnical, Inc., Supplemental Geotechnical Investigation, Grading Plan Review, and Responses to County Review Comments**

In April 2005, Petra Geotechnical, Inc. (PGI) completed a supplemental geotechnical investigation and grading plan review for Planning Areas 9 through 12 and 16 through 34 (Lytle Creek North PDP) and Planning Area 14, Tract 15900. PGI (2005a) also addressed County review comments pertaining to HGI's (2004) investigation of the property. PGI (2005b) responded to County review comments pertaining to PGI (2005a). Based on the available data, GSI believes that the PGI (2005a and 2005b) data and conclusions cannot be reasonably extrapolated to the Sycamore Canyon study.

GENERAL SITE GEOLOGY AND GEOMORPHOLOGY

Sycamore Canyon divides Tertiary granitic, intrusive rocks exposed along its northern wall from relatively older, Cretaceous mylonitic, granitic rocks on the southern wall. Erosion and runoff in the surrounding hills have resulted in the deposition and continued incision of alluvial sediments on the canyon floor. The thickness of alluvial soils in Sycamore Canyon is about 100 feet or less (Fife, *et al.*, 1976).

Dutcher and Garrett (1963) mapped the subject site as consisting of younger alluvium within the canyon and basement complex in the highland area. Morton and Matti (2001) mapped five Quaternary deposits: modern wash, modern alluvial fans, young alluvial fans, old alluvial fans, and very old alluvial fans. They also map the north wall of Sycamore Canyon as the Tertiary "Granodiorite of Telegraph Peak" and the south wall of Sycamore Canyon as Cretaceous (?) Mylonitic Leucogranite (Figure 5). Morton and Miller (2003 and 2006) depict Quaternary sediments ranging from very young wash deposits and very young alluvial fans to very old alluvial fans. Morton and Miller (2003 and 2006) mapped the north and south walls of Sycamore Canyon similar to Morton and Matti (2001). Both Morton and Matti (2001) and Morton and Miller (2003 and 2006) show modern/very young wash deposits and the modern/very young alluvial fan deposits as age-equivalent. Dibblee (2003) mapped Holocene alluvial gravel and sand, Oligocene granodiorite and Cretaceous granitic rocks within the study area.

SITE GEOLOGY

As observed in the field, site geologic units, are mainly undocumented artificial fill, Quaternary colluvium, Quaternary alluvial fan deposits and Quaternary alluvium, Tertiary Granodiorite of Telegraph Peak, and Cretaceous mylonitic leucogranite (Plate 1). GSI generally agrees with Morton and Matti (2001) and Morton and Miller (2003 and 2006) that the Holocene alluvium and alluvial fan deposits are age-equivalent, as they were observed to interfinger in some of our trench exposures. Contrary to previous accounts, GSI did not encounter older alluvial fan deposits within the site. Supplemental descriptions for subsurface units are shown on Plates 3 through 12. As shown on Plate 1, except for compacted fill described in GSI (2007), the major geologic units are generally described (from youngest to oldest):

Roadway Fill (Map Symbol - Afr)

Surface fill is associated with construction of Glen Helen Parkway. Roadway fill was not exposed in our trenches.

Artificial Fill - Undocumented (Map Symbol - Afu)

Locally encountered, undocumented fill is most likely associated with trench backfill for underground utilities and previous subsurface investigations by STE (1988), E&S (unpublished), and LOR (1994a), as well as roadways. The artificial fill consists of pale yellow to light yellowish brown, dry to damp, poorly to moderately indurated fine- to coarse-grained sand and silty sand with trace, sub-angular to sub-rounded pebble- to cobble-sized clasts. The undocumented fill ranges in thickness from less than 1 foot to ~30½ feet. The undocumented fill is potentially compressible and may settle appreciably under loading conditions. Therefore, mitigation in the form of removal and recompaction is recommended should undocumented fill be encountered in settlement-sensitive areas.

Quaternary Colluvium (Not Mapped)

Quaternary colluvium was encountered at the surface in some trenches and consists of light gray, dry, poorly indurated, fine- to coarse-grained sand with traces of angular to subangular pebble- to cobble-sized clasts. All colluvium is potentially compressible and may settle appreciably under load. Removal and recompaction is recommended if undocumented fill occurs in settlement-sensitive areas.

Quaternary Alluvial Fan Deposits (Map Symbol - Qaf)

Quaternary alluvial fan deposits discontinuously mantle the site along hillsides and adjacent toes of slopes. Along distal margins, alluvial fan deposits interfinger with Quaternary alluvium. The alluvial fan deposits are light gray to light yellowish brown, fine- to coarse-grained sand and silty sands with traces of angular to sub-angular pebble-to cobble-sized clasts. These deposits are dry and poorly indurated and become damp and moderately indurated with depth. These deposits have a low to medium expansion potential; however, high expansion potential may exist in clayey sediments. The near-surface (upper 5 to 7 feet), alluvial fan deposits may be unsuitable to support settlement-sensitive improvements. These deposits are likely no older than mid-Holocene.

Quaternary Alluvium (Map Symbol - Qal)

Quaternary alluvium was observed to underlie the canyon floor. These sediments are generally grayish brown, dark olive brown, light gray, and pale yellow fine- to medium-grained sand and grayish brown, dark olive brown, light gray, pale yellow, light brownish gray, and light yellowish brown fine- to coarse-grained sand and silty sand with traces of sub-rounded to sub-angular pebble- to cobble-sized clasts. The sediments are dry and poorly indurated and become moist to occasionally wet and moderately indurated with depth. The alluvium is typically massive to thickly bedded with a trace of thin bedding and localized cross-bedding. These sediments regionally dip to the south. However, local topset, foreset, and bottomset beds dip to the north. These sediments typically have a very low to low, and possibly medium expansion potential; however, a high expansion potential may exist in clayey sediments. These deposits are similarly no older than mid-Holocene in age.

Tertiary Granodiorite of Telegraph Peak (Map Symbol Ttp)

The northern wall of Sycamore Canyon exposes Oligocene biotite granodiorite that ranges to biotite monzogranite and is termed the "Granodiorite of Telegraph Peak" (Morton and Matti [2001]). This bedrock unit is medium- to coarse-grained, predominately massive, and highly fractured/sheared. Miocene-age olivine diabase and gabbro plutons, as well as andesitic dikes, are commonly associated with this unit.

Cretaceous Mylonitic Leucogranite (Map Symbol Kgc)

Morton and Matti (2001) mapped the southern wall of Sycamore Canyon as leucocratic mylonitic monzogranite, which is "characterized by distinct mylonitic layering defined by deformed quartz and feldspar." It is thoroughly fractured and decomposed.

SUMMARY OF TRENCH EXPOSURES AND DOCUMENTATION

The findings of each fault-locating trench are discussed below. Additional descriptions are provided on the Trench Logs (Plates 3 through 12). The exploratory trenches were emplaced mainly to intercept the fault projections of LOR (1994a) and aerial-photographic lineaments. Prior to excavation, the ends of the proposed trenches were located in the field by Dawson Surveying, Inc. Subsequent to graphic logging, trench locations, selected controlling faults, and faults that exhibited the largest vertical displacements were surveyed and are shown on Plate 2. There is a small error between surveyed trench lengths indicated on Plate 2, and those indicated on the trench logs (Plates 3 through 12) owing to slight sagging of the measuring tape and curvatures of the trench. Based on soil stratigraphic and radiocarbon dating, the local trench-exposed sediments near the bottoms of the excavations are about ~4,500 years old (mid-Holocene).

Fault Trench 200 (FT-200)

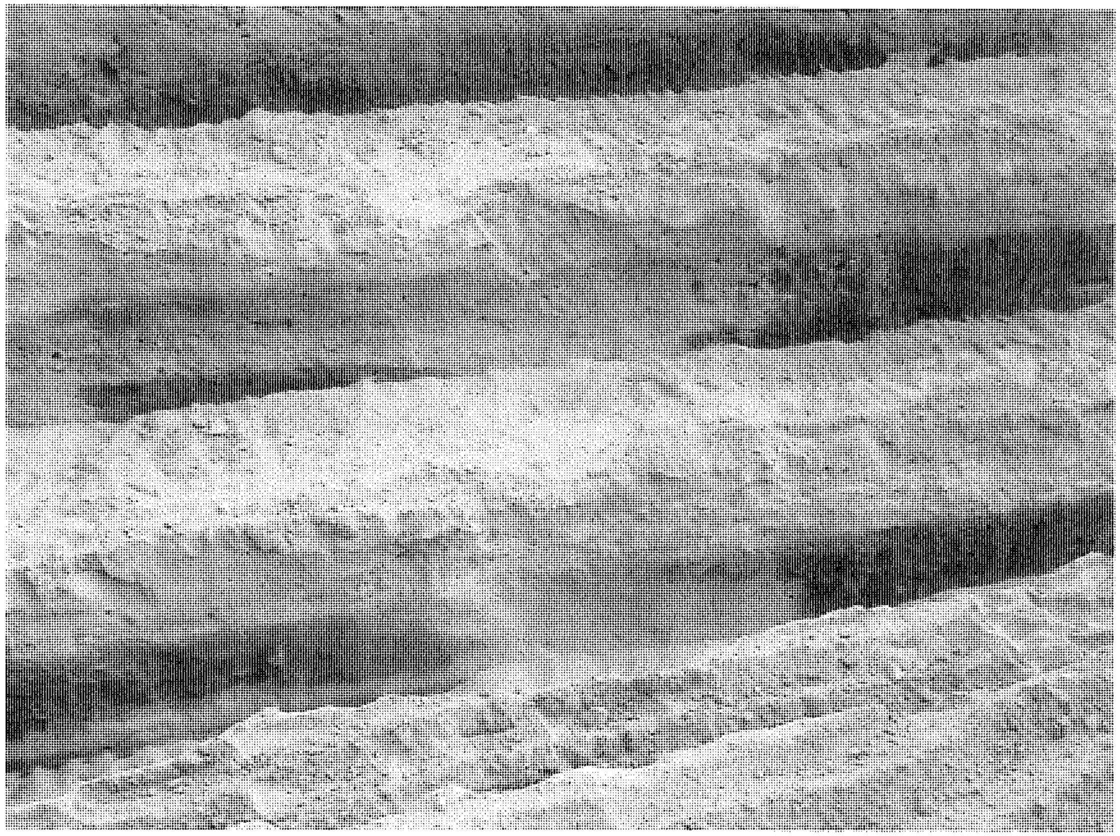
Fault Trench FT-1 intercepted and extended beyond the LOR (1994a) fault zone (Plate 2). This trench exposed four to five fining-upward sequences of stratified, Holocene alluvium, each of which was capped by regionally extensive, but locally eroded, buried paleosols (Plates 3 and 4). Faulting was not observed within this trench; however, paleoliquefaction features (i.e., sand blows and lateral spreads), most likely attributed to near-field paleoseismicity, were observed (Figure 11).

Fault Trench 201 (FT-201)

FT-201 crossed and extended beyond LOR's fault zone directly down-canyon (to the southeast) of FT-200. This trench location satisfies County guidelines for trench spacing and geologic extrapolation distance from T-101 (GSI, 1999a) and FT-200 (this investigation). This trench exposed four to five fining-upward sequences of stratified, Holocene alluvium, each of which was capped by regionally extensive, but locally eroded, buried paleosols (Plate 5). No faults were observed; however, paleoliquefaction features (i.e., sand blows and lateral spreads) were apparent.

Fault Trench 202 (FT-202)

Fault Trench 202 (FT-202) similarly crossed and extended beyond the LOR (1994a) fault directly up-canyon (to the northwest) from FT-200 (Plate 2). FT-202 also exposed four to five fining-upward sequences of stratified, Holocene alluvium capped by regionally extensive, locally eroded, buried paleosols (Plate 6). Two samples of charred wood fragments were collected at different locations and depths within this trench for radiocarbon dating. Radiocarbon dating was provided by Beta Analytic, Inc. (Appendix B). Sample No. 1 was taken from the northwest wall (opposite the wall indicated on the trench logs) at approximately Station No. 73 at about 13 feet below grade. The sample yielded a conventional radiocarbon age of 3,220 ±40 years before present (ybp). Sample No. 2 from the southeast wall (wall indicated on the trench logs) at approximately Station No.136 and 24½ feet below grade provided a conventional age of 4,560 ±40 ybp. Because Sample No. 2 was collected near the bottom of the trench, most sediments in FT-202 are somewhat younger than ~4,500 ybp. No faults were identified in FT-202; however, paleoliquefaction features were observed.



Photograph of FT-200 displaying paleoliquefaction in Holocene alluvium (see Plate 3 for station numbers and wall).

GeoSoils, Inc.

SITE PHOTOGRAPH

Figure 11

DATE 2/2007

W.O. NO. 5278-A-SC

Geotechnical · Geologic · Coastal · Environmental

Fault trending N51°W@74°SW in FT-203 (extension) at Station -10. Fault exhibited ~7 inches of maximum vertical displacement. Fault has been etched for better visibility (see Plate 7).

GeoSoils, Inc.

SITE PHOTOGRAPH

Figure 12

DATE 2/2007	W.O. NO. 5278-A-SC

Geotechnical · Geologic · Coastal · Environmental

Fault on southeast wall of FT-203A trending N47°W@58°NE (recorded on the opposite wall of the trench). Fault displayed ~35 inches of maximum vertical displacement on the northwest wall (see Plate 9).

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SITE PHOTOGRAPH

Figure 13

DATE 2/2007	W.O. NO. 5278-A-SC

Geotechnical · Geologic · Coastal · Environmental

Fault Trench 203 (FT-203)

FT-203 crossed and extended beyond the LOR (1994a) fault zone directly up-canyon (to the northwest of) FT-202. This trench likewise exposed four to five fining-upward sequences of stratified Holocene alluvium capped by regionally extensive and locally eroded, buried paleosols. This trench was extended approximately 74 feet to the northeast to intercept faults identified in Fault Trench 203A (FT-203A) as summarized below. The extension of FT-203 is indicated on the graphic logs. "Negative" stations were used in the extension. An approximately 26-foot wide fault zone consisting of four Holocene faults, trending N47° - 52°W, were identified between approximate Station Nos. -5 and -31 (Plate 7). Vertical displacement increased with depth suggesting recurrence. Paleoliquefaction features were also noted in this trench. Photographic documentation of faulting in FT-203 is provided as Figure 12. The faults in this trench are further described in Table 1.

TABLE 1

FAULT TRENCH 203 (FT-203)			
APPROXIMATE STATION NO. AS INDICATED ON FIELD LOG	FAULT ATTITUDE (STRIKE, DIP)	MAXIMUM APPARENT VERTICAL DISPLACEMENT (INCHES)	FAULT NO. INDICATED ON PLATE 2 (SURVEYED AT THE SURFACE PROJECTION OF FAULT)
-31½	N47°W, Vertical	12	1
-23	N52°W, 82°SW	8	2
-10	N51°W, 74°SW	7	3
-5	N51°W, 70°NE	30*	4
* - Maximum displacement was measured from the northwest wall of the trench			

Fault Trench 203A (FT-203A)

Dr. Shlemon recommended that FT-203A be emplaced northwest of FT-203 in order to overlap FT-203; to investigate the narrowest point of the canyon not previously explored by LOR; and to intercept secondary-fracture trends in LOR Trench T-2. Additionally, FT-203A could verify or refute the LOR faults as well as the origin of a aerial-photographic lineament. The FT-203A trench commenced at the north wall of Sycamore Canyon and terminated southwest after overlapping FT-203. FT-203A exposed three to four fining-upward sequences of Holocene alluvium. The northeast end of the trench exposed highly fractured crystalline bedrock ("Granodiorite of Telegraph Peak") and overlying Holocene alluvial deposits to the southwest. The crystalline bedrock extended to the base of the trench near Station No. 81. Minor to locally extensive areas of undocumented artificial fill were encountered; these relate to underground utility pipelines and previous subsurface investigation (T-8 [LOR, 1994a]). FT-203A (Plates 8 and 9) exposed an approximately 129-foot wide fault zone, consisting of 8 Holocene faults and one 12-inch wide bedrock fault gouge zone, between Station Nos. 63 and 192. These faults reflect both normal, reverse, and probable horizontal movement, and generally trended N31°-63°W. Vertical displacement increased with depth indicating recurrent movement. The overlying alluvium is less than 11,000 years old and, therefore, the bedrock fault is conservatively judged to be "active" although it did not likely propagate upward into the overlying alluvium. GSI opines that the LOR (1994a) fault zone was intercepted between approximate Station Nos. 182 and 191. Figure 13 is a photograph of the fault at Station No. 192. The faults in FT-203A are further described on the trench logs (Plates 8 and 9) and in Table 2.

TABLE 2

FAULT TRENCH 203A (FT-203A)			
APPROXIMATE STATION NO. AS INDICATED ON FIELD LOG	**FAULT ATTITUDE (STRIKE, DIP)**	**MAXIMUM APPARENT VERTICAL DISPLACEMENT (INCHES)**	**FAULT NO. INDICATED ON PLATE 2 (SURVEYED AT THE SURFACE PROJECTION OF FAULT)**
63	N31°W, 81°SW	ND**	5
67	N63°W, 45°SW	11	6
75	N53°W, 70°SW	2½ - 3	7
82	N55°W, 73°SW	3 - 4	8
140½	N40°W, 69°SW	3	9
140	N55°W, 51°SW	5	10
183*	N47°W, 82°NE	1½	11
183*	N61°W, 74°NE	9½	12
192*	N47°W, 58°NE	35	13

* - The Station No. was measured on the Southwest Wall as the faults vertical limits were truncated by undocumented fill.
** - ND = Not Determined

Fault Trench 204 (FT-204)

FT-204 was emplaced southwest of FT-203 and FT-203A to intercept the trends of active faults observed in those trenches. FT-204 exposed four fining-upward sequences of Holocene alluvium capped by regionally extensive, but locally discontinuous, buried paleosols. Age-equivalent Holocene alluvial fan deposits and alluvium were observed to interfinger at the northeast end of the trench. Between Station Nos. 0 and 63, highly fractured and sheared "Granodiorite of Telegraph Peak" with localized diabasic basalt intrusions underlies the Holocene sediments. Also noted were local undocumented fill, most likely associated with underground-utility pipeline backfill. The backfill of LOR's T-6 was not identified in the exposure as indicated by the survey data (Plate 2). Apparently, therefore, the backfill for portions of T-6 that overlapped FT-204 must have been entirely removed during excavation. FT-204 also exposed an approximately 45½-foot wide zone of Holocene faulting between Station Nos. 229½ and 275 (Plates 10 and 11). This zone consisted of two faults trending N42° - 44°W that exhibited reverse and inferred horizontal movement. Vertical displacement increased with depth suggesting recurrence. Review of LOR's T-6 trench log did not show faulting, although these faults do project through their trench (Plate 2). A reasonable southeast projection, indicates that these faults would have been intercepted by FT-202. Because FT-202 exposed unfaulted, correlative alluvium, we judge that these faults terminated prior to reaching FT-202 or stepped over to the Glen Helen fault. Two major bedrock shears, trending N54° - 61°W, were observed near Station Nos. 27½ and 20½, respectively. Although these shears did not propagate upward into the overlying Holocene sediments, additional trenching to the southwest was necessary to determine if the shears related to active faulting or to deformation during batholith emplacement. A charred wood fragment (Sample No. 3) collected near Station No. 93 and a depth of 20½ feet, yielded a conventional radiocarbon date of 4,420 ±60 ybp (Appendix B) was determined for Radiocarbon Sample No. 3 (Appendix B). The unit in which this charred wood fragment was deposited is considered the youngest, faulted unit in this trench. A summary of faulting in FT-204 is provided in Table 3.

TABLE 3

FAULT TRENCH 204 (FT-204)			
APPROXIMATE STATION NO. AS INDICATED ON FIELD LOG	FAULT ATTITUDE (STRIKE, DIP)	MAXIMUM APPARENT VERTICAL DISPLACEMENT (INCHES)	FAULT NO. INDICATED ON PLATE 2 (SURVEYED AT THE SURFACE PROJECTION OF FAULT)
229½	N44°W, 80°SW	3	14
275	N42°W, 66°SW	16	15

Fault Trench 205 (FT-205)

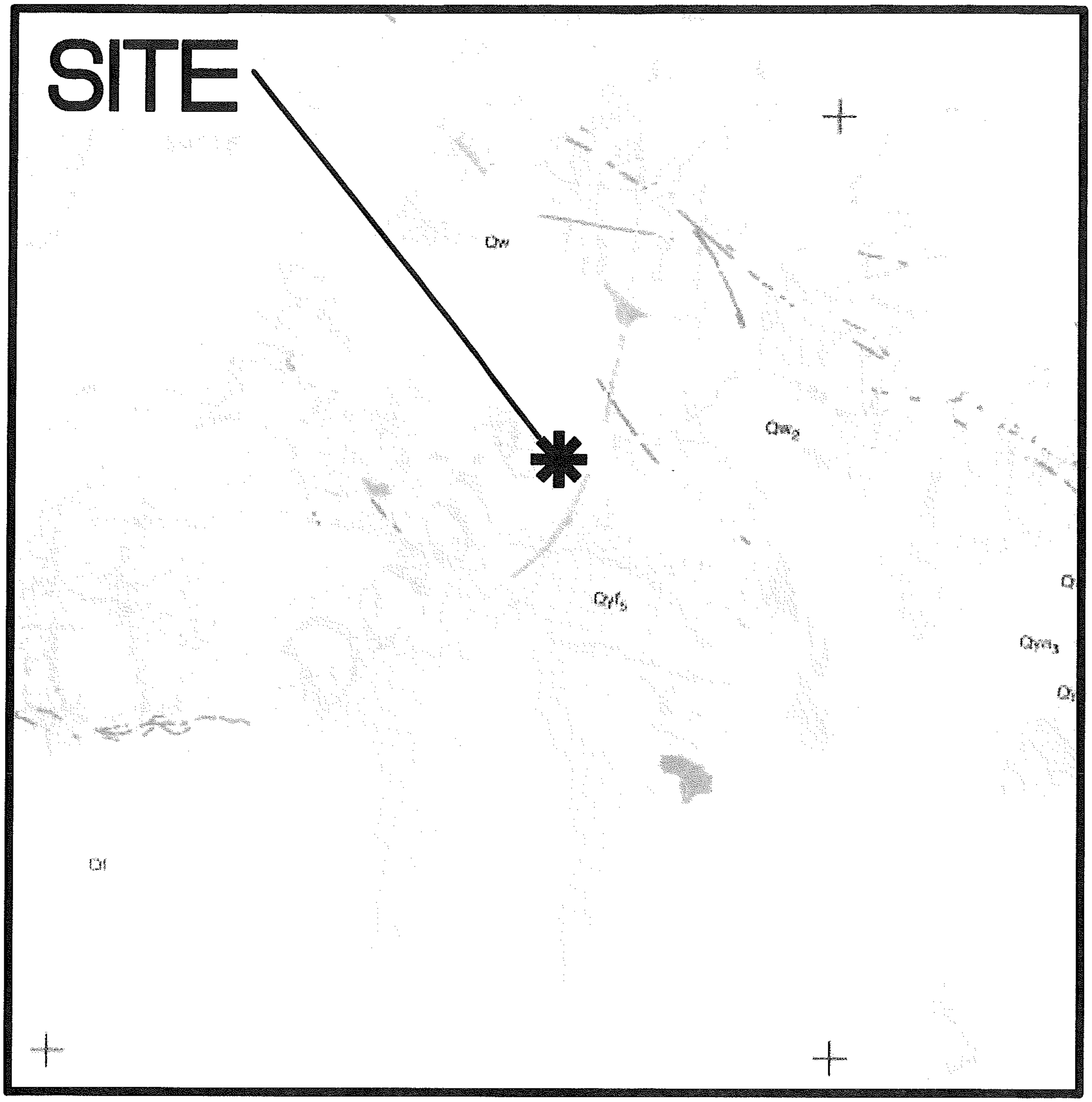
FT-205 intercepted the bedrock shears identified in FT-204. This trench exposed four to five fining-upward sequences of Holocene alluvium capped by regionally extensive but discontinuous, buried paleosols (Plate 12). The ~mid-Holocene alluvium was neither observed to be faulted or deformed indicating that the FT-204 shears are likely related to deformation during batholith emplacement, or to likely pre-Holocene tectonism.

SUMMARY OF FAULTING

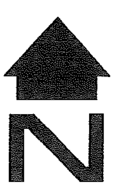
Holocene faults, most likely associated with active traces of the SJFZ, were observed in some trenches. The faults are generally on trend with those identified by LOR (1994a) within Sycamore Canyon. However, field observations, survey data, and document review indicate that these faults are not through-going as portrayed in LOR (1994a). Rather, our data indicates that the faults are not seismogenic, but rather secondary tectonic features, characterized by short and discontinuous trend and apparent vertical displacements of ~35 inches or less. Additionally, vertical displacements apparently decrease to the southeast.

Our site-specific findings show that portions of the LOR fault zone cannot be corroborated. by field data presented on their trench logs. We also determine that some of the LOR (1994a) trench logs, which show no faulting is incorrect. Rather, we identify Holocene faults in FT-204 (Plates 10 and 11), which overlaps the LOR T-6 trench (Plate 2). Further we document unbroken, mid-Holocene stratigraphy in our FT-200, FT-201, or FT-202 (Plates 3 through 6) to which these faults project. Also, Trench 101 (T-101 [GSI, 1999a]) intercepted LOR's fault zone on the adjacent, southeastern Sycamore Flat property but did not expose any faults. We thus conclude that the LOR fault zone is not through-going and is not warranted southeast of FT-202. The State of California (1995) also shows that the LOR fault zone is not through-going. We note that the Client is relying on the data presented in the LOR (1994a) report for areas of Neighborhood 1 that were not investigated by GSI.

We construct a reasonable model to characterize faults in the area: the short and discontinuous nature of faulting; the decrease in vertical displacements to the southeast; and the absence of faults southeast of FT-204 may be related to a right step-over of the San Jacinto strands to the Glen Helen fault. Our data show that the onsite faults are not likely seismogenic. Rather, they probably relate to slip partitioning along en-echelon tears that respond to major seismic events on the Glen Helen fault. As indicated by Sharp (1975) and Matti, *et al.* (1992), the Glen Helen fault is likely the active strand of the SJFZ in the San Gabriel Mountain region based on geomorphic expression(scarps, sag ponds) in young, Holocene alluvium, at the northern end of the San Bernardino Valley (Figure 14). The complete absence of such geormorphic on-site features further substantiates that the faults in our trenches are non-seismogenic. This conclusion is also supported by Morton and Miller (2006), who note the absence of "young faults" within the study area but document the youthfulness of the Glen Helen fault north of the site (Figure 14). Elsewhere on the site, we conclude that any faults below our trench depth (pre- mid-Holocene) are not sufficiently active or well-defined to satisfy Alquist-Priolo criteria for an active fault. Further, such hypothetical faults would have recurrence far less than typical activity associated with the SJFZ. Additionally, such faults cumulatively have such small displacements that they should be effectively mitigated by engineering design.



Base Map from Morton and Miller, 2006, scale 1:100,000.



GeoSoils, Inc.		RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.
"YOUNG FAULTS" MAP Figure 14		
W.O. 5278-A-SC	DATE 02/07	SCALE 1:100,000

N

Aerial Photograph, USDA, Flight Line 180, Photograph Number 159, dated August 10, 1980, 1:40,000

GeoSoils, Inc.

RIVERSIDE CO.
ORANGE CO.
SAN DIEGO CO.

AERIAL PHOTOGRAPH
SAN JACINTO FAULT ZONE
(North of San Bernardino, CA)

Figure 15

W.O. 5278-A-SC	DATE 02/07	SCALE 1:40,000

RATIONALE FOR FAULT SETBACK ZONES

The recommended fault setback zone indicated on Plate 2, is based on observations of active faults exposed in the GSI trenches FT-203, FT-203A, and FT-204 and LOR's T-2. Consistent with current standards-of-practice for the number and separation distance of trenches, setbacks for habitable structures are recommended for a distance of 50 feet outside the most northeastern and southwestern faults identified in these trenches. This setback zone merges with the County approved setback zone at LOR's T-2 located northwest of FT-203A. It is our understanding that no development is proposed northwest of the open space boundary indicated on Plates 1 and 2. The southeastern limit of the recommended setback zone is the northwest wall of T-202, for this trench did not expose any faults. If desired from a cost versus benefit standpoint, additional trenching may help to reduce this zone to the northwest of FT-203A and southeast of FT-204.

FAULT RUPTURE RECURRENCE

As previously mentioned, the faults identified in the GSI trenches are associated with the SJFZ. Although "active," the on-site faults are not "main splays" of the SJFZ. According to CDMG (1996), the most active branch of the SJFZ is the western branch or Claremont fault. However, as postulated by Sharp (1975), transfer of displacement by crustal extension between the Claremont fault and the closely aligned Glen Helen Fault may be occurring at the northern edge of the San Bernardino Valley. Here, the Glen Helen fault appears to be the dominant trace of the SJFZ, for the Glen Helen fault has scarps and sag ponds in young Holocene alluvium (Figure 15), whereas the Claremont fault does not. Matti, *et al.* (1992) also believe that the Glen Helen fault is the active trace of the SJFZ in the San Gabriel Mountain region.

SCEC (2006a) indicates that recurrence for the Glen Helen and Claremont faults is between 100 and 300 years for earthquake magnitudes M6.5 and M7.5. CDMG (1996) reported that recurrence for the San Jacinto fault (San Bernardino Segment) is 100 years. Fault investigations, within the SJFZ, at two sites near Colton and San Bernardino, California (Kendrick and Fumal, 2005) identified approximately 100- and 266-year return periods, respectively. However, onsite faults have longer recurrence.

As indicated by LOR (1994a), the age of the last event was bracketed by radiocarbon dates from charred wood fragments (Trench T-2). These dates suggest that the last seismic event on that portion of their fault probably occurred between "AD 1380" and "AD 1810" (197 to 626 years before present).

GSI used both soil stratigraphy and radiocarbon age-dating techniques to estimate on-site fault recurrence. This requires that the fault strand with the largest vertical separation be compared with other observed strands that likely move in response to seismic events along the "principal" strand. Assuming that the last seismic event on the fault splay occurred prior to the deposition of the lowermost, unfaulted paleosol, recurrence can be reasonably estimated. Evaluating recurrence by radiocarbon dating is based on the same assumption as long as sediments amenable to radiocarbon dating are present.

The principal fault strand analyzed for recurrence for this particular splay of the SJFZ was exposed in FT-203A at approximately Station No. 191½ (northwest wall [Station No. 192 southeast wall]) and trends N 47° W @ 58° NE [Plate 9]). This fault has approximately ~35 inches of vertical separation near the bottom of the trench and about 22 inches above. The upper two paleosols in this trench were not offset by this strand. Each unbroken paleosol was estimated to have required about 1,000 to 1,500 years to develop (Appendix B). Accordingly, the most recent event on this strand must have occurred prior to at least 2,000 to 3,000 ybp (combined age of the two unfaulted paleosols).

GSI evaluated recurrence through radiocarbon dates by analyzing the fault at approximately Station No. 275, trending N 42° W @ 66° SW in FT-204 (Plate 11). This fault has about 16 inches of apparent, vertical separation near the bottom of the trench, and although difficult to assess due its massiveness and coarse-grained size, about 3 to 4 inches of vertical separation was measured above. Radiocarbon dates indicate that the youngest, faulted unit in this trench is 4,420 ±60 ybp. Sediments amenable to radiocarbon dating were not identified within the oldest, faulted unit in this trench. However, Sample No. 1 was collected from a unit in FT-202 that correlates well to deposits stratigraphically above the most recent seismic event on this strand. The radiocarbon date for this sample is 3,220 ±40 ybp. Thus, the most recent event on this strand occurred between ~4,420 and 3,220 ybp. This further corroborates the recurrence interval evaluated using soil-stratigraphic markers previously mentioned.

In summary, the onsite fault splay displays a longer recurrence interval than recognized by SCEC, CDMG, and Kendrick and Fumal for the SJFZ. Additionally, the splays in our trenches have longer recurrence than stated by LOR. Accordingly, we reasonably judge that possible surface fault rupture over the lifetime of any structure is very low. Nonetheless, setbacks for structures for human occupancy are warranted for the near-surface fault identified in our trenches. Such setbacks are shown on Plate 2. Additionally, owing to the site's proximity to active seismic sources, structures for human occupancy and supporting infrastructure should be designed for strong ground motion (approximately 1g) produced by nearby earthquakes.

SEISMICITY AND SEISMIC HISTORY

The possibility of ground shaking at the site is generally similar to the entire southern California region. The acceleration-attenuation relations of Campbell and Bozorgnia (1997), Bozorgnia, Campbell, and Niazi (1999), and Sadigh, *et al.* (1997) have been incorporated into EQFAULT (Blake, 2000a). EQFAULT is a computer program that performs deterministic seismic hazard analyses using digitized California faults as earthquake sources. For this study, peak horizontal ground accelerations anticipated at the site were based on the mean and mean plus 1 - sigma attenuation curves. The program estimates the closest distance between each fault and a given site. If a fault occurs within a user-selected radius, the program estimates the peak horizontal ground acceleration that may occur at the site from the "upper bound" or "maximum credible" earthquakes. Site acceleration (g) is computed by any of a number of user-selected acceleration-attenuation relations that are contained in EQFAULT. Based on the EQFAULT program, peak horizontal ground accelerations from an upper bound event may be on the order of 0.64g to 1.07g. The computer printouts of pertinent portions of the EQFAULT program are included within Appendix C.

Table 4 lists the major faults and fault zones in southern California (within 100 kilometers [~62 miles] of the site) that could affect the site. The faults and distances have been generated by the EQFAULT program. The approximate geographical center of the study area was used for this analysis. Thus, the distances from the faults, listed below, is dependent upon the coordinates within the site (i.e., latitude and longitude) entered into the program.

TABLE 4

ABBREVIATED FAULT NAME	APPROX. DISTANCE MILES (KM)	ABBREVIATED FAULT NAME	APPROX. DISTANCE MILES (KM)
Blackwater	61.5 (99.0)	North Frontal Fault Zone (East)	35.2 (56.7)
Burnt Mtn.	57.8 (93.1)	North Frontal Fault Zone (West)	11.2 (18.1)
Calico-Hidalgo	60.3 (97.0)	Northridge (E. Oak Ridge)	57.2 (92.1)
Chino-Central Ave. (Elsinore)	23.0 (37.0)	Palos Verdes	58.0 (93.3)
Clamshell - Sawpit	26.2 (42.1)	Pinto Mountain	40.6 (65.3)
Cleghorn	6.6 (10.6)	Raymond	34.2 (55.0)
Compton Trust	42.8 (68.9)	San Andreas - 1857 Rupture	10.5 (16.9)
Cucamonga	2.6 (4.2)	San Andreas - Coachella	57.2 (92.0)
Elsinore - Glen Ivy	27.0 (43.5)	San Andreas - Mojave	10.5 (16.9)
Elsinore - Julian	61.1 (98.3)	San Andreas - San Bernardino	3.9 (6.3)
Elsinore - Temecula	38.5 (61.9)	San Andreas - Southern	3.9 (6.3)
Elysian Park Thrust	30.8 (49.6)	San Grabriel	50.3 (81.0)
Emerson So. - Copper Mtn.	55.1 (88.7)	San Jacinto - Anza	42.4 (68.3)
Eureka Peak	58.5 (94.1)	San Jacinto - San Bernardino	0.0 (0.0)
Gravel Hills - Harper Lake	54.3 (87.4)	San Jacinto - San Jacinto Valley	16.1 (25.9)
Helendale - S. Lockhardt	30.9 (49.8)	San Jose	17.1 (27.6)
Hollywood	47.1 (75.8)	Santa Monica	57.7 (92.9)

ABBREVIATED FAULT NAME	APPROX. DISTANCE MILES (KM)	ABBREVIATED FAULT NAME	APPROX. DISTANCE MILES (KM)
Johnson Valley (Northern)	47.7 (76.8)	Sierra Madre	17.8 (28.6)
Landers	52.0 (83.7)	Sierra Madre (San Fernando)	51.0 (82.1)
Lenwood - Lockhardt - Old Woman Springs	44.4 (71.4)	Verdugo	38.8 (62.5)
Newport - Inglewood (LA Basin)	49.5 (79.6)	Whittier	27.0 (43.5)
Newport - Inglewood (Offshore)	50.8 (81.7)		

The possibility of ground shaking at the site may be considered similar to the southern California region as a whole. The relationship of the site location to these major mapped faults is indicated on Figures 5, 6, 8, and 9. In the event of a "maximum probable" or upper bound ("maximum credible") earthquake on any of the nearby major faults, strong ground shaking would impact the site. Potential damage to any structure(s) would likely be greater from the vibrations and impelling force caused by the inertia of a structure's mass than from the hazards indicated above. This potential would be no greater than that for other existing structures and improvements in the immediate vicinity.

Locating earthquake epicenters is often inaccurate. Estimates of magnitude and epicenter locations for earthquakes prior to recording instruments were usually based on description of the earthquakes by individuals in different areas. Seismic instrumentation did not become available until about 1932, and these earlier instruments were imprecise. Nevertheless historical site seismicity has been evaluated with the acceleration-attenuation relations of Bozorgnia, *et al.* (1999) and the computer program EQSEARCH (Blake, 2000b). This program searches historical earthquake records for magnitude 5.0 to 9.0 seismic events within a 100-mile radius between 1800 to December 2006. Based on the selected acceleration-attenuation relation, a peak horizontal ground acceleration has been estimated, which may have affected the site during specific seismic events in the past. Based on the available data and attenuation relationship used, the estimated maximum (peak) site acceleration between 1800 to December 2006 was about 0.43g. In addition, a seismic recurrence curve and a historic earthquake epicenter map has also been estimated from the historical data (see Appendix C).

A probabilistic seismic-hazards analyses was also performed using FRISKSP (Blake, 2000c) which models earthquake sources as 3-D planes and evaluates the site-specific probabilities of exceedance for given peak acceleration levels or pseudo-relative velocity. These data suggest that the site could be subject to a peak horizontal ground acceleration of 0.99g. This value corresponds to a 10 percent probability of exceedance in 50 years (or a 475-year return period). Computer printouts of the FRISKSP program are included in Appendix C.

The site is located on the SJFZ, as well as near-field to the CFZ and SAFZ. It is therefore potentially subject to ~M7 seismic events (CDMG, 1996). Accordingly, appropriate engineering mitigation for both buildings and infrastructure is mandatory.

SEISMIC SHAKING PARAMETERS

The site is located within the San Jacinto fault zone (SJFZ [San Bernardino Segment]) and now has documented Holocene displacements (see Plate 2). Fault splays or segments associated with the Cucamonga fault zone (CFZ) were not observed during this or previous investigations. However, the Uniform Building Code/California Building Code ([UBC/CBC], International Conference of Building Officials [ICBO]: 1997; 1998; and 2001), which indicates active fault near-source zones to determine near-source factors, such as directivity and fling (Abrahamson, 2005) for seismic design, has designated that portions of the site lie within the Cucamonga fault near-source zone. Therefore, according to code (minimal standards), we provide the following minimal seismic design parameters for the Cucamonga fault near-source zones for preliminary planning. This inherently excludes the effects of earthquake-induced liquefaction. Based on site conditions and Chapter 16 of the UBC (ICBO, 1997), the seismic parameters are provided in Table 5.

TABLE 5

PRELIMINARY FAULT NEAR-SOURCE DATA	
Seismic Zone (per Figure 16-2*)	4
Seismic Zone Factor Z (per Table 16-I*)	0.40
Soil Profile Types (per Table 16-J*)	(Bedrock) S_D/(Alluvium) S_E
Seismic Coefficient C_a (per Table 16-Q*)	0.44 N_a/0.36 N_a
Seismic Coefficient C_v (per Table 16-R*)	0.64 N_v/0.96 N_v
Near-Source Factor N_a (per Table 16-S*)	1.3
Near-Source Factor N_v (per Table 16-T*)	1.7
Seismic Source Type (per Table 16-U*)	A
Distance to Seismic Source	4.2 km
Upper Bound Earthquake	Cucamonga fault M_w = 7.0**
Probabilistic Horizontal Site Acceleration (PHSA) - 10% in 50 years	0.99g
*Figure and table references from Chapter 16 of ICBO (1997) ** ICBO (1998)	

GROUNDWATER

No groundwater barriers have been mapped as transecting the site (Fife, *et al.*, 1976). Fife, *et al.* (1976) indicated that groundwater depths, within the study area, are about 100, or less. Historic groundwater levels reported by CDWR (2006), in a well near the study area, ranged from ±19 to ±108 feet between 1919 and 2000. LOR (1994a) encountered seeps in their exploratory Trench T-1 within Sycamore Canyon, and standing water was encountered in exploratory Trenches T-13, T-14, and T-17 at depths ranging between 10 and 30 feet below the surface within the adjacent Sycamore Flat. STE (1988) also reported seepage in their trenches located near the northwest corner of the site. Thus, perched water may occur due to above average precipitation or the rapid melting of snow packs within the San Gabriel Mountains from "Pineapple Express" or "El Niño" storm events.

No evidence for artesian/spring conditions were noted during our investigation. Subsurface water was not encountered in any excavation completed during this study. These observations reflect site conditions at the time of our investigation and do not preclude changes in local groundwater conditions in the future from heavy irrigation, precipitation, or other factors not obvious at the time of our field work. Perched groundwater may occur in the future due to increased precipitation or increased irrigation and runoff from urbanization, and/or along zones of contrasting permeabilities. (i.e., younger and older alluvial fan deposit contacts).

SUBSIDENCE

Our experience in the site vicinity and review of readily available data indicate that the study area is not subsiding. Lu and Danskin (2001) suggest that, in fact, the site may actually be uplifting, based on rising regional groundwater levels. Subsidence typically occurs due to down-faulting along bordering fault zones and although unlikely at this site, to regional groundwater withdrawal.

The effects of areal subsidence generally occurs at the transition between sediments with substantially different engineering properties. Based on available data, bedrock underlies all alluvial deposits throughout the site; therefore, this potential is considered low. The stereoscopic aerial photographs (Appendix A) also show no features generally associated with areal subsidence (i.e., radially-directed drainages flowing into a depression(s), linearity of depressions associated with mountain fronts).

Ground fissures are generally associated with rapid groundwater withdrawal and associated subsidence, or active faults. Our review did not indicate that rapid groundwater withdrawal is occurring at this time. At the site, should fault induced subsidence (or uplift) occur, it would likely be mitigated by the recommended setback zones indicated on Plate 2.

LIQUEFACTION POTENTIAL

Seismically induced liquefaction is a phenomenon in which cyclic stresses, produced by earthquake-induced ground motion, create excess pore pressures in soils. The soils may thereby acquire a high degree of mobility and lead to lateral movement, sliding, sand boils, consolidation and settlement of loose sediments, and other damaging deformation. This phenomenon occurs only below the water table; but after liquefaction has developed, it can propagate upward into overlying, non-saturated soil as excess pore water dissipates. Typically, liquefaction has a relatively low potential at depths greater than 50 feet and is unlikely and/or will produce vertical strains well below 1 percent for depths below 60 feet when relative densities are 40 to 60 percent and effective overburden pressures are two or more atmospheres, i.e., 4,000 psf (Seed, 2005).

Liquefaction has two principal effects. One is the consolidation of loose sediments with resultant settlement of the ground surface. The other is lateral sliding. Significant permanent lateral movement generally occurs only when there is considerable differential loading on susceptible soils, such as fill or natural ground slopes on alluvium.

Liquefaction susceptibility is related to many factors and the following conditions should be present for liquefaction to occur: 1) sediments must be relatively young in age and not be strongly cemented; 2) sediments generally consist of medium- to fine-grained, relatively cohesionless sands; 3) the sediments must have low relative density; 4) free groundwater must be present in the sediment, and; 5) the site must experience a seismic event of a sufficient duration and magnitude to induce straining of soil particles.

In the site area, at least four to possibly five of the previously mentioned criteria for liquefaction to occur were noted, as the sediments encountered during subsurface investigations, generally consist of poorly cemented, fine- to medium-grained, cohesionless, loose to medium dense, clean, Holocene sands. Although, groundwater was not present within any of our exploratory trenches, historic well data, within the site vicinity, indicates that groundwater depth has fluctuated significantly in the past and that perched water has been recorded, possibly due to above average precipitation or the rapid melting of above average snow packs in the San Gabriel Mountains. LOR (1994a) indicated that groundwater was encountered their exploratory trenches as seeps within Sycamore Canyon (T-1) and standing water within Sycamore Flats (T-13, T-14, and T-17) at depths ranging between 10 and 30 feet. Therefore, shallow groundwater conditions at the site have been recorded in the past and cannot be precluded from occurring in the future. Owing to its location within the San Jacinto fault zone and near-field to the San Andreas and Cucamonga fault zones, the likelihood of the site to experience a seismic event of sufficient magnitude and duration to induce straining of soil particles is generally considered high. Furthermore, the susceptibility of the site to seismically induced liquefaction was substantiated because paleoliquefaction features (sand blows and lateral spreads) were observed within Holocene sediments in Fault Trenches FT-200, FT-201, and FT-202 (Plates 3 through 6) as well as indicated in STE (1988). These features would be expected if the site area had been subject to liquefaction in the past (Obermeier, 1996). Inasmuch as the future performance of the site with respect to liquefaction should be similar to the past, it is imperative that potential for liquefaction be further evaluated, particularly in light of the possibility of future rises in groundwater levels as a result of urbanization or precipitation.

OTHER GEOLOGIC HAZARDS

Landslides

Although no evidence for significant landslides was noted during our investigation, LOR (1994a) has mapped landslides on the site. Since development is proposed within this steep-walled canyon, the potential for slope instability cannot be entirely precluded, especially during significant seismic events. This potential geologic hazard and its mitigation should be evaluated.

Rockfalls

Our investigation did not indicate any significant rockfalls within the areas of proposed development. However, many highly fractured outcrops occur in the northern wall of Sycamore Canyon. Large rocks may become dislodged due to erosion or significant seismic events and could potentially impact the proposed development. Therefore, mitigative recommendations concerning this potential hazard should be provided.

Debris Flows/Flooding/Inundation

Evidence for major active debris flows that may impact the subject development was generally not noted on the property and on aerial photographs. However, the potential for large debris flows within drainages and tributary canyons is moderate to high under present soil cover, vegetation and excessive precipitation conditions and may be further exacerbated in burn areas. Further, low-lying areas of the site are underlain by alluvial deposits that owe their origin, at least in part, to irregular flooding. In consideration of the potential for prolonged rainfall, possible brush fires, and vegetation denudation, we recommend that the project civil engineer consider using debris/desilting/detention basins and/or debris impact walls with sufficient freeboard where swales or their watershed intersect the proposed development.

Settlement

The low-lying alluvial areas of the site have local potential for dry sand settlement, and differential settlement (both static and seismic). This will need evaluation with respect to buildings and critical infrastructure.

CONCLUSIONS AND RECOMMENDATIONS

Based on our current geologic analyses, the proposed project is feasible for its intended use, provided the recommendations in this report are properly implemented during planning, design, and construction. The most significant elements of our investigation are summarized below:

1. The site lies within a region of faults known as the San Jacinto fault zone (SJFZ), which is active (i.e., movement within the Holocene Epoch), according to the State of California (Hart and Bryant, 1997). Holocene faults were identified in some trench exposures during our investigation. Habitable structures will require setbacks from active faults, as shown on Plate 2 (Fault Setback Map). We understand that the Client is relying on the LOR (1994a) data in areas of proposed development not investigated by GSI.

2. Joints and dry sand settlement cracks (i.e., no offset or displacement), presumably associated with near-field seismic activity, were documented in a few trenches; however, these features likely can be reasonably mitigated by properly designed, post-tensioned or mat foundations and/or other engineering design.

3. The site is in an area of potentially high seismic activity and horizontal seismic accelerations are anticipated to be near 1g, should the design earthquake occur. Therefore, there is a potential for more onerous, near-field seismic effects (based on the type and size of the seismic source, distance, and geological aspects), and therefore appropriate mitigation, should take place.

4. Historic well-water data (California Department of Water Resources [CDWR], 2006) indicate that regional groundwater depths, recorded between 1919 and 2000 in a well near the study area, have fluctuated between ±19 and ±108 feet below the surface. Perched water has been observed at the site by other investigators. We also note that perched water may also occur, during and after development, owing to a combination of high rainfall, rapid snowmelt, irrigation runoff and seepage, broken utilities, improper drainage, and relatively impermeable subsoils.

5. We observed local paleoliquefaction features in mid-Holocene and younger sediments, indicating that liquefaction and possible ground deformation has previously occurred onsite. We therefore recommend that additional, site-specific investigations evaluate liquefaction potential, dry sand settlement, as well as other typical geotechnical conditions, such as remedial-removal depths, settlement, engineered and natural slope stability, and design criteria. In view of the site seismic setting and the potential for seismic settlement, post-tensioned and/or mat foundations appear particularly appropriate for this project.

6. Based on our current geological assessments, and excluding proposed setback zones, GSI concludes that active faults (i.e., "sufficiently active" and "well-defined") likely do not exist within the remainder of the property. If present, however, they are of such small displacement to be reasonably mitigated by appropriate engineering design.

7. Major underground or above-ground utility lines should cross active faults at high angles approaching perpendicular. Cut-off valves should be located on both sides of active fault zones to facilitate repair.

8. As a result of strong ground shaking, seiching (periodic oscillation of an enclosed body of water) may occur in any planned lakes (if proposed), potentially topping the confining sides of the lake. Additionally, during a seiche, flooding adjacent to and down-gradient of the lakes (if proposed) may occur.

9. Flooding may also occur during periods of heavy precipitation. The mid- to late-Holocene alluvial sediments at the site were primarily deposited by debris flows emanating from the up-gradient canyon. Therefore, the potential for flooding should be evaluated by the design civil engineer and mitigation should be provided by the design civil engineer and geotechnical consultant, as warranted.

10. Owing to the relatively steep walls of Sycamore Canyon, there is potential for local landslides and rockfalls. Therefore, these potential hazards should be appropriately mitigated.

LIMITATIONS

The materials encountered on the project site and utilized for our analysis are believed representative of the area; however, soil materials vary in character between excavations and natural outcrops or conditions exposed during mass grading. Site conditions may vary due to seasonal changes or other factors.

Inasmuch as our study is based upon our review and engineering analyses and laboratory data, the conclusions and recommendations are professional opinions. These opinions have been derived in accordance with current standards of practice, and no warranty, either express or implied, is given. Standards of practice are subject to change with time. GSI assumes no responsibility or liability for work or testing performed by others, or their inaction; or work performed when GSI is not requested to be onsite, to evaluate if our recommendations have been properly implemented. Use of this report constitutes an agreement and consent by the user to all the limitations outlined above, notwithstanding any other agreements that may be in place. In addition, this report may be subject to review by the controlling authorities. Thus, this report brings to completion our scope of services for this portion of the project. All samples will be disposed of after 30 days, unless specifically requested by the Client, in writing.

APPENDIX A

SELECTED REFERENCES

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APPENDIX A

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APPENDIX B

GEOMORPHIC AND SOIL-STRATIGRAPHY REPORT BY DR. ROY J. SHLEMON AND ^{14}C DATA

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Quaternary Geology
Economic Geomorphology
Soil Stratigraphy
Geoarchaeology

APPENDIX B

QUALITY ASSURANCE ASSESSMENT, GEOSOILS, INC. SUPPLEMENTAL FAULT-ACTIVITY INVESTIGATIONS, LYTLE CREEK RANCH, NEIGHBORHOOD 1, SYCAMORE CANYON AREA, CITY OF RIALTO SAN BERNARDINO COUNTY, CALIFORNIA

INTRODUCTION

This Appendix summarizes field observations and review of a GeoSoils, Inc. (GSI) report concerning the presence, relative activity and age of sediments exposed in trenches emplaced in the Sycamore Canyon area of the proposed Neighborhood 1 development in the City of Rialto. The main purposes of these observations and review were three-fold:

1. To provide internal quality assurance (QA) on behalf of the Lytle Creek Development Company (Anaheim Hills);

2. To assist GSI in dating site sediments and faults based mainly on soil (pedogenic) and geomorphic field observations and on radiocarbon assay;

3. To critique the GSI draft report, logs and related graphics for documentation adequacy, reasonableness of interpretation and compliance with present geologic standards-of-practice.

The field observations were carried out periodically during the summer and fall of 2006, dictated mainly by availability of trench exposures. Formal soil-stratigraphic sections were not measured and described; however, field comparison of relative profile development with those in similar soil-climatic regimes provided initial age estimates that were later corroborated by three, GSI-obtained radiocarbon dates.

Logistical support was kindly provided by the GSI staff, particularly geologists R. Boehmer, J. Franklin and P. McClay. The Independent Reviewer, M. Mills (Pacific Soils Engineering) likewise participated in field discussions. Pertinent location and geologic maps and references are provided in the GSI report and hence are referred to, but not replicated in this Appendix. Soil terminology follows that of the U.S. Natural Resources Conservation Service (Soil Survey Division Staff, 1963; Soil Survey Staff, 1972); and application of soil-stratigraphy to engineering geology is summarized in Shlemon (1985), Birkeland (1999), Birkeland and others (1991), Noller and others (2000) and Schaetzl and Anderson (2005).

GSI INVESTIGATION PROCEDURES

GSI investigated potential on-site faults using traditional and well accepted procedures: Initial review of pertinent literature; aerial-photographic lineament analysis; geological mapping; trench emplacement across suspect lineaments and previously mapped or inferred on-site faults; trench logging and documentation of sediment age using geomorphic, soil-stratigraphic and, where applicable, radiocarbon assay; assessment of fault age, recurrence and character compared with nearby, active San Jacinto splays; reconstruction of the regional neotectonic framework; and technical interpretation and final-report documentation.

DATING ON-SITE SEDIMENTS

Much of the Sycamore Canyon proposed development site lies within a State of California-designated "Earthquake Hazard Zone" for the San Jacinto fault zone (GSI Fig. 2). Various San Jacinto fault splays are demonstrably active (Holocene) and display offset drainage, linear alignments, abrupt scarps and other classic geomorphic expression of recent fault-generated, ground displacement. The Sycamore Canyon area, however, is capped by contemporary, coalescing distal fan deposits derived mainly from surrounding Tertiary and Cretaceous granitic "bedrock" (GSI Plate 1). Accordingly, there is no obvious geomorphic expression of on-site faulting. Further, the modern surface soil (pedogenic profile) is "undeveloped;" namely, a patchy organic epipedon (A horizon; Munsell 2.5Y 4/3) capping unweathered parent sediments (C horizon; 10YR 3/2). Nevertheless, the GSI trenches, up to 30-ft deep, locally exposed 4 to 5 buried paleosols, each of which marks an epoch of relative landscape stability potentially datable by relative profile development.

Each buried paleosol is "slightly developed;" that is, characterized by incipient subsoil oxidation and resulting rubification (cambic [Bw] horizon). As documented on the GSI logs, these horizons are typically 10YR 5/3 to 10YR 6/4 in color and can be readily traced from trench to trench, thus providing stratigraphic markers useful to date fault recurrence and approximate time of last apparent vertical offset. Based on relative profile development, each paleosol is judged to represent ~1.0 to 1.5 ka of weathering. Thus, based on cumulative paleosol age, most GSI trenches bottomed in mid-Holocene alluvium.

The soil-stratigraphic age assessments were ultimately corroborated by three, GSI-obtained radiocarbon dates. For example, in trench FT-202 (GSI Plate 6), GSI documents 5 discrete buried paleosols to a depth of ~25 ft. The second buried paleosol has an estimated soil-stratigraphic age of ~3 ka. At station 0+73, "charred wood fragments" from immediately below the soil yielded a conventional radiocarbon age of 3,330 yrs (Beta-222204). Similarly, sediments at station 1+36, immediately below the estimated 4-6 ka, fifth buried paleosol, yielded a radiocarbon age of 4,560 yrs (Beta-222205). Trench FT-204 (GSI Plates 11 and 12) likewise exposed organic matter suitable for radiocarbon assay. Here, at station 0+93, parent material for a ~4.5 ka, soil-stratigraphically dated paleosol yielded a radiocarbon age of 4,430 yrs bp (Beta-223099).

ON-SITE FAULT CHARACTERISTICS

For the most part, the GSI trenches expose sediments no older than about mid-Holocene in age. Accordingly, any faults exposed are, by current State definition, "active" and therefore warrant appropriate setbacks for placement of habitable structures (GSI Plate 2). But individual faults are not through-going. Rather, as documented on the logs of adjacent trenches, many are apparently less than a few hundred ft long; others appear to bifurcate; and still others showed evidence of recurrence. For example, a fault exposed at station 230 in Trench FT-2004 apparently vertically displaces an estimated 4-5 ka paleosol about 3 inches. This particular fault, however, is capped by unbroken sediments at least ~ 3 ka old (GSI Plates 11 and 12). Thus last surface or near-surface fault displacement took place between ~4-5 and 3 ka ago.

GSI Trench 203A (Plate 9, station 192) exposed a fault displaying the maximum vertical displacement in the site; namely, ~35 inches near the base decreasing to ~22 inches in the middle of the exposed section (Table 2). These offsets suggest that possibly three, ~11-inch displacement events took place after ~5 ka but before ~2-3 ka ago, based on the cumulative age of two, unbroken overlying paleosols.

These on-site fault characteristics, coupled with lack of geomorphic expression to the contrary, contrast with active traces of the San Jacinto system as documented by many others (see GSI references). It is therefore reasonable that most on-site fault are not primary seismogenic structures, but rather are secondary features that coseismically react to ~M7 events on nearby main traces of the San Jacinto system. GSI thus judges that possible surface fault rupture during the lifetime of any structure is likely to be low. Nevertheless, GSI conservatively – and reasonably – recommends habitable-structure setbacks in compliance with current State requirements (Plate 2).

OTHER GEOTECHNICAL CONSTRAINTS

Although not encountering standing groundwater, GSI documents paleoliquefaction features in several on-site trenches. Additionally, regional or perched groundwater levels may rise owing to potential infiltration of urban-induced runoff. Reasonably, therefore, liquefaction analyses need to be carried out to design appropriate mitigation.

GSI also notes that some adjacent canyon walls may possibly fail during a local, high-magnitude earthquake, thus producing local landslides or rockfalls. Also, some GSI trenches exposed mud- and debris flows, indicating that these phenomena may again occur during lifetime of proposed structures. Therefore, appropriate mitigation is similarly warranted.

Owing to proximity of the San Jacinto fault system, the potential for local, seismically induced ground shaking is very high, perhaps reaching or exceeding ~1g (horizontal). Therefore, in addition to liquefaction, dry sand settlement may also induce ground deformation. GSI therefore reasonably recommends engineering analysis and potential mitigation in the form of over-excavation, geotextile placement and strengthened foundations.

SUMMARY AND CONCLUSIONS

GSI now documents supplemental, fault-activity investigations for the proposed, Neighborhood 1 development in the Sycamore Canyon area of Rialto.

GSI investigations were appropriate and conformed to present, geologic standards-of-practice for the area.

Though lacking obvious geomorphic expression, GSI trenched previously inferred or mapped faults across the entire proposed development within the State-mandated, "Earthquake Hazard Zone." The trenches typically ranged in depth from ~25 to 30 ft, and exposed mainly coalescing distal-fan sediments containing up to 5 discrete, slightly developed buried paleosols. The soils are dated by relative development; and each was judged to represent ~1.0 to ~1.5 ka of relative landscape stability. The soil-stratigraphic estimates were corroborated by three, GSI-obtained radiocarbon dates. The soil-stratigraphic and the radiocarbon dates indicate that alluvium at ~25 to 30-ft deep is mid-Holocene in age.

GSI exposed and characterized several on-site faults. Some faults show recurrence; and most surface or near-surface faulting took place prior to ~3 ka ago. By virtue of their mid- to late-Holocene age, all on-site faults are deemed "active" and therefore warrant appropriate, habitable-structure setbacks in compliance with State requirements.

Paleo-liquefaction features in some trenches indicate a potential for future ground failure in the event of urban-induced rises in regional or perched water levels. Additionally, the near proximity of the San Jacinto fault system suggests that horizontal ground motions may exceed 1g, and that this potential must similarly be evaluated and mitigated, ostensibly by appropriate engineering design.

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Roy J. Shlemon, Ph.D.
Quality Assurance Reviewer

February 2007

PG: 2867
CPG: 1766
CPESC: 2167

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MR. DARDEN HOOD
Director

Mr. Ronald Hatfield
Mr. Christopher Patrick
Deputy Directors

October 19, 2006

Mr. Paul L. McClay
GeoSoils, Inc.
26590 Madison Avenue
Murrieta, CA 92562
USA

RE: Radiocarbon Dating Results For Samples Sample No. 1 FT-22@Sta. 73+00, Sample No. 2 FT-202@Sta.136+00

Dear Mr. McClay:

Enclosed are the radiocarbon dating results for two samples recently sent to us. They each provided plenty of carbon for accurate measurements and all the analyses proceeded normally. The report sheet contains the dating result, method used, material type, applied pretreatment and two-sigma calendar calibration result (where applicable) for each sample.

This report has been both mailed and sent electronically, along with a separate publication quality calendar calibration page. This is useful for incorporating directly into your reports. It is also digitally available in Windows metafile (.wmf) format upon request. Calibrations are calculated using the newest (1998) calibration database. References are quoted on the bottom of each calibration page. Multiple probability ranges may appear in some cases, due to short-term variations in the atmospheric 14C contents at certain time periods. Examining the calibration graphs will help you understand this phenomenon. Calibrations may not be included with all analyses. The upper limit is about 20,000 years, the lower limit is about 250 years and some material types are not suitable for calibration (e.g. water).

We analyzed these samples on a sole priority basis. No students or intern researchers who would necessarily be distracted with other obligations and priorities were used in the analyses. We analyzed them with the combined attention of our entire professional staff.

Information pages are enclosed with the mailed copy of this report. They should answer most of questions you may have. If they do not, or if you have specific questions about the analyses, please do not hesitate to contact us. Someone is always available to answer your questions.

Thank you for prepaying the analyses. A receipt is enclosed. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,

Darden Hood

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UNIVERSITY BRANCH
4985 S.W. 74 COURT
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REPORT OF RADIOCARBON DATING ANALYSES

Mr. Paul L. McClay — Report Date: 10/19/2006

GeoSoils, Inc. — Material Received: 10/12/2006

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 222204	3230 +/- 40 BP	-25.6 o/oo	3220 +/- 40 BP

SAMPLE : Sample No. 1 FT-22@Sta. 73+00
ANALYSIS : AMS-PRIORITY delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal BC 1540 to 1410 (Cal BP 3490 to 3360)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 222205	4560 +/- 40 BP	-24.9 o/oo	4560 +/- 40 BP

SAMPLE : Sample No. 2 FT-202@Sta.136+00
ANALYSIS : AMS-PRIORITY delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal BC 3480 to 3470 (Cal BP 5440 to 5420) AND Cal BC 3370 to 3270 (Cal BP 5320 to 5220)
Cal BC 3240 to 3110 (Cal BP 5190 to 5060)

Dates are reported as RCYBP (raduicarbon years before present, "present" = 1950A.D.). By International convention, the modern reference standard was 95% of the C14 content of the National Bureau of Standards' Oxalic Acid & calculated using the Libby C14 half life (5568 years). Quoted errors represent 1 standard deviation statistics (68% probability) & are based on combined measurements of the sample, background, and modern reference standards.

Measured C13/C12 ratios were calculated relative to the PDB-1 international standard and the RCYBP ages were normalized to -25 per mil. If the ratio and age are accompanied by an (*), then the C13/C12 value was estimated, based on values typical of the material type. The quoted results are NOT calibrated to calendar years. Calibration to calendar years should be calculated using the Conventional C14 age.

W.O. 5248-A-SC

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.6:lab. mult=1)

Laboratory number: **Beta-222204**

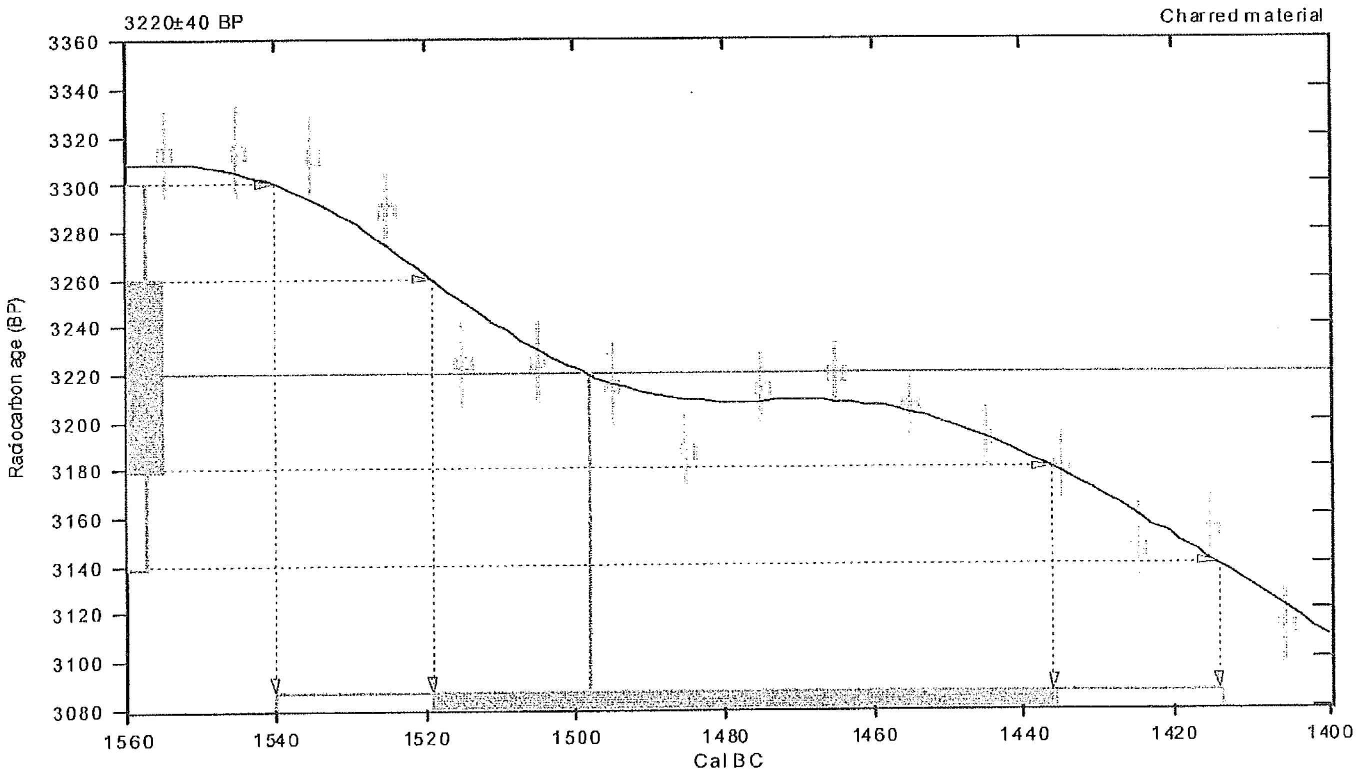
Conventional radiocarbon age: **3220±40 BP**

2 Sigma calibrated result: (95% probability) **Cal BC 1540 to 1410 (Cal BP 3490 to 3360)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal BC 1500 (Cal BP 3450)

1 Sigma calibrated result: (68% probability) Cal BC 1520 to 1440 (Cal BP 3470 to 3390)



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Database used
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Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083
Mathematics
A Simplified Approach to Calibrating C14 Dates
Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.9:lab. mult=1)

Laboratory number: **Beta-222205**

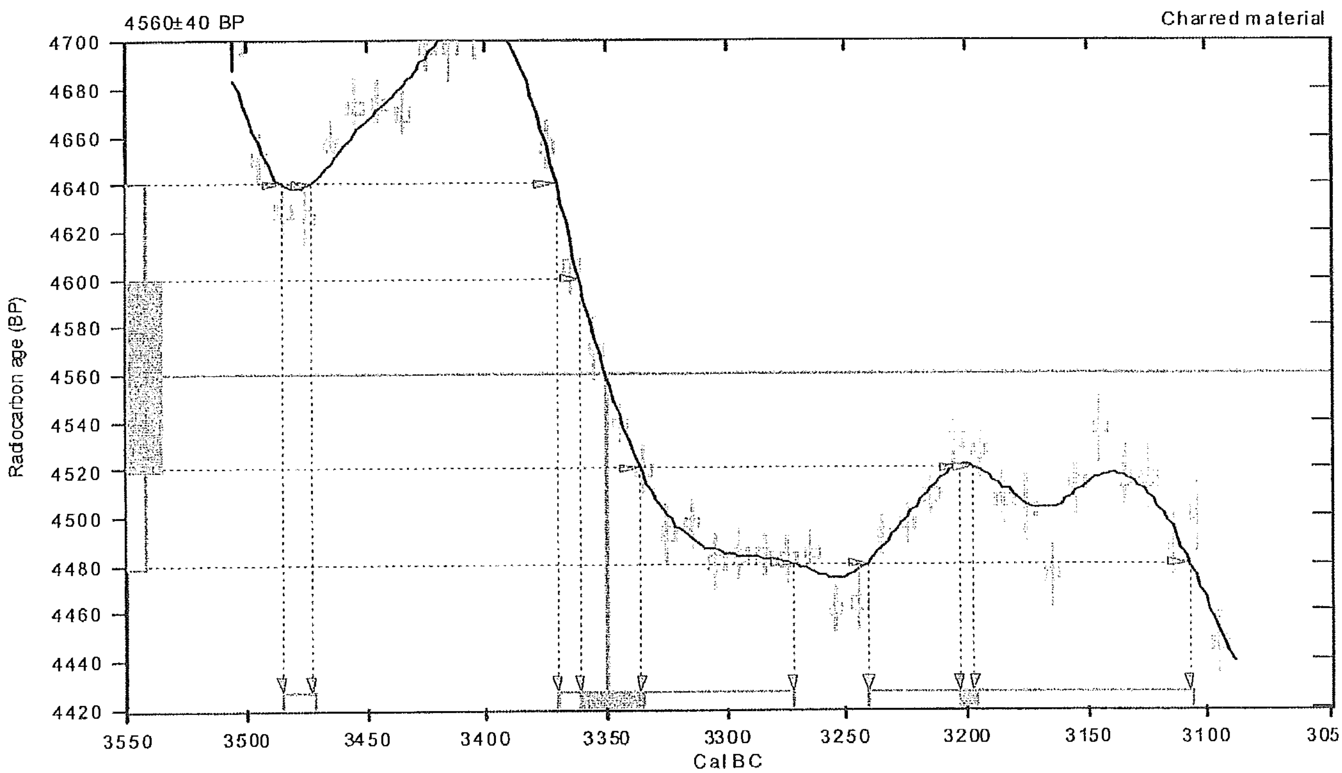
Conventional radiocarbon age: **4560±40 BP**

2 Sigma calibrated results: **Cal BC 3480 to 3470 (Cal BP 5440 to 5420) and**
(95% probability) **Cal BC 3370 to 3270 (Cal BP 5320 to 5220) and**
Cal BC 3240 to 3110 (Cal BP 5190 to 5060)

Intercept data

Intercept of radiocarbon age with calibration curve: Cal BC 3350 (Cal BP 5300)

1 Sigma calibrated results: Cal BC 3360 to 3340 (Cal BP 5310 to 5290) and
(68% probability) Cal BC 3200 to 3200 (Cal BP 5150 to 5150)



References:

Database used
INTCAL98
Calibration Database
Editorial Comment
Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii
INTCAL98 Radiocarbon Age Calibration
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PRETREATMENT GLOSSARY
Standard Pretreatment Protocols at Beta Analytic

Unless otherwise requested by a submitter or discussed in a final date report, the following procedures apply to pretreatment of samples submitted for analysis. This glossary defines the pretreatment methods applied to each result listed on the date report form (e.g. you will see the designation "acid/alkali/acid" listed along with the result for a charcoal sample receiving such pretreatment).

Pretreatment of submitted materials is required to eliminate secondary carbon components. These components, if not eliminated, could result in a radiocarbon date, which is too young or too old. Pretreatment does not ensure that the radiocarbon date will represent the time event of interest. This is determined by the sample integrity. Effects such as the old wood effect, burned intrusive roots, bioturbation, secondary deposition, secondary biogenic activity incorporating recent carbon (bacteria) and the analysis of multiple components of differing age are just some examples of potential problems. The pretreatment philosophy is to reduce the sample to a single component, where possible, to minimize the added subjectivity associated with these types of problems. If you suspect your sample requires special pretreatment considerations be sure to tell the laboratory prior to analysis.

"acid/alkali/acid"

The sample was first gently crushed/dispersed in deionized water. It was then given hot HCI acid washes to eliminate carbonates and alkali washes (NaOH) to remove secondary organic acids. The alkali washes were followed by a final acid rinse to neutralize the solution prior to drying. Chemical concentrations, temperatures, exposure times, and number of repetitions, were applied accordingly with the uniqueness of the sample. Each chemical solution was neutralized prior to application of the next. During these serial rinses, mechanical contaminants such as associated sediments and rootlets were eliminated. This type of pretreatment is considered a "full pretreatment". On occasion the report will list the pretreatment as "acid/alkali/acid - insolubles" to specify which fraction of the sample was analyzed. This is done on occasion with sediments (See "acid/alkali/acid - solubles"

Typically applied to: charcoal, wood, some peats, some sediments, and textiles "acid/alkali/acid - solubles"

On occasion the alkali soluble fraction will be analyzed. This is a special case where soil conditions imply
That the soluble fraction will provide a more accurate date. It is also used on some occasions to verify the present/absence or degree of contamination present from secondary organic acids. The sample was first pretreated with acid to remove any carbonates and to weaken organic bonds. After the alkali washes (as discussed above) are used, the solution containing the alkali soluble fraction is isolated/filtered and combined with acid. The soluble fraction, which precipitates, is rinsed and dried prior to combustion.

"acid/alkali/acid/cellulose extraction"

Following full acid/alkali/acid pretreatments, the sample is bathed in (sodium chlorite) $NaClO_2$ under very controlled conditions (Ph = 3, temperature = 70 degrees C). This eliminates all components except wood cellulose. It is useful for woods that are either very old or highly contaminated.

Applied to: wood

"acid washes"

Surface area was increased as much a possible. Solid chunks were crushed, fibrous materials were shredded, and sediments were dispersed. Acid (HCI) was applied repeatedly to ensure the absence of carbonates. Chemical concentrations, temperatures, exposure times, and number of repetitions, were applied accordingly with the uniqueness of each sample. The sample was not be subjected to alkali washes to ensure the absence of secondary organic acids for intentional reasons. The most common reason is that the primary carbon is soluble in the alkali. Dating results reflect the total organic content of the analyzed material. Their accuracy depends on the researcher's ability to subjectively eliminate potential contaminants based on contextual facts.

Typically applied to: organic sediments, some peats, small wood or charcoal, special cases

PRETREATMENT GLOSSARY
Standard Pretreatment Protocols at Beta Analytic
(Continued)

"collagen extraction: with alkali or collagen extraction: without alkali

The material was first tested for friability ("softness"). Very soft bone material is an indication of the potential absence of the collagen fraction (basal bone protein acting as a "reinforcing agent" within the crystalline apatite structure). It was then washed in de-ionized water, the surface scraped free of the outer most layers and then gently crushed. Dilute, cold HCI acid was repeatedly applied and replenished until the mineral fraction (bone apatite) was eliminated. The collagen was then dissected and inspected for rootlets. Any rootlets present were also removed when replenishing the acid solutions. "With alkali" refers to additional pretreatment with sodium hydroxide (NaOH) to ensure the absence of secondary organic acids. "Without alkali" refers to the NaOH step being skipped due to poor preservation conditions, which could result in removal of all available organics if performed.

Typically applied to: bones

"acid etch"

The calcareous material was first washed in de-ionized water, removing associated organic sediments and debris (where present). The material was then crushed/dispersed and repeatedly subjected to HCI etches to eliminate secondary carbonate components. In the case of thick shells, the surfaces were physically abraded prior to etching down to a hard, primary core remained. In the case of porous carbonate nodules and caliches, very long exposure times were applied to allow infiltration of the acid. Acid exposure times, concentrations, and number of repetitions, were applied accordingly with the uniqueness of the sample.

Typically applied to: shells, caliches, and calcareous nodules

"neutralized"

Carbonates precipitated from ground water are usually submitted in an alkaline condition (ammonium Hydroxide or sodium hydroxide solution). Typically this solution is neutralized in the original sample container, using deionized water. If larger volume dilution was required, the precipitate and solution were transferred to a sealed separatory flask and rinsed to neutrality. Exposure to atmosphere was minimal.

Typically applied to: Strontium carbonate, Barium carbonate
(i.e. precipitated ground water samples)

"carbonate precipitation"

Dissolved carbon dioxide and carbonate species are precipitated from submitted water by complexing them as ammonium carbonate. Strontium chloride is added to the ammonium carbonate solution and strontium carbonate is precipitated for the analysis. The result is representative of the dissolved inorganic carbon within the water. Results are reported as "water DIC".

Applied to: water

"solvent extraction"

The sample was subjected to a series of solvent baths typically consisting of benzene, toluene, hexane, pentane, and/or acetone. This is usually performed prior to acid/alkali/acid pretreatments.

Applied to: textiles, prevalent or suspected cases of pitch/tar contamination, conserved materials.

"none"

No laboratory pretreatments were applied. Special requests and pre-laboratory pretreatment usually accounts for this.

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Mr. Darden Hood
Director

Mr. Ronald Hatfield
Mr. Christopher Patrick
Deputy Directors

Final Report

The final report package includes the final date report, a statement outlining our analytical procedures, a glossary of pretreatment terms, calendar calibration information, billing documents (containing balance/credit information and the number of samples submitted within the yearly discount period), and peripheral items to use with future submittals. The final report includes the individual analysis method, the delivery basis, the material type and the individual pretreatments applied. The final report has been sent by mail and e-mail (where available).

Pretreatment

Pretreatment methods are reported along with each result. All necessary chemical and mechanical pretreatments of the submitted material were applied at the laboratory to isolate the carbon which may best represent the time event of interest. When interpreting the results, it is important to consider the pretreatments. Some samples cannot be fully pretreated, making their ^{14}C ages more subjective than samples which can be fully pretreated. Some materials receive no pretreatments. Please look at the pretreatment indicated for each sample and read the pretreatment glossary to understand the implications.

Analysis

Materials measured by the radiometric technique were analyzed by synthesizing sample carbon to benzene (92% C), measuring for ^{14}C content in one of 53 scintillation spectrometers, and then calculating for radiocarbon age. If the Extended Counting Service was used, the ^{14}C content was measured for a greatly extended period of time. AMS results were derived from reduction of sample carbon to graphite (100% C), along with standards and backgrounds. The graphite was then detected for ^{14}C content in one of 9 accelerator-mass-spectrometers (AMS) .

The Radiocarbon Age and Calendar Calibration

The "Conventional ^{14}C Age (*)" is the result after applying $^{13}C/^{12}C$ corrections to the measured age and is the most appropriate radiocarbon age. If an "*" is attached to this date, it means the $^{13}C/^{12}C$ was estimated rather than measured (The ratio is an option for radiometric analysis, but included on all AMS analyses.) Ages are reported with the units "BP" (Before Present). "Present" is defined as AD 1950 for the purposes of radiocarbon dating.

Results for samples containing more ^{14}C than the modern reference standard are reported as "percent modern carbon" (pMC). These results indicate the material was respiring carbon after the advent of thermo-nuclear weapons testing (and is less than ~ 50 years old).

Applicable calendar calibrations are included for materials between about 100 and 19,000 BP. If calibrations are not included with a report, those results were either too young, too old, or inappropriate for calibration. Please read the enclosed page discussing calibration.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Variables used in the calculation of age calibration → (Variables: est. C13/C12=-25:lab. mult=1)

Laboratory number: **Beta-123456**

Conventional radiocarbon age[1]**:** **2400±60 BP** ← The uncalibrated Conventional Radiocarbon Age (± 1 sigma)

The calendar age range in both calendar years (AD or BC) and in Radiocarbon Years (BP) → **2 Sigma calibrated result: (95% probability)** **Cal BC 770 to 380 (Cal BP 2720 to 2330)**

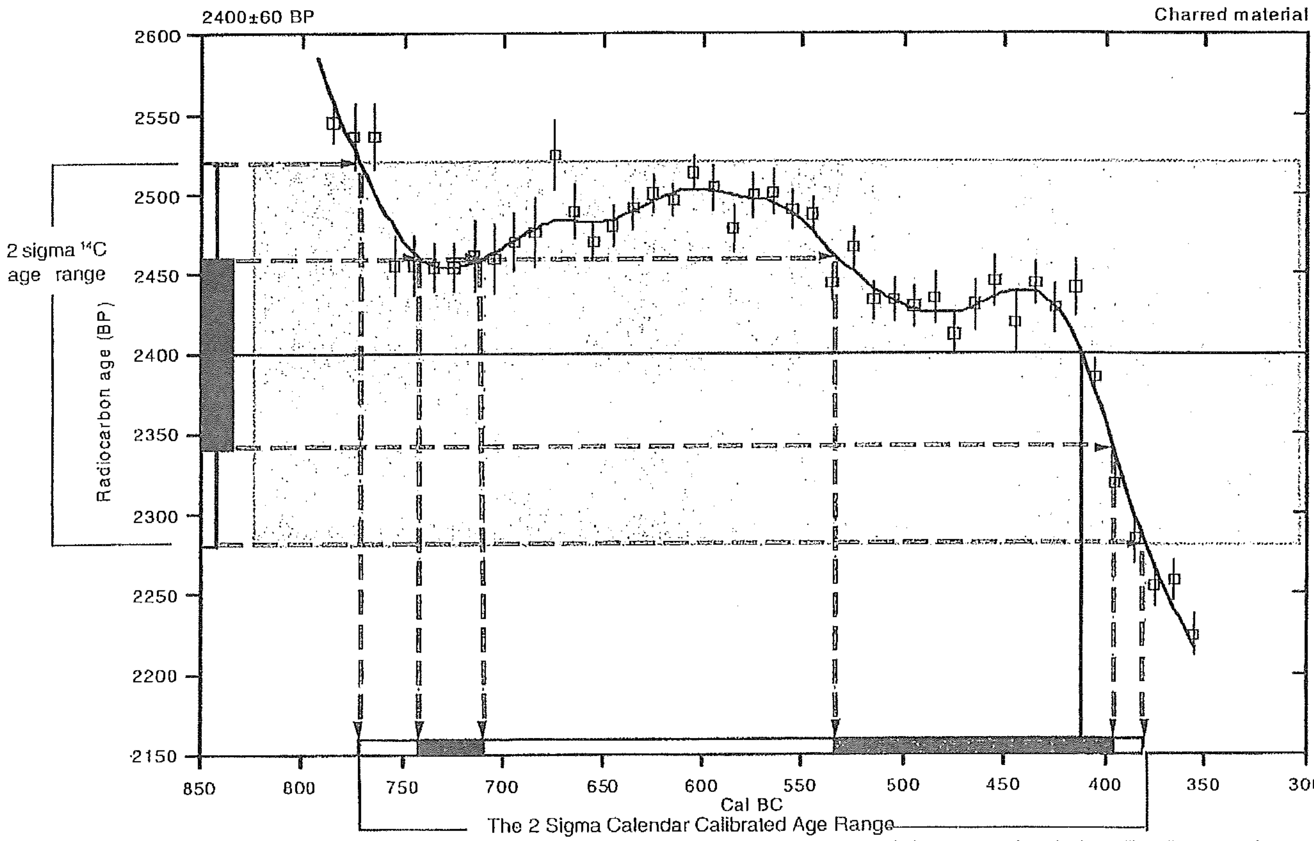
[1] C13/C12 ratio estimated

Intercept data

The intercept between the average radiocarbon age and the calibrated curve time scale. This value is illustrative and should not be used by itself.

Intercept of radiocarbon age with calibration curve: Cal BC 410 (Cal BP 2360)

1 Sigma calibrated result: (68% probability) Cal BC 740 to 710 (Cal BP 2690 to 2660) and Cal BC 535 to 395 (Cal BP 2485 to 2345)



This range is determined by the portion of the curve that is in a "box" drawn from the 2 sigma limits on the radiocarbon age. If a section of the curve goes outside of the "box", multiple ranges will occur as shown by the two 1 sigma ranges which occur from sections going outside of a similar "box" which would be drawn at the 1 sigma limits.

References:

Database used

Intcal 98

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

← References for the calibration data and the mathematics applied to the data. These references, as well as the Conventional Radiocarbon Age and the 13C/12C ratio used should be included in your papers.

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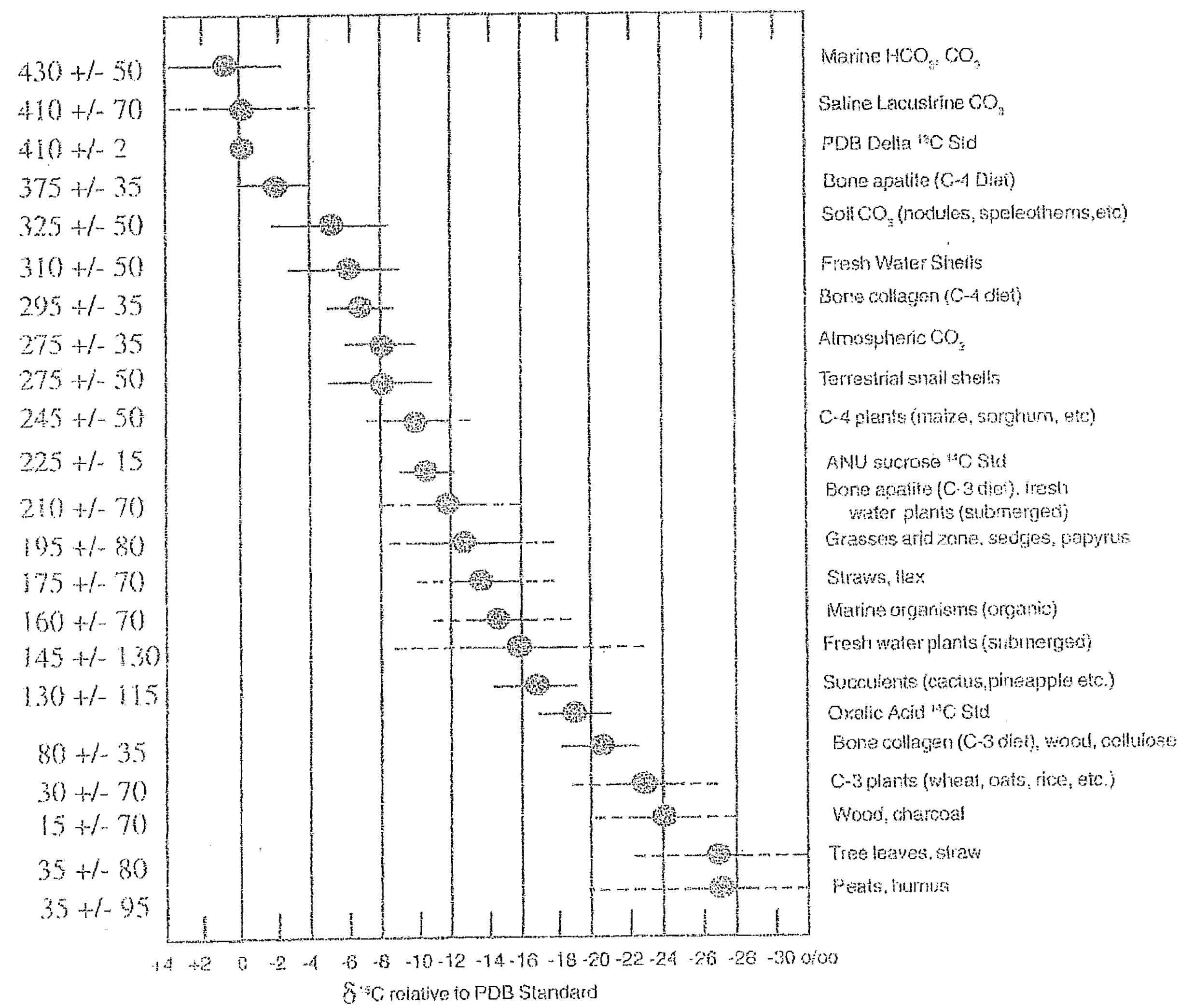
Derivation of a radiometric or accelerator dendro-calibrated (CALENDAR) date requires use of the CONVENTIONAL radiocarbon date (Stuiver and Polach)[1]. The conventional date is a basic radiocarbon date that has been normalized to the modern standard through the use of $^{13}C/^{12}C$ ratios* (analyzed or estimated). The statistical error (+/-) on an analyzed $^{13}C/^{12}C$ value is quite small and does not contribute significantly to the combined error on the date. However, use of an estimated $^{13}C/^{12}C$ ratio for an unknown sample may incur a large combined error term. This is clearly illustrated in the figure below (Gupta & Polach;modifiec by J. Head)[2] where the possible range of $^{13}C/^{12}C$ values for a particular material type may be so large as to preclude any practical application or correction.

In cases where analyzed $^{13}C/^{12}C$ values are not available, we provide (for illustration) dendro-calibrations assuming a mean "chart" value, but without an estimated error term.

Where a sample carbon reservoir different from that modern oxalic acid/wood modern standard is involved (e.g. shell), further reservoir correction must be employed; the variables used in each calibration displayed on each individual calibration sheet.



[1] Stuiver, M. and Polach, H. A., 1977, Discussion: Reporting of 14-C data, Radiocarbon 19, 355-363

[2] Gupta S.K. and Polach H A., 1985, Radiocarbon Dating Practices at ANU Handbook, p. 114, Radiocarbon Laboratory, Research School of Pacific Studies, ANU, Canberra

*Radiocarbon is incorporated into various materials by different pathways and this introduces differing degrees of isotopic fractionation. The $^{13}C/^{12}C$ ratio of any material is the millesimal difference of the sample to the carbonate PDB standard and is directly related to the $^{14}C/^{12}C$ ratio. The degree of sample ^{14}C enrichment or depletion then is normalized to that of the modern standard.

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Mr. Darden Hood
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Mr. Ronald Hatfield
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Deputy Directors

Calendar Calibration at Beta Analytic

Calibrations of radiocarbon age determinations are applied to convert BP results to calendar years. The short-term difference between the two is caused by fluctuations in the heliomagnetic modulation of the galactic cosmic radiation and, recently, large scale burning of fossil fuels and nuclear devices testing. Geomagnetic variations are the probable cause of longer-term differences.

The parameters used for the corrections have been obtained through precise analyses of hundreds of samples taken from known-age tree rings of oak, sequoia, and fir up to about 10,000 BP. Calibration using tree-rings to about 12,000 BP is still being researched and provides somewhat less precise correlation. Beyond that, up to about 20,000 BP, correlation using a modeled curve determined from U/Th measurements on corals is used. This data is still highly subjective. Calibrations are provided up to about 19,000 years BP using the most recent calibration data available.

The Pretoria Calibration Procedure (Radiocarbon, Vol 35, No.1, 1993, pg 317) program has been chosen for these calendar calibrations. It uses splines through the tree-ring data as calibration curves, which eliminates a large part of the statistical scatter of the actual data points. The spline calibration allows adjustment of the average curve by a quantified closeness-of-fit parameter to the measured data points. A single spline is used for the precise correlation data available back to 9900 BP for terrestrial samples and about 6900 BP for marine samples. Beyond that, splines are taken on the error limits of the correlation curve to account for the lack of precision in the data points.

In describing our calibration curves, the solid bars represent one sigma statistics (68% probability) and the hollow bars represent two sigma statistics (95% probability). Marine carbonate samples that have been corrected for $^{13}C/^{12}C$, have also been corrected for both global and local geographic reservoir effects (as published in Radiocarbon, Volume 35, Number 1, 1993) prior to the calibration. Marine carbonates that have not been corrected for $^{13}C/^{12}C$ are adjusted by an assumed value of 0 %0 in addition to the reservoir corrections. Reservoir corrections for fresh water carbonates are usually unknown and are generally not accounted for in those calibrations. In the absence of measured $^{13}C/^{12}C$ ratios, a typical value of -5 %0 is assumed for freshwater carbonates.

(Caveat: the correlation curve for organic materials assume that the material dated was living for exactly ten years (e.g. a collection of 10 individual tree rings taken from the outer portion of a tree that was cut down to produce the sample in the feature dated). For other materials, the maximum and minimum calibrated age ranges given by the computer program are uncertain. The possibility of an "old wood effect" must also be considered, as well as the potential inclusion of younger or older material in matrix samples. Since these factors are indeterminant error in most cases, these calendar calibration results should be used only for illustrative purposes. In the case of carbonates, reservoir correction is theoretical and the local variations are real, highly variable and dependent on provenience. Since imprecision in the correlation data beyond 10,000 years is high, calibrations in this range are likely to change in the future with refinement in the correlation curve. The age ranges and especially the intercept ages generated by the program must be considered as approximations.)

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MR. DARDEN HOOD
Director

Mr. Ronald Hatfield
Mr. Christopher Patrick
Deputy Directors

RECEIVED
DEC 04 2006
BY:

November 16, 2006

Mr. Paul L. McClay
GeoSoils, Inc.
26590 Madison Avenue
Murrieta, CA 92562
USA

RE: Radiocarbon Dating Result For Sample FT-204 @ Sta. 93+00

Dear Mr. McClay:

Enclosed is the radiocarbon dating result for one sample recently sent to us. It provided plenty of carbon for an accurate measurement and the analysis proceeded normally. As usual, the method of analysis is listed on the report sheet and calibration data is provided where applicable.

As always, no students or intern researchers who would necessarily be distracted with other obligations and priorities were used in the analysis. It was analyzed with the combined attention of our entire professional staff.

If you have specific questions about the analyses, please contact us. We are always available to answer your questions.

Thank you for prepaying the analysis. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,

Darden Hood

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BETA ANALYTIC INC.

DR. M.A. TAMERS and MR. D.G. HOOD

UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964
E-MAIL: beta@radiocarbon.com

REPORT OF RADIOCARBON DATING ANALYSES

Mr. Paul L. McClay — Report Date: 11/16/2006

GeoSoils, Inc. — Material Received: 11/9/2006

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 223099	4430 +/- 60 BP	-25.7 o/oo	4420 +/- 60 BP

SAMPLE : FT-204 @ Sta. 93+00
ANALYSIS : AMS-PRIORITY delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal BC 3340 to 2900 (Cal BP 5290 to 4850)

Dates are reported as RCYBP (raduicarbon years before present, "present" = 1950A.D.). By International convention, the modern reference standard was 95% of the C14 content of the National Bureau of Standards' Oxalic Acid & calculated using the Libby C14 half life (5568 years). Quoted errors represent 1 standard deviation statistics (68% probability) & are based on combined measurements of the sample, background, and modern reference standards.

Measured C13/C12 ratios were calculated relative to the PDB-1 international standard and the RCYBP ages were normalized to -25 per mil. If the ratio and age are accompanied by an (*), then the C13/C12 value was estimated, based on values typical of the material type. The quoted results are NOT calibrated to calendar years. Calibration to calendar years should be calculated using the Conventional C14 age.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.7:lab. mult=1)

Laboratory number: **Beta-223099**

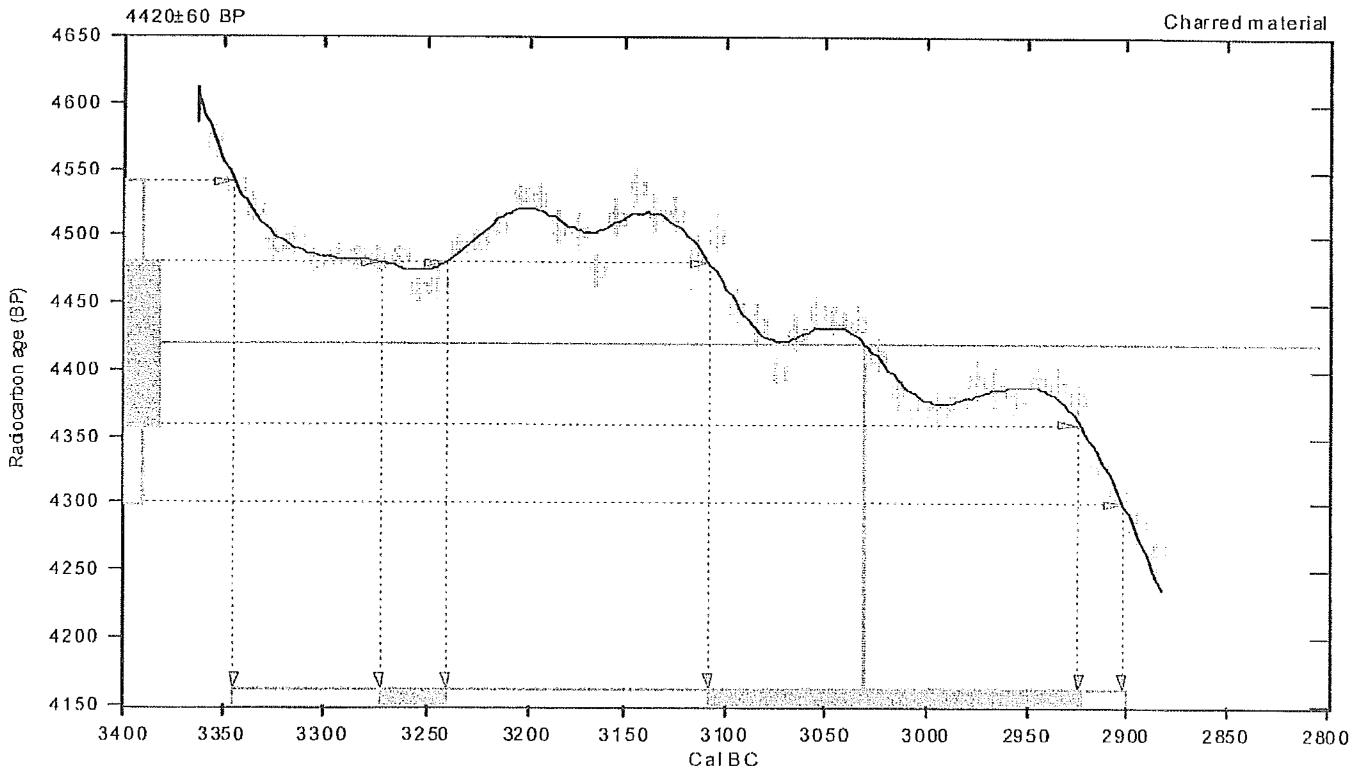
Conventional radiocarbon age: **4420±60 BP**

2 Sigma calibrated result: **Cal BC 3340 to 2900 (Cal BP 5290 to 4850)**
(95% probability)

Intercept data

Intercept of radiocarbon age with calibration curve: Cal BC 3030 (Cal BP 4980)

1 Sigma calibrated results: Cal BC 3270 to 3240 (Cal BP 5220 to 5190) and
(68% probability) Cal BC 3110 to 2920 (Cal BP 5060 to 4870)



References:

Database used
INTCAL98
Calibration Database
Editorial Comment
Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii
INTCAL98 Radiocarbon Age Calibration
Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083
Mathematics
A Simplified Approach to Calibrating C14 Dates
Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

Beta Analytic Radiocarbon Dating Laboratory

4985 S.W. 74th Court, Miami, Florida 33155 • Tel: (305)667-5167 • Fax: (305)663-0964 • E-Mail: beta@radiocarbon.com

PRETREATMENT GLOSSARY
Standard Pretreatment Protocols at Beta Analytic

Unless otherwise requested by a submitter or discussed in a final date report, the following procedures apply to pretreatment of samples submitted for analysis. This glossary defines the pretreatment methods applied to each result listed on the date report form (e.g. you will see the designation "acid/alkali/acid" listed along with the result for a charcoal sample receiving such pretreatment).

Pretreatment of submitted materials is required to eliminate secondary carbon components. These components, if not eliminated, could result in a radiocarbon date, which is too young or too old. Pretreatment does not ensure that the radiocarbon date will represent the time event of interest. This is determined by the sample integrity. Effects such as the old wood effect, burned intrusive roots, bioturbation, secondary deposition, secondary biogenic activity incorporating recent carbon (bacteria) and the analysis of multiple components of differing age are just some examples of potential problems. The pretreatment philosophy is to reduce the sample to a single component, where possible, to minimize the added subjectivity associated with these types of problems. If you suspect your sample requires special pretreatment considerations be sure to tell the laboratory prior to analysis.

"acid/alkali/acid"

The sample was first gently crushed/dispersed in deionized water. It was then given hot HCI acid washes to eliminate carbonates and alkali washes (NaOH) to remove secondary organic acids. The alkali washes were followed by a final acid rinse to neutralize the solution prior to drying. Chemical concentrations, temperatures, exposure times, and number of repetitions, were applied accordingly with the uniqueness of the sample. Each chemical solution was neutralized prior to application of the next. During these serial rinses, mechanical contaminants such as associated sediments and rootlets were eliminated. This type of pretreatment is considered a "full pretreatment". On occasion the report will list the pretreatment as "acid/alkali/acid - insolubles" to specify which fraction of the sample was analyzed. This is done on occasion with sediments (See "acid/alkali/acid - solubles"

Typically applied to: charcoal, wood, some peats, some sediments, and textiles "acid/alkali/acid - solubles"

On occasion the alkali soluble fraction will be analyzed. This is a special case where soil conditions imply
That the soluble fraction will provide a more accurate date. It is also used on some occasions to verify the present/absence or degree of contamination present from secondary organic acids. The sample was first pretreated with acid to remove any carbonates and to weaken organic bonds. After the alkali washes (as discussed above) are used, the solution containing the alkali soluble fraction is isolated/filtered and combined with acid. The soluble fraction, which precipitates, is rinsed and dried prior to combustion.

"acid/alkali/acid/cellulose extraction"

Following full acid/alkali/acid pretreatments, the sample is bathed in (sodium chlorite) $NaClO_2$ under very controlled conditions (Ph = 3, temperature = 70 degrees C). This eliminates all components except wood cellulose. It is useful for woods that are either very old or highly contaminated.

Applied to: wood

"acid washes"

Surface area was increased as much a possible. Solid chunks were crushed, fibrous materials were shredded, and sediments were dispersed. Acid (HCI) was applied repeatedly to ensure the absence of carbonates. Chemical concentrations, temperatures, exposure times, and number of repetitions, were applied accordingly with the uniqueness of each sample. The sample was not be subjected to alkali washes to ensure the absence of secondary organic acids for intentional reasons. The most common reason is that the primary carbon is soluble in the alkali. Dating results reflect the total organic content of the analyzed material. Their accuracy depends on the researcher's ability to subjectively eliminate potential contaminants based on contextual facts.

Typically applied to: organic sediments, some peats, small wood or charcoal, special cases

PRETREATMENT GLOSSARY
Standard Pretreatment Protocols at Beta Analytic
(Continued)

"collagen extraction: with alkali or collagen extraction: without alkali

The material was first tested for friability ("softness"). Very soft bone material is an indication of the potential absence of the collagen fraction (basal bone protein acting as a "reinforcing agent" within the crystalline apatite structure). It was then washed in de-ionized water, the surface scraped free of the outer most layers and then gently crushed. Dilute, cold HCI acid was repeatedly applied and replenished until the mineral fraction (bone apatite) was eliminated. The collagen was then dissected and inspected for rootlets. Any rootlets present were also removed when replenishing the acid solutions. "With alkali" refers to additional pretreatment with sodium hydroxide (NaOH) to ensure the absence of secondary organic acids. "Without alkali" refers to the NaOH step being skipped due to poor preservation conditions, which could result in removal of all available organics if performed.

Typically applied to: bones

"acid etch"

The calcareous material was first washed in de-ionized water, removing associated organic sediments and debris (where present). The material was then crushed/dispersed and repeatedly subjected to HCI etches to eliminate secondary carbonate components. In the case of thick shells, the surfaces were physically abraded prior to etching down to a hard, primary core remained. In the case of porous carbonate nodules and caliches, very long exposure times were applied to allow infiltration of the acid. Acid exposure times, concentrations, and number of repetitions, were applied accordingly with the uniqueness of the sample.

Typically applied to: shells, caliches, and calcareous nodules

"neutralized"

Carbonates precipitated from ground water are usually submitted in an alkaline condition (ammonium Hydroxide or sodium hydroxide solution). Typically this solution is neutralized in the original sample container, using deionized water. If larger volume dilution was required, the precipitate and solution were transferred to a sealed separatory flask and rinsed to neutrality. Exposure to atmosphere was minimal.

Typically applied to: Strontium carbonate, Barium carbonate
(i.e. precipitated ground water samples)

"carbonate precipitation"

Dissolved carbon dioxide and carbonate species are precipitated from submitted water by complexing them as ammonium carbonate. Strontium chloride is added to the ammonium carbonate solution and strontium carbonate is precipitated for the analysis. The result is representative of the dissolved inorganic carbon within the water. Results are reported as "water DIC".

Applied to: water

"solvent extraction"

The sample was subjected to a series of solvent baths typically consisting of benzene, toluene, hexane, pentane, and/or acetone. This is usually performed prior to acid/alkali/acid pretreatments.

Applied to: textiles, prevalent or suspected cases of pitch/tar contamination, conserved materials.

"none"

No laboratory pretreatments were applied. Special requests and pre-laboratory pretreatment usually accounts for this.

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Final Report

The final report package includes the final date report, a statement outlining our analytical procedures, a glossary of pretreatment terms, calendar calibration information, billing documents (containing balance/credit information and the number of samples submitted within the yearly discount period), and peripheral items to use with future submittals. The final report includes the individual analysis method, the delivery basis, the material type and the individual pretreatments applied. The final report has been sent by mail and e-mail (where available).

Pretreatment

Pretreatment methods are reported along with each result. All necessary chemical and mechanical pretreatments of the submitted material were applied at the laboratory to isolate the carbon which may best represent the time event of interest. When interpreting the results, it is important to consider the pretreatments. Some samples cannot be fully pretreated, making their ^{14}C ages more subjective than samples which can be fully pretreated. Some materials receive no pretreatments. Please look at the pretreatment indicated for each sample and read the pretreatment glossary to understand the implications.

Analysis

Materials measured by the radiometric technique were analyzed by synthesizing sample carbon to benzene (92% C), measuring for ^{14}C content in one of 53 scintillation spectrometers, and then calculating for radiocarbon age. If the Extended Counting Service was used, the ^{14}C content was measured for a greatly extended period of time. AMS results were derived from reduction of sample carbon to graphite (100% C), along with standards and backgrounds. The graphite was then detected for ^{14}C content in one of 9 accelerator-mass-spectrometers (AMS) .

The Radiocarbon Age and Calendar Calibration

The "Conventional ^{14}C Age (*)" is the result after applying $^{13}C/^{12}C$ corrections to the measured age and is the most appropriate radiocarbon age. If an "*" is attached to this date, it means the $^{13}C/^{12}C$ was estimated rather than measured (The ratio is an option for radiometric analysis, but included on all AMS analyses.) Ages are reported with the units "BP" (Before Present). "Present" is defined as AD 1950 for the purposes of radiocarbon dating.

Results for samples containing more ^{14}C than the modern reference standard are reported as "percent modern carbon" (pMC). These results indicate the material was respiring carbon after the advent of thermo-nuclear weapons testing (and is less than ~ 50 years old).

Applicable calendar calibrations are included for materials between about 100 and 19,000 BP. If calibrations are not included with a report, those results were either too young, too old, or inappropriate for calibration. Please read the enclosed page discussing calibration.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Variables used in the calculation of age calibration → (Variables: est. C13/C12=-25:lab. mult=1)

Laboratory number: **Beta-123456**

Conventional radiocarbon age[1]: **2400±60 BP** ← The uncalibrated Conventional Radiocarbon Age (± 1 sigma)

The calendar age range in both calendar years (AD or BC) and in Radiocarbon Years (BP) → **2 Sigma calibrated result: (95% probability)** **Cal BC 770 to 380 (Cal BP 2720 to 2330)**

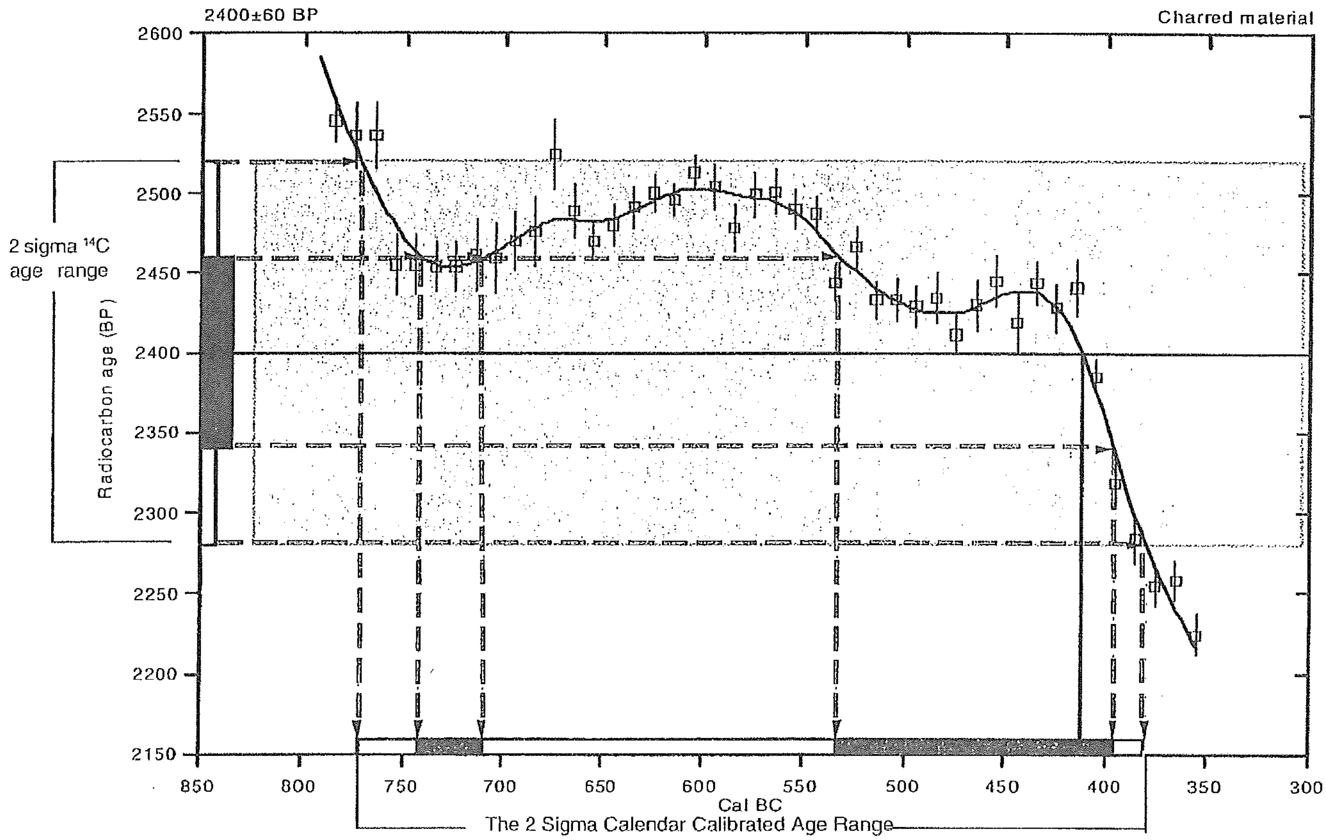
[1] *C13/C12 ratio estimated*

Intercept data

The intercept between the average radiocarbon age and the calibrated curve time scale. This value is illustrative and should not be used by itself.

Intercept of radiocarbon age with calibration curve: Cal BC 410 (Cal BP 2360)

1 Sigma calibrated result: (68% probability) Cal BC 740 to 710 (Cal BP 2690 to 2660) and Cal BC 535 to 395 (Cal BP 2485 to 2345)



The 2 Sigma Calendar Calibrated Age Range

This range is determined by the portion of the curve that is in a "box" drawn from the 2 sigma limits on the radiocarbon age. If a section of the curve goes outside of the "box", multiple ranges will occur as shown by the two 1 sigma ranges which occur from sections going outside of a similar "box" which would be drawn at the 1 sigma limits.

References:

Database used
Intcal 98
Calibration Database
Editorial Comment
Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii
INTCAL98 Radiocarbon Age Calibration
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Mathematics
A Simplified Approach to Calibrating C14 Dates
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← References for the calibration data and the mathematics applied to the data. These references, as well as the Conventional Radiocarbon Age and the 13C/12C ratio used should be included in your papers.

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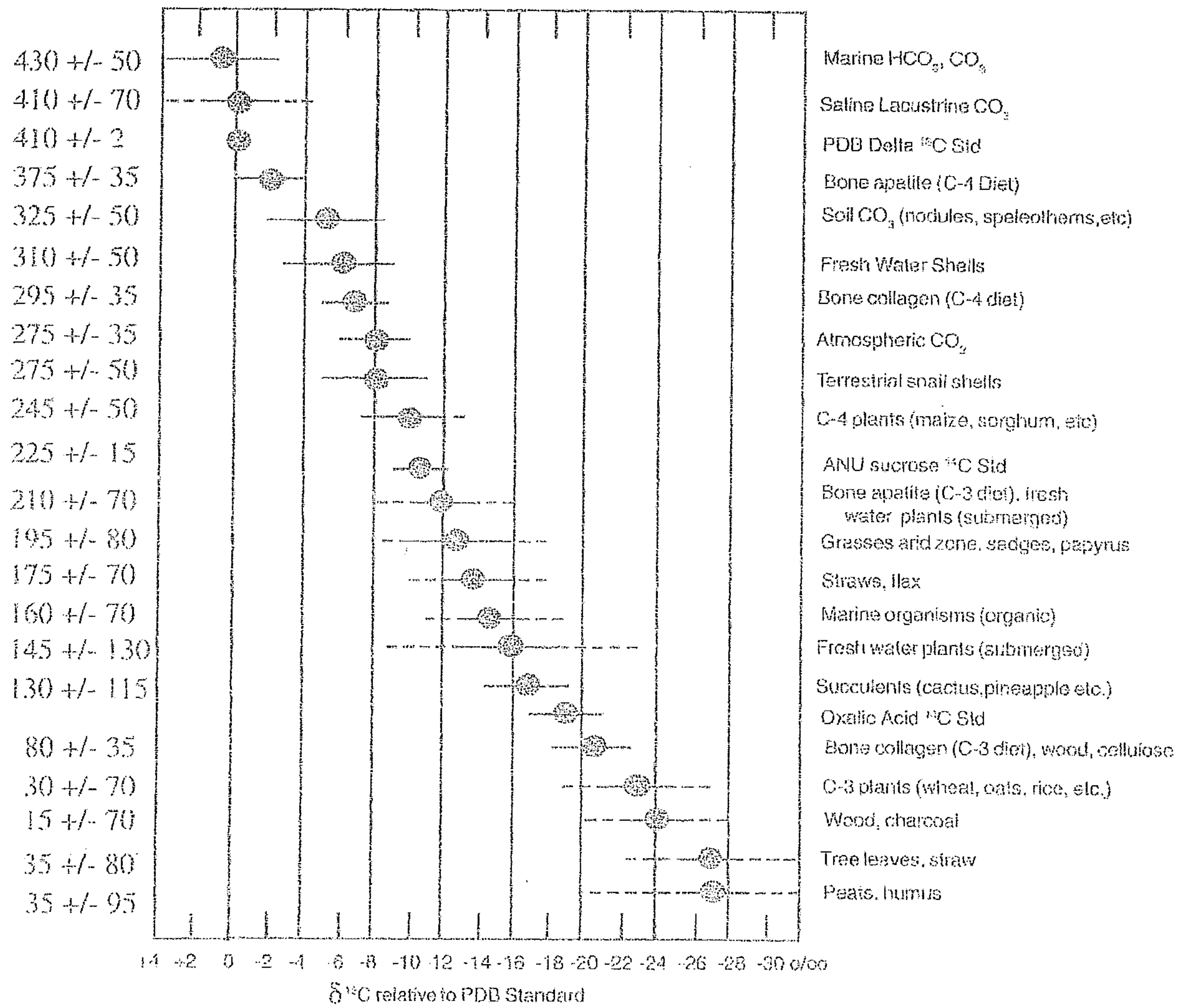
Derivation of a radiometric or accelerator dendro-calibrated (CALENDAR) date requires use of the CONVENTIONAL radiocarbon date (Stuiver and Polach)[1]. The conventional date is a basic radiocarbon date that has been normalized to the modern standard through the use of $^{13}C/^{12}C$ ratios* (analyzed or estimated). The statistical error (+/-) on an analyzed $^{13}C/^{12}C$ value is quite small and does not contribute significantly to the combined error on the date. However, use of an estimated $^{13}C/^{12}C$ ratio for an unknown sample may incur a large combined error term. This is clearly illustrated in the figure below (Gupta & Polach;modified by J. Head)[2] where the possible range of $^{13}C/^{12}C$ values for a particular material type may be so large as to preclude any practical application or correction.

In cases where analyzed $^{13}C/^{12}C$ values are not available, we provide (for illustration) dendro-calibrations assuming a mean "chart" value, but without an estimated error term.

Where a sample carbon reservoir different from that modern oxalic acid/wood modern standard is involved (e.g. shell), further reservoir correction must be employed: the variables used in each calibration displayed on each individual calibration sheet.



[1] Stuiver, M. and Polach, H.A., 1977, Discussion: Reporting of 14-C data, Radiocarbon 19, 355-363

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APPENDIX C

SEISMIC ANALYSIS

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*************************
*                       *
*     E Q S E A R C H   *
*                       *
*     Version 3.00      *
*                       *
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ESTIMATION OF
PEAK ACCELERATION FROM
CALIFORNIA EARTHQUAKE CATALOGS

JOB NUMBER: 5278-A-SC

DATE: 11-13-2006

JOB NAME: LYTLE DEVELOPMENT COMPANY

EARTHQUAKE-CATALOG-FILE NAME: ALLQUAKE.DAT

SITE COORDINATES:
SITE LATITUDE: 34.1963
SITE LONGITUDE: 117.4123

SEARCH DATES:
START DATE: 1800
END DATE: 2006

SEARCH RADIUS:
100.0 mi
160.9 km

ATTENUATION RELATION: 10) Bozorgnia Campbell Niazi (1999) Hor.-Holocene Soil-Cor.
UNCERTAINTY (M=Median, S=Sigma): S   Number of Sigmas: 1.0
ASSUMED SOURCE TYPE: SS [SS=Strike-slip, DS=Reverse-slip, BT=Blind-thrust]
SCOND: 1 Depth Source: A
Basement Depth: 1.00 km   Campbell SSR: 0   Campbell SHR: 0
COMPUTE PEAK HORIZONTAL ACCELERATION

MINIMUM DEPTH VALUE (km): 3.0

EARTHQUAKE SEARCH RESULTS

Page 1

FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
DMG	34.2000	117.4000	07/22/1899	046 0.0	0.0	5.50	0.430	X	0.7(1.2)
DMG	34.3000	117.5000	07/22/1899	2032 0.0	0.0	6.50	0.339	IX	8.7(14.1)
DMG	34.2700	117.5400	09/12/1970	143053.0	8.0	5.40	0.169	VIII	8.9(14.3)
MGI	34.1000	117.3000	07/15/1905	2041 0.0	0.0	5.30	0.153	VIII	9.2(14.9)
DMG	34.3000	117.6000	07/30/1894	512 0.0	0.0	6.00	0.177	VIII	12.9(20.7)
MGI	34.0000	117.5000	12/16/1858	10 0 0.0	0.0	7.00	0.292	IX	14.4(23.2)
DMG	34.0000	117.2500	07/23/1923	73026.0	0.0	6.25	0.163	VIII	16.4(26.4)
GSP	34.1400	117.7000	02/28/1990	234336.6	5.0	5.20	0.082	VII	16.9(27.2)
DMG	34.2000	117.1000	09/20/1907	154 0.0	0.0	6.00	0.128	VIII	17.8(28.7)
DMG	34.3700	117.6500	12/08/1812	15 0 0.0	0.0	7.00	0.237	IX	18.1(29.1)
DMG	33.9000	117.2000	12/19/1880	0 0 0.0	0.0	6.00	0.095	VII	23.8(38.3)
DMG	34.2670	116.9670	08/29/1943	34513.0	0.0	5.50	0.064	VI	25.9(41.6)
GSP	34.2900	116.9460	02/10/2001	210505.8	9.0	5.10	0.048	VI	27.4(44.1)
DMG	34.2000	117.9000	08/28/1889	215 0.0	0.0	5.50	0.059	VI	27.8(44.8)
DMG	34.1800	116.9200	01/16/1930	034 3.6	0.0	5.10	0.046	VI	28.1(45.3)
DMG	34.1800	116.9200	01/16/1930	02433.9	0.0	5.20	0.049	VI	28.1(45.3)
MGI	33.8000	117.6000	04/22/1918	2115 0.0	0.0	5.00	0.042	VI	29.4(47.3)
GSP	34.3400	116.9000	11/27/1992	160057.5	1.0	5.30	0.047	VI	30.9(49.7)
GSP	34.1950	116.8620	08/17/1992	204152.1	11.0	5.30	0.046	VI	31.4(50.6)
GSP	34.3690	116.8970	12/04/1992	020857.5	3.0	5.30	0.046	VI	31.7(51.0)
GSP	34.1630	116.8550	06/28/1992	144321.0	6.0	5.30	0.046	VI	31.9(51.4)
GSP	34.2390	116.8370	07/09/1992	014357.6	0.0	5.30	0.044	VI	33.0(53.1)
GSG	34.3100	116.8480	02/22/2003	121910.6	1.0	5.20	0.041	V	33.1(53.3)
GSN	34.2030	116.8270	06/28/1992	150530.7	5.0	6.70	0.105	VII	33.4(53.8)
GSP	34.2620	118.0020	06/28/1991	144354.5	11.0	5.40	0.045	VI	34.0(54.7)
DMG	33.7000	117.4000	05/15/1910	1547 0.0	0.0	6.00	0.065	VI	34.3(55.1)
DMG	33.7000	117.4000	04/11/1910	757 0.0	0.0	5.00	0.036	V	34.3(55.1)
DMG	33.7000	117.4000	05/13/1910	620 0.0	0.0	5.00	0.036	V	34.3(55.1)
DMG	33.6990	117.5110	05/31/1938	83455.4	10.0	5.50	0.047	VI	34.8(56.0)
DMG	34.1000	116.8000	10/24/1935	1448 7.6	0.0	5.10	0.036	V	35.6(57.3)
DMG	33.8000	117.0000	12/25/1899	1225 0.0	0.0	6.40	0.080	VII	36.1(58.1)
MGI	34.0000	118.0000	12/25/1903	1745 0.0	0.0	5.00	0.034	V	36.2(58.3)
DMG	33.9500	116.8500	09/28/1946	719 9.0	0.0	5.00	0.034	V	36.4(58.5)
DMG	33.7500	117.0000	06/06/1918	2232 0.0	0.0	5.00	0.031	V	38.8(62.5)
DMG	33.7500	117.0000	04/21/1918	223225.0	0.0	6.80	0.096	VII	38.8(62.5)
PAS	34.0610	118.0790	10/01/1987	144220.0	9.5	5.90	0.053	VI	39.2(63.1)
MGI	34.1000	118.1000	07/11/1855	415 0.0	0.0	6.30	0.067	VI	39.8(64.1)
PAS	34.0730	118.0980	10/04/1987	105938.2	8.2	5.30	0.036	V	40.1(64.5)
DMG	34.1000	116.7000	02/07/1889	520 0.0	0.0	5.30	0.035	V	41.2(66.4)
DMG	33.9760	116.7210	06/12/1944	104534.7	10.0	5.10	0.030	V	42.4(68.2)
DMG	33.9940	116.7120	06/12/1944	111636.0	10.0	5.30	0.034	V	42.4(68.2)
DMG	33.7100	116.9250	09/23/1963	144152.6	16.5	5.00	0.028	V	43.7(70.3)
PAS	33.9980	116.6060	07/08/1986	92044.5	11.7	5.60	0.036	V	48.1(77.4)
MGI	34.0800	118.2600	07/16/1920	18 8 0.0	0.0	5.00	0.025	V	49.1(79.0)
DMG	33.7500	118.0830	03/11/1933	230 0.0	0.0	5.10	0.026	V	49.2(79.2)
DMG	33.7500	118.0830	03/11/1933	2 9 0.0	0.0	5.00	0.024	V	49.2(79.2)
DMG	33.7500	118.0830	03/11/1933	323 0.0	0.0	5.00	0.024	V	49.2(79.2)

DMG	33.7500	118.0830	03/13/1933	131828.0	0.0	5.30	0.029	V	49.2(79.2)
DMG	33.7500	118.0830	03/11/1933	910 0.0	0.0	5.10	0.026	V	49.2(79.2)
T-A	34.0000	118.2500	09/23/1827	0 0 0.0	0.0	5.00	0.024	V	49.8(80.1)
T-A	34.0000	118.2500	03/26/1860	0 0 0.0	0.0	5.00	0.024	V	49.8(80.1)
T-A	34.0000	118.2500	01/10/1856	0 0 0.0	0.0	5.00	0.024	V	49.8(80.1)
DMG	34.5190	118.1980	08/23/1952	10 9 7.1	13.1	5.00	0.024	V	50.0(80.5)

EARTHQUAKE SEARCH RESULTS

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FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
DMG	33.7830	118.1330	10/02/1933	91017.6	0.0	5.40	0.030	V	50.2(80.7)
DMG	33.7000	118.0670	03/11/1933	51022.0	0.0	5.10	0.025	V	50.8(81.7)
DMG	33.7000	118.0670	03/11/1933	85457.0	0.0	5.10	0.025	V	50.8(81.7)
DMG	33.6830	118.0500	03/11/1933	658 3.0	0.0	5.50	0.032	V	50.9(81.9)
DMG	33.6170	117.9670	03/11/1933	154 7.8	0.0	6.30	0.052	VI	51.1(82.2)
GSP	34.3410	116.5290	06/28/1992	124053.5	6.0	5.20	0.026	V	51.4(82.7)
MGI	34.0000	118.3000	09/03/1905	540 0.0	0.0	5.30	0.027	V	52.5(84.5)
DMG	33.6170	118.0170	03/14/1933	19 150.0	0.0	5.10	0.024	V	52.9(85.2)
DMG	34.0170	116.5000	07/26/1947	24941.0	0.0	5.10	0.024	IV	53.6(86.3)
DMG	34.0170	116.5000	07/25/1947	04631.0	0.0	5.00	0.022	IV	53.6(86.3)
DMG	34.0170	116.5000	07/25/1947	61949.0	0.0	5.20	0.025	V	53.6(86.3)
DMG	34.0170	116.5000	07/24/1947	221046.0	0.0	5.50	0.030	V	53.6(86.3)
DMG	33.5750	117.9830	03/11/1933	518 4.0	0.0	5.20	0.025	V	53.9(86.8)
DMG	33.8500	118.2670	03/11/1933	1425 0.0	0.0	5.00	0.022	IV	54.4(87.6)
GSP	34.3320	116.4620	07/01/1992	074029.9	9.0	5.40	0.027	V	55.0(88.6)
GSN	34.2010	116.4360	06/28/1992	115734.1	1.0	7.60	0.116	VII	55.8(89.7)
DMG	33.7830	118.2500	11/14/1941	84136.3	0.0	5.40	0.027	V	55.8(89.8)
PAS	34.3270	116.4450	03/15/1979	21 716.5	2.5	5.20	0.024	V	55.9(90.0)
GSP	34.1390	116.4310	06/28/1992	123640.6	10.0	5.10	0.023	IV	56.2(90.4)
PAS	34.5160	116.4950	06/01/1975	13849.2	4.5	5.20	0.024	IV	56.8(91.3)
GSP	34.2680	116.4020	06/16/1994	162427.5	3.0	5.00	0.021	IV	57.9(93.1)
GSP	34.1080	116.4040	06/29/1992	141338.8	9.0	5.40	0.026	V	57.9(93.2)
DMG	34.4110	118.4010	02/09/1971	14 041.8	8.4	6.40	0.048	VI	58.3(93.8)
DMG	34.4110	118.4010	02/09/1971	141028.0	8.0	5.30	0.024	V	58.3(93.8)
DMG	34.4110	118.4010	02/09/1971	14 244.0	8.0	5.80	0.033	V	58.3(93.8)
DMG	34.4110	118.4010	02/09/1971	14 1 8.0	8.0	5.80	0.033	V	58.3(93.8)
DMG	34.3080	118.4540	02/09/1971	144346.7	6.2	5.20	0.022	IV	59.9(96.5)
GSP	34.2310	118.4750	03/20/1994	212012.3	13.0	5.30	0.023	IV	60.7(97.7)
GSP	34.0640	116.3610	09/15/1992	084711.3	9.0	5.20	0.022	IV	60.8(97.8)
DMG	33.9330	116.3830	12/04/1948	234317.0	0.0	6.50	0.049	VI	61.6(99.2)
DMG	34.0670	116.3330	05/18/1940	55120.2	0.0	5.20	0.021	IV	62.3(100.3)
DMG	34.0670	116.3330	05/18/1940	72132.7	0.0	5.00	0.019	IV	62.3(100.3)
DMG	34.7120	116.5030	09/25/1965	174344.1	10.6	5.20	0.021	IV	62.8(101.1)
GSP	34.9700	116.8190	03/18/1997	152447.7	1.0	5.10	0.020	IV	63.2(101.7)
GSP	34.0290	116.3210	08/21/1993	014638.4	9.0	5.00	0.019	IV	63.4(102.1)
DMG	34.0000	118.5000	08/04/1927	1224 0.0	0.0	5.00	0.019	IV	63.6(102.4)
MGI	34.0000	118.5000	11/19/1918	2018 0.0	0.0	5.00	0.019	IV	63.6(102.4)
DMG	34.0830	116.3000	05/18/1940	5 358.5	0.0	5.40	0.023	IV	64.0(103.1)
GSP	34.2130	118.5370	01/17/1994	123055.4	18.0	6.70	0.053	VI	64.2(103.4)
GSP	33.9610	116.3180	04/23/1992	045023.0	12.0	6.10	0.036	V	64.7(104.0)
GSB	34.3010	118.5650	01/17/1994	204602.4	9.0	5.20	0.020	IV	66.2(106.5)
GSP	33.5290	116.5720	06/12/2005	154146.5	14.0	5.20	0.020	IV	66.7(107.3)
GSP	34.3050	118.5790	01/29/1994	112036.0	1.0	5.10	0.019	IV	67.0(107.8)

DMG	34.8300	116.5200	09/26/1929	20 022.7	0.0	5.10	0.019	IV	67.0(107.8)
GSP	33.9020	116.2840	07/24/1992	181436.2	9.0	5.00	0.017	IV	67.7(108.9)
GSP	34.5830	116.3190	07/05/1992	211827.1	0.0	5.40	0.022	IV	67.8(109.1)
DMG	34.3000	118.6000	04/04/1893	1940 0.0	0.0	6.00	0.032	V	68.2(109.7)
GSP	34.4420	116.2480	10/16/1999	125721.0	1.0	5.70	0.026	V	68.5(110.3)
GSP	33.8760	116.2670	06/29/1992	160142.8	1.0	5.20	0.019	IV	69.2(111.3)
GSP	34.3780	118.6180	01/19/1994	211144.9	11.0	5.10	0.018	IV	69.9(112.5)
GSP	33.5080	116.5140	10/31/2001	075616.6	15.0	5.10	0.018	IV	70.1(112.8)
PAS	33.5010	116.5130	02/25/1980	104738.5	13.6	5.50	0.022	IV	70.5(113.4)
GSG	34.5940	116.2710	10/16/1999	094644.1	0.0	7.10	0.063	VI	70.6(113.6)

EARTHQUAKE SEARCH RESULTS

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FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
GSP	34.8000	116.4100	10/21/1999	015435.0	1.0	5.00	0.017	IV	70.6(113.7)
DMG	33.5000	116.5000	09/30/1916	211 0.0	0.0	5.00	0.017	IV	71.0(114.3)
DMG	34.2500	116.1670	03/20/1945	2155 7.0	0.0	5.00	0.017	IV	71.2(114.6)
DMG	33.9500	118.6320	08/31/1930	04036.0	0.0	5.20	0.018	IV	71.8(115.5)
PAS	33.9190	118.6270	01/19/1989	65328.8	11.9	5.00	0.016	IV	72.1(116.0)
DMG	34.9500	116.5330	04/10/1947	171822.0	0.0	5.00	0.016	IV	72.2(116.1)
DMG	34.9670	116.5500	04/11/1947	747 0.0	0.0	5.00	0.016	IV	72.3(116.4)
DMG	34.9670	116.5500	04/10/1947	16 3 0.0	0.0	5.10	0.017	IV	72.3(116.4)
GSP	34.6800	116.2800	10/16/1999	095935.0	8.0	5.80	0.026	V	72.6(116.8)
GSP	34.3690	118.6720	04/26/1997	103730.7	16.0	5.10	0.017	IV	72.8(117.2)
GSP	34.3940	118.6690	06/26/1995	084028.9	13.0	5.00	0.016	IV	73.0(117.4)
GSP	34.8600	116.4100	10/22/1999	160848.0	1.0	5.00	0.016	IV	73.1(117.7)
DMG	34.9830	116.5500	04/10/1947	1558 6.0	0.0	6.20	0.033	V	73.2(117.7)
GSP	34.3260	118.6980	01/17/1994	233330.7	9.0	5.60	0.023	IV	73.9(118.9)
GSP	34.8600	116.3900	10/21/1999	015738.0	4.0	5.00	0.016	IV	74.0(119.1)
GSP	34.3770	118.6980	01/18/1994	004308.9	11.0	5.20	0.018	IV	74.4(119.7)
PAS	33.9440	118.6810	01/01/1979	231438.9	11.3	5.00	0.016	IV	74.6(120.1)
GSB	34.3790	118.7110	01/19/1994	210928.6	14.0	5.50	0.021	IV	75.1(120.9)
GSP	35.2100	118.0660	07/11/1992	181416.2	10.0	5.70	0.022	IV	79.2(127.5)
DMG	33.2000	116.7000	01/01/1920	235 0.0	0.0	5.00	0.015	IV	80.0(128.8)
DMG	34.0000	116.0000	04/03/1926	20 8 0.0	0.0	5.50	0.019	IV	81.9(131.8)
DMG	34.0000	116.0000	09/05/1928	1442 0.0	0.0	5.00	0.014	IV	81.9(131.8)
DMG	33.0000	117.3000	11/22/1800	2130 0.0	0.0	6.50	0.035	V	82.8(133.3)
MGI	33.2000	116.6000	10/12/1920	1748 0.0	0.0	5.30	0.017	IV	83.1(133.8)
DMG	33.4000	116.3000	02/09/1890	12 6 0.0	0.0	6.30	0.031	V	84.2(135.6)
DMG	34.5330	115.9830	07/18/1946	142758.0	0.0	5.60	0.020	IV	84.7(136.3)
DMG	33.3430	116.3460	04/28/1969	232042.9	20.0	5.80	0.022	IV	84.9(136.7)
DMG	33.4080	116.2610	03/25/1937	1649 1.8	10.0	6.00	0.025	V	85.6(137.7)
MGI	33.0000	117.0000	09/21/1856	730 0.0	0.0	5.00	0.014	III	85.9(138.3)
DMG	34.7110	116.0270	09/26/1965	7 0 1.7	8.3	5.00	0.013	III	86.5(139.2)
T-A	34.8300	118.7500	11/27/1852	0 0 0.0	0.0	7.00	0.047	VI	87.8(141.3)
PAS	32.9710	117.8700	07/13/1986	1347 8.2	6.0	5.30	0.016	IV	88.6(142.6)
PAS	34.9430	118.7430	06/10/1988	23 643.0	6.8	5.40	0.016	IV	91.5(147.3)
DMG	34.0000	119.0000	09/24/1827	4 0 0.0	0.0	7.00	0.045	VI	91.8(147.7)
MGI	34.0000	119.0000	12/14/1912	0 0 0.0	0.0	5.70	0.019	IV	91.8(147.7)
DMG	34.3330	115.8000	12/22/1943	155028.0	0.0	5.50	0.017	IV	92.5(148.8)
DMG	34.0650	119.0350	02/21/1973	144557.3	8.0	5.90	0.021	IV	93.2(150.0)
DMG	33.2830	116.1830	03/19/1954	95429.0	0.0	6.20	0.025	V	94.6(152.3)
DMG	33.2830	116.1830	03/19/1954	95556.0	0.0	5.00	0.012	III	94.6(152.3)

DMG	33.2830	116.1830	03/23/1954	41450.0	0.0	5.10	0.013	III	94.6(152.3)
DMG	33.2830	116.1830	03/19/1954	102117.0	0.0	5.50	0.016	IV	94.6(152.3)
DMG	35.1500	118.6330	01/27/1954	141948.0	0.0	5.00	0.012	III	95.6(153.8)
DMG	35.2330	118.5330	07/21/1952	174244.0	0.0	5.10	0.013	III	95.8(154.1)
DMG	34.0000	115.7500	03/03/1942	1 324.0	0.0	5.00	0.012	III	96.0(154.5)
DMG	34.7000	119.0000	10/23/1916	254 0.0	0.0	5.50	0.016	IV	96.9(155.9)
DMG	34.9000	118.9000	10/23/1916	244 0.0	0.0	6.00	0.022	IV	97.6(157.0)
DMG	34.9500	118.8670	07/21/1952	121936.0	0.0	5.30	0.014	IV	97.7(157.2)
DMG	35.1830	118.6500	07/21/1952	151358.0	0.0	5.10	0.013	III	97.9(157.5)
DMG	33.2000	116.2000	05/28/1892	1115 0.0	0.0	6.30	0.026	V	97.9(157.5)
DMG	35.0000	118.8330	07/23/1952	181351.0	0.0	5.20	0.013	III	98.0(157.7)
DMG	35.0000	118.8330	07/23/1952	75319.0	0.0	5.40	0.015	IV	98.0(157.7)
MGI	32.8000	117.1000	05/25/1803	0 0 0.0	0.0	5.00	0.012	III	98.1(157.8)
DMG	34.8670	118.9330	09/21/1941	1953 7.2	0.0	5.20	0.013	III	98.1(157.9)

EARTHQUAKE SEARCH RESULTS

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FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DISTANCE mi [km]
DMG	35.3110	118.4990	07/25/1952	1313 8.2	2.8	5.00	0.012	III	98.6(158.7)
DMG	35.3170	118.4940	07/25/1952	19 944.6	5.5	5.70	0.018	IV	98.8(158.9)
DMG	35.6310	117.5130	09/17/1938	1423 4.1	-2.0	5.00	0.012	III	99.2(159.7)
T-A	34.9200	118.9200	05/23/1857	0 0 0.0	0.0	5.00	0.012	III	99.2(159.7)
T-A	34.9200	118.9200	01/20/1857	0 0 0.0	0.0	5.00	0.012	III	99.2(159.7)
DMG	35.3150	118.5160	07/25/1952	194323.7	11.2	5.70	0.018	IV	99.4(160.0)
DMG	34.0170	115.6830	05/02/1949	112547.0	0.0	5.90	0.020	IV	99.6(160.3)
DMG	33.2170	116.1330	08/15/1945	175624.0	0.0	5.70	0.017	IV	99.9(160.7)
DMG	33.0000	116.4330	06/04/1940	1035 8.3	0.0	5.10	0.012	III	100.0(160.9)

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-END OF SEARCH- 168 EARTHQUAKES FOUND WITHIN THE SPECIFIED SEARCH AREA.

TIME PERIOD OF SEARCH: 1800 TO 2006

LENGTH OF SEARCH TIME: 207 years

THE EARTHQUAKE CLOSEST TO THE SITE IS ABOUT 0.7 MILES (1.2 km) AWAY.

LARGEST EARTHQUAKE MAGNITUDE FOUND IN THE SEARCH RADIUS: 7.6

LARGEST EARTHQUAKE SITE ACCELERATION FROM THIS SEARCH: 0.430 g

COEFFICIENTS FOR GUTENBERG & RICHTER RECURRENCE RELATION:
  a-value= 1.658
  b-value= 0.399
  beta-value= 0.919

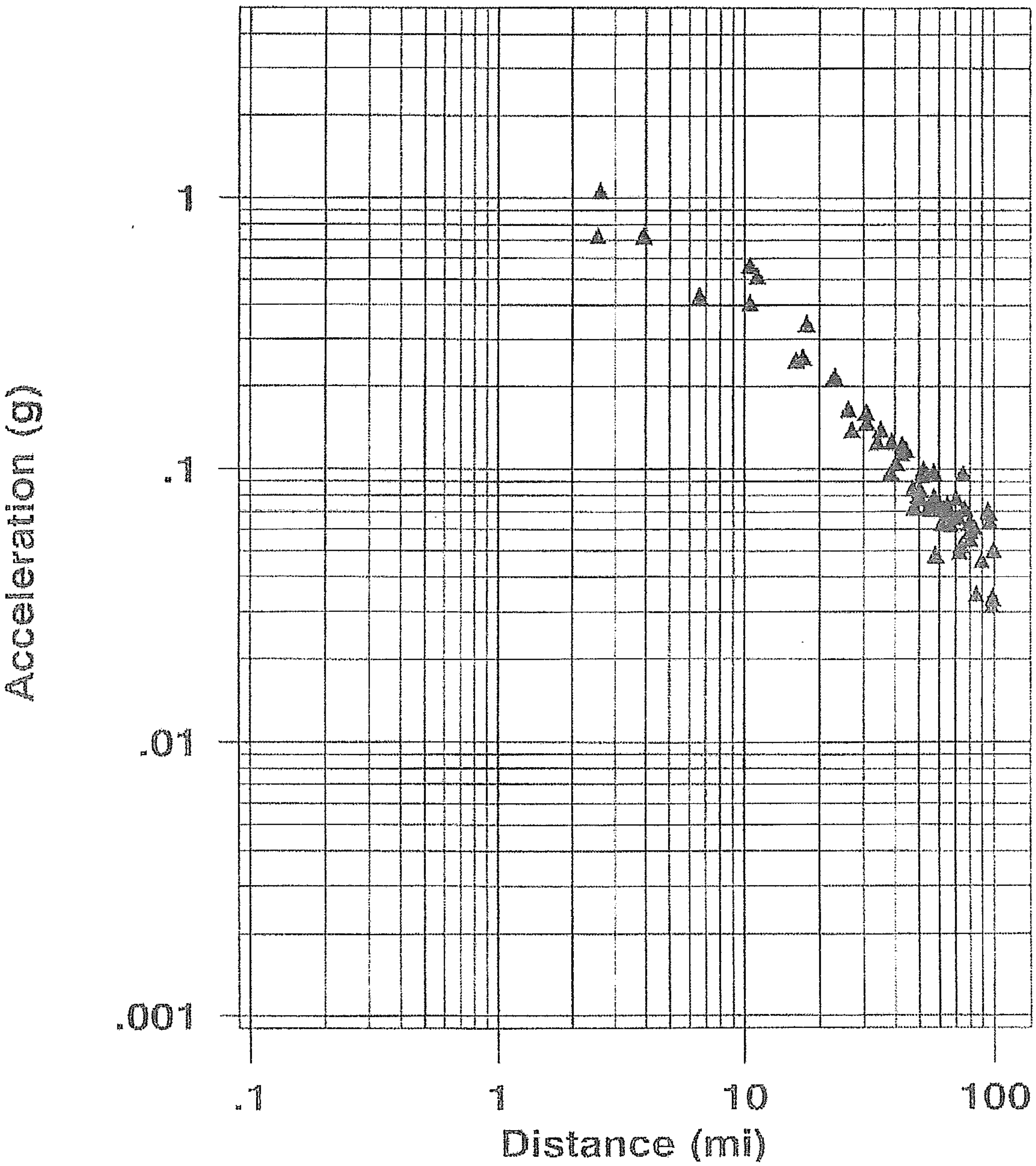
TABLE OF MAGNITUDES AND EXCEEDANCES:

Earthquake Magnitude	Number of Times Exceeded	Cumulative No. / Year

4.0	168	0.81553
4.5	168	0.81553
5.0	168	0.81553
5.5	57	0.27670
6.0	29	0.14078
6.5	12	0.05825
7.0	6	0.02913
7.5	1	0.00485

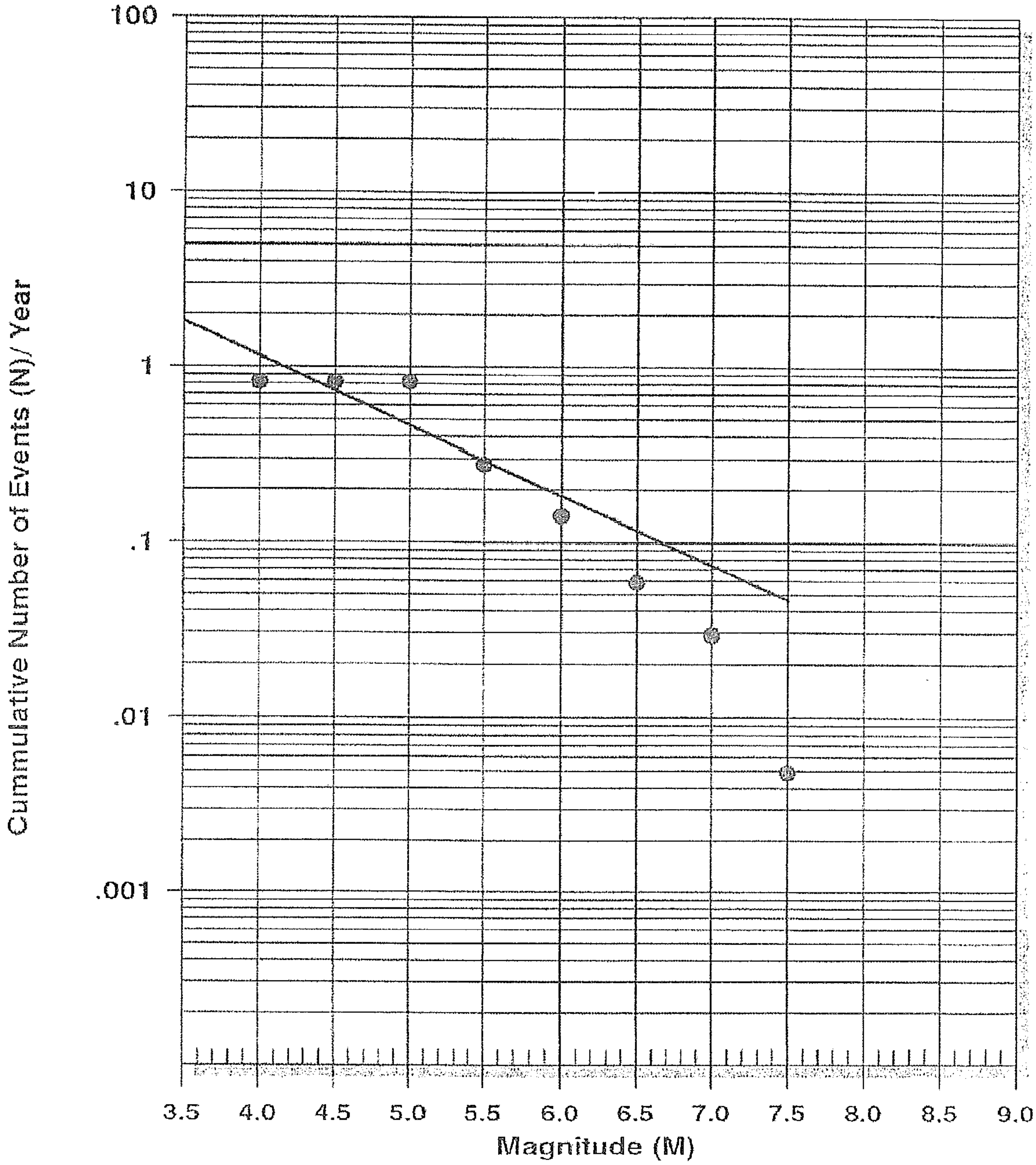
MAXIMUM EARTHQUAKES

LYTLE DEVELOPMENT COMPANY



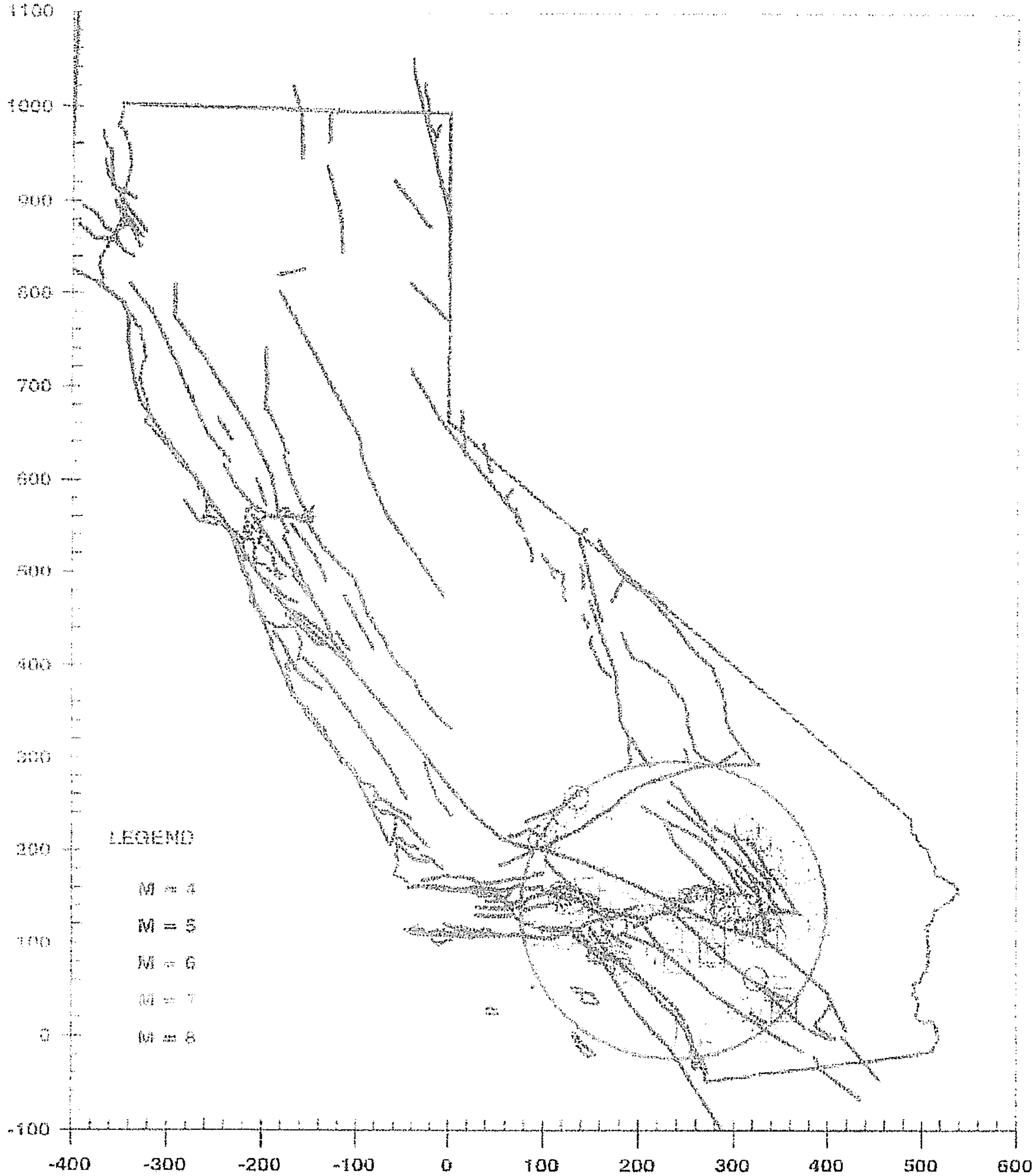
EARTHQUAKE RECURRENCE CURVE

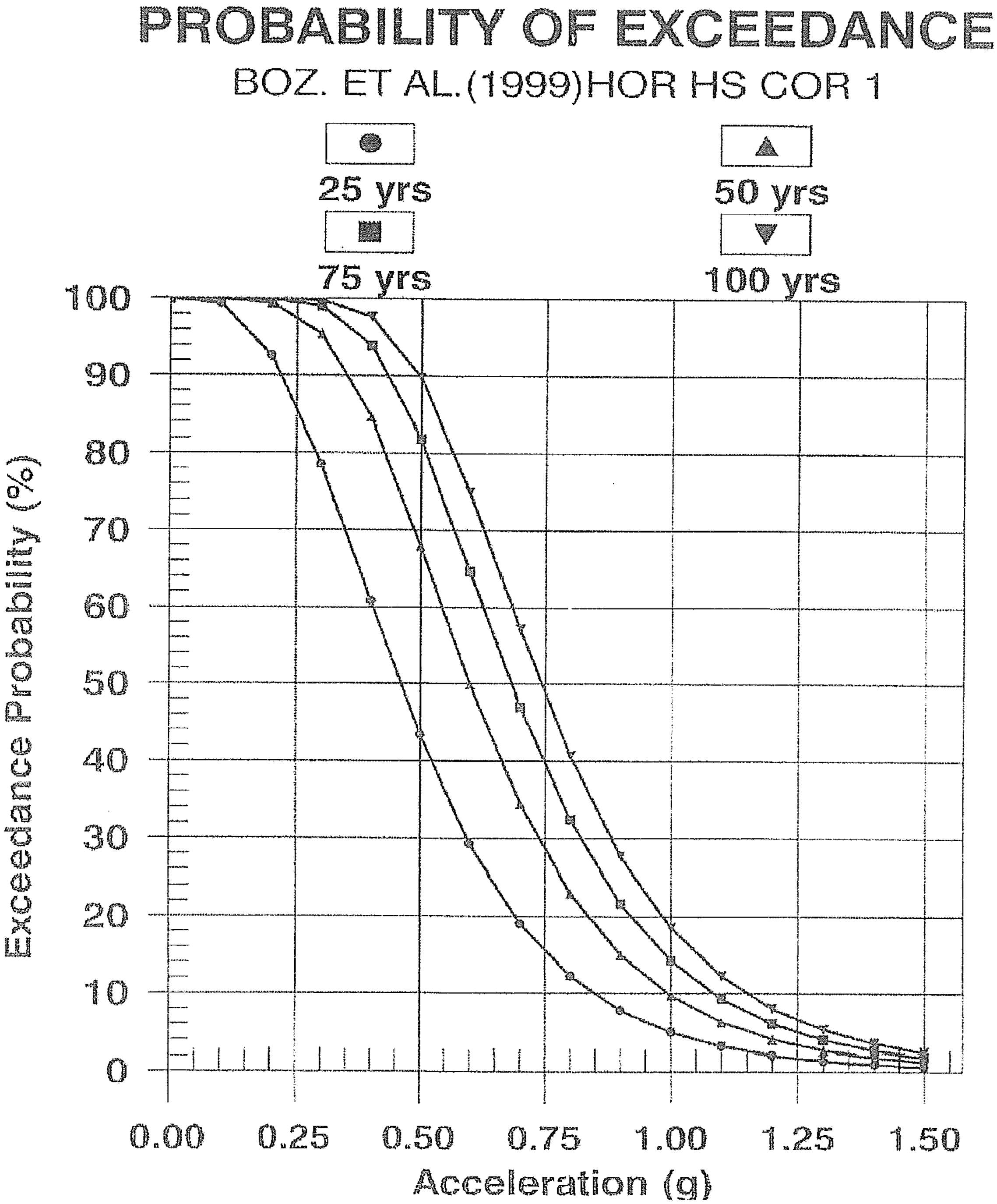
LYTLE DEVELOPMENT COMPANY

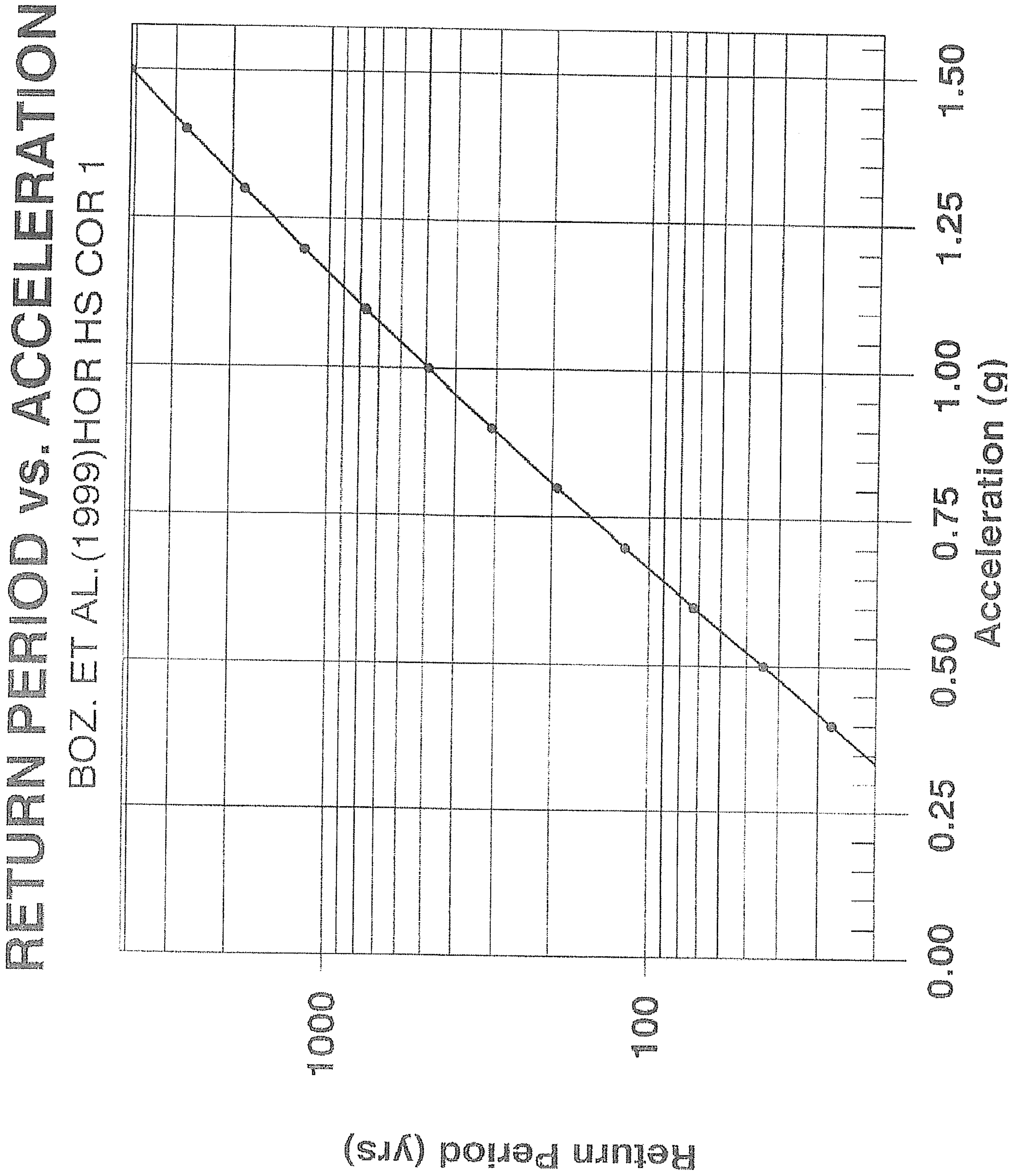


EARTHQUAKE EPICENTER MAP

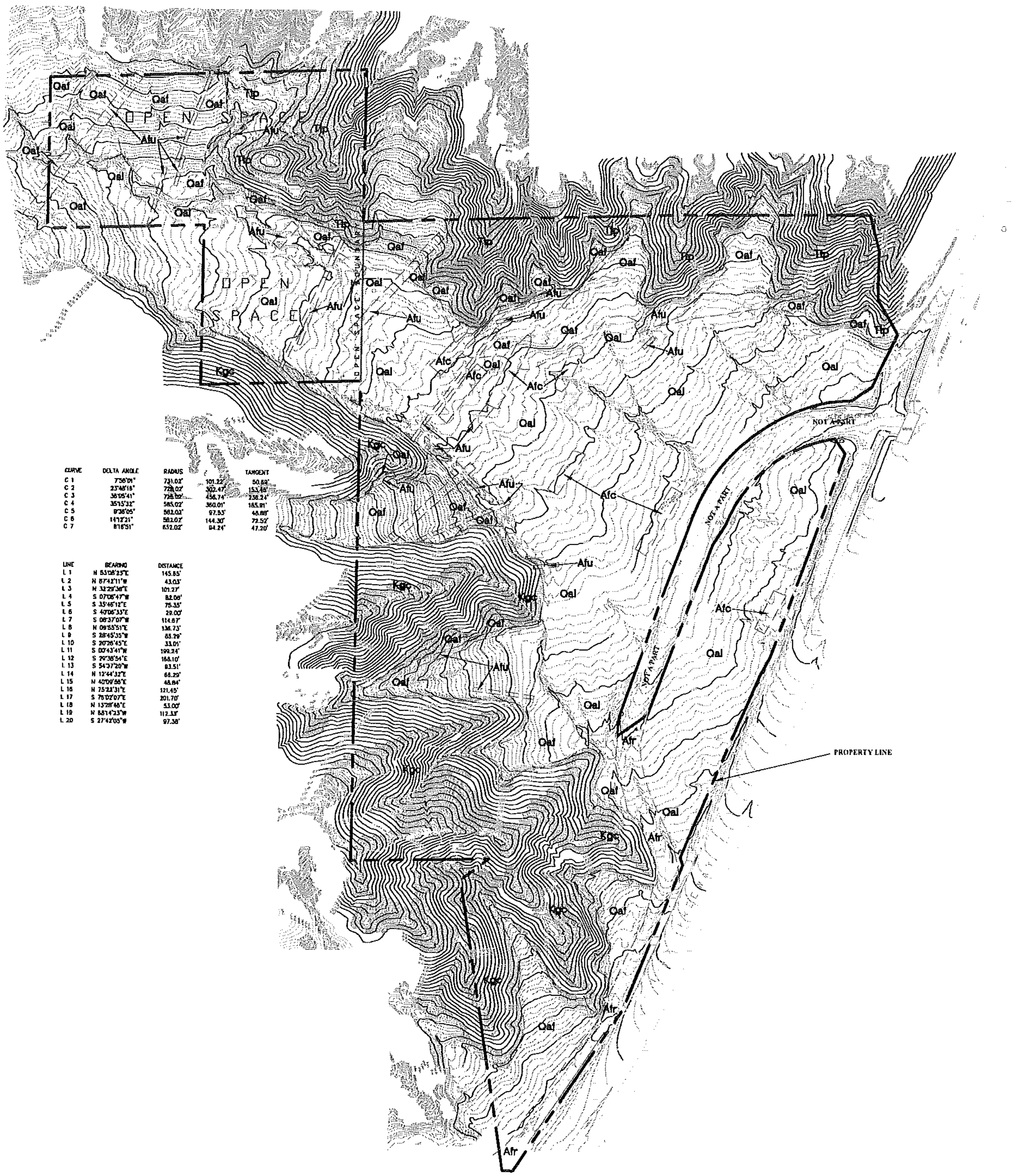
LYTLE DEVELOPMENT COMPANY




PROBABILITY OF EXCEEDANCE
BOZ. ET AL.(1999)HOR HS COR 1
25 yrs
50 yrs
75 yrs
100 yrs
100
90
80
70
60
50
40
30
20
10
0
Exceedance Probability (%)
0.00
0.25
0.50
0.75
1.00
1.25
1.50
Acceleration (g)



RETURN PERIOD VS. ACCELERATION
BOZ. ET AL. (1999) HOR HS COR 1
Return Period (yrs)
1000
100
Acceleration (g)
0.00
0.25
0.50
0.75
1.00
1.25
1.50



CURVE	DELTA ANGLE	RADIUS		TANGENT
C 1	7°56'01"	731.02'	101.22'	50.69'
C 2	23°48'18"	728.02'	302.47'	153.45'
C 3	36°05'41"	725.02'	456.74'	236.24'
C 4	35°15'32"	585.02'	360.01'	185.91'
C 5	9°36'05"	582.02'	97.53'	48.88'
C 6	14°12'21"	582.02'	144.30'	72.52'
C 7	8°16'51"	652.02'	94.24'	47.20'

LINE	BEARING	DISTANCE
L 1	N 53°08'25"E	145.85'
L 2	N 87°42'11"W	43.03'
L 3	N 32°29'38"E	101.27'
L 4	S 07°06'47"W	82.08'
L 5	S 35°46'12"E	75.35'
L 6	S 40°06'33"E	29.00'
L 7	S 08°37'07"W	114.87'
L 8	N 09°53'51"E	136.73'
L 9	S 28°45'35"W	85.29'
L 10	S 20°26'45"E	33.01'
L 11	S 00°43'41"W	199.24'
L 12	S 29°38'54"E	168.10'
L 13	S 54°37'20"W	83.51'
L 14	N 12°44'32"E	66.29'
L 15	N 40°09'58"E	48.84'
L 16	N 75°22'31"E	121.45'
L 17	S 78°02'07"E	201.70'
L 18	N 13°28'48"E	53.00'
L 19	N 68°14'23"W	112.33'
L 20	S 27°42'05"W	97.38'

LEGEND

Afc	Artificial fill - compacted (GSI, 2007)
Afr	Artificial fill - roadway
Afu	Artificial fill - undocumented
Qal	Quaternary alluvium
Qaf	Quaternary alluvial fan deposits
Ttp	Tertiary "Granodiorite of Telegraph Peak"
Kgc	Cretaceous mylonitic leucogranite
	Approximate location of geologic contact

ALL LOCATIONS, SCALE, AND NORTH ARROW ARE APPROXIMATE

Base Map Provided by Dawson Surveying, Inc. (November, 2006)

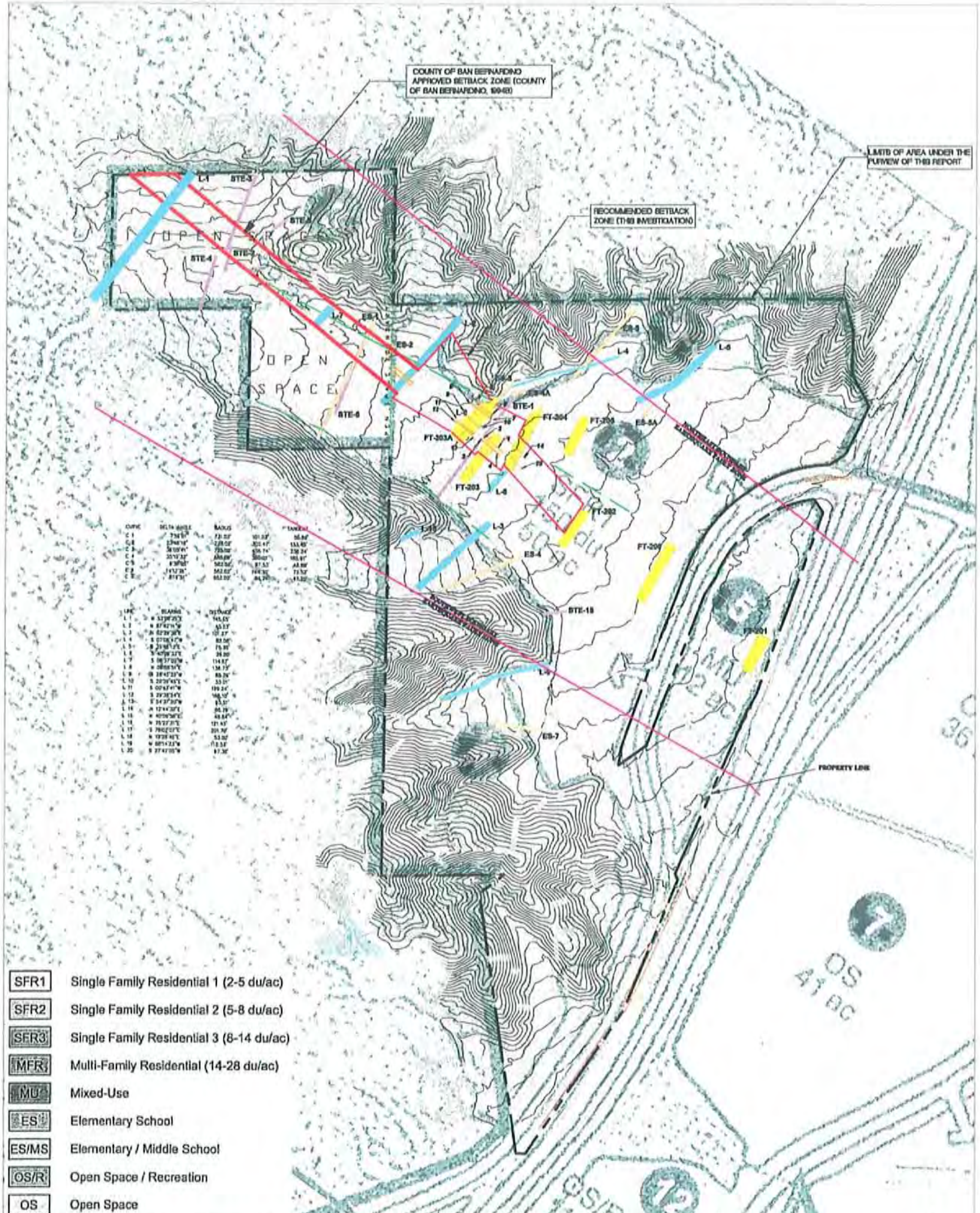
GeoSoils, Inc.

RIVERSIDE CO.
ORANGE CO.
SAN DIEGO CO.

GEOLOGIC UNITS MAP

Plate 1 of 12

W.O. 5278-A-SC | DATE 02/07 | SCALE 1"=200'



LEGEND

15	Approximate location of plotted fault (see Table of Plotted Faults)
	Approximate location of aerial-photographic lineaments
	Approximate location of setback limit for habitable structures
FT-203	Approximate location of fault-locating trench (this study)
L-8	Approximate location of fault locating trench (LOR Geotechnical Group, Inc., 2004a)
ES-7	Approximate location of fault-locating trench (Eberhart and Stone, Inc., [illegible], unpublished, adapted from LOR Geotechnical Group, Inc., 2004a)
STE-6	Approximate location of fault-locating trench (Soil Testing and Engineers, Inc., [illegible])

TABLE OF PLOTTED FAULTS

Fault Trench	Approximate Station No. as Indicated on Field Log	Fault Attitude (Strike, Dip)	Maximum Apparent Vertical Displacement (Inches)*	Fault No. Indicated on Geologic Map (Surveyed at the Surface Projection of Fault) NS - Not Surveyed
FT-203	-31½	[illegible]	12	1
	-23	[illegible]	8	2
	-10	[illegible]	7	3
	-3	[illegible]	22	4
FT-203A	53	[illegible]	Not Determined	5
	57	[illegible]	11	[illegible]
	75	[illegible]	2½-3	7
	82	[illegible]	3-4	8
	100½	[illegible]	3	9
	140	[illegible]	5	10
	183'	[illegible]	4	11
	183'	[illegible]	8	12
	191'	[illegible]	30	13
FT-204	227½	[illegible]	3	14
	275	[illegible]	10	15

* Maximum displacement was measured from the northeast wall of the trench.

0 200 400 600
Scale Feet

ALL LOCATIONS, SCALE, AND NORTH ARROW ARE APPROXIMATE

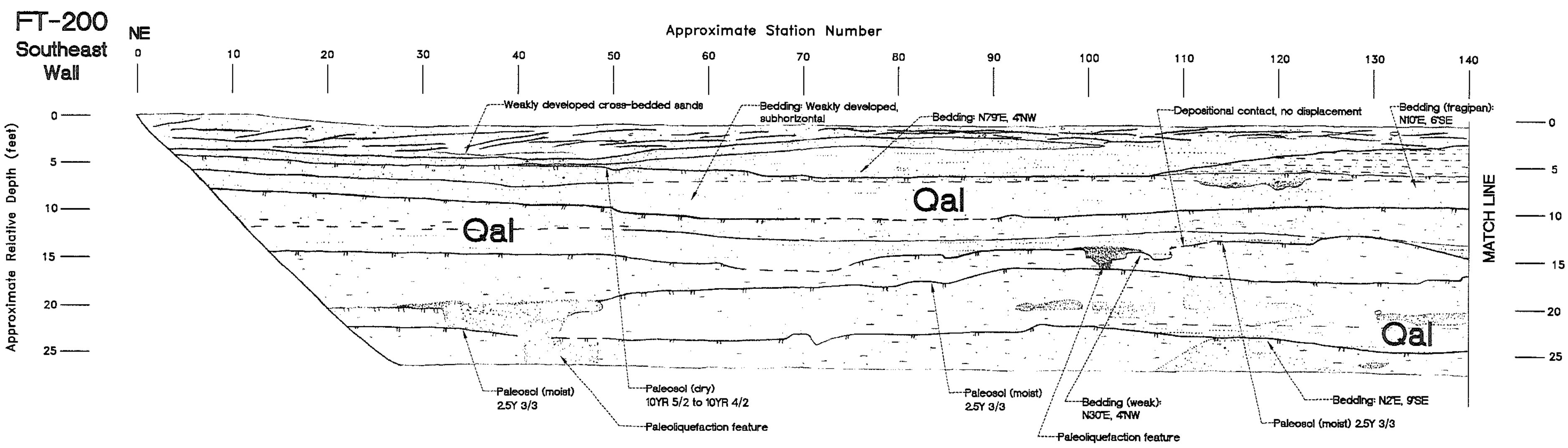
Base Map Provided by 1) Dawson Surveying, Inc., 2005
2) EDAW/AECOM, 2006

GeoSoils, Inc. RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.

REVISED
SUPPLEMENTAL FAULT SETBACK MAP

Plate 1 of 1

W.O. 53770-B-SC | DATE 08/07 | SCALE 1"=200'

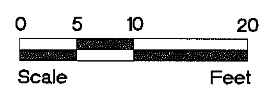


LEGEND

Afu Artificial fill - undocumented: Fine- to coarse-grained sand (SW) and silty sand (SM) with trace sub-angular to sub-rounded pebble- to cobble-sized igneous and metamorphic clasts, pale yellow to light yellowish brown (2.5Y 8/4 to 2.5Y 6/3), dry, poorly to moderately indurated; trace debris

Qal Quaternary alluvium: Fine- to medium-grained sand (SP) and silty sand (SM) with trace sub-rounded to sub-angular pebble- to cobble-sized igneous and metamorphic clasts, grayish brown to dark olive brown (2.5Y 5/2 to 2.5Y 3/3 [parent]), dry to moist, poorly to moderately indurated; generally massive and thickly bedded with trace thin bedding and local cross-bedding, locally lenticular, fining upward sequences capped by discontinuous, regional, buried paleosols


Approximate location of paleosol



ALL LOCATIONS, STATION NUMBERS, AND DEPTHS ARE APPROXIMATE

GeoSoils, Inc.

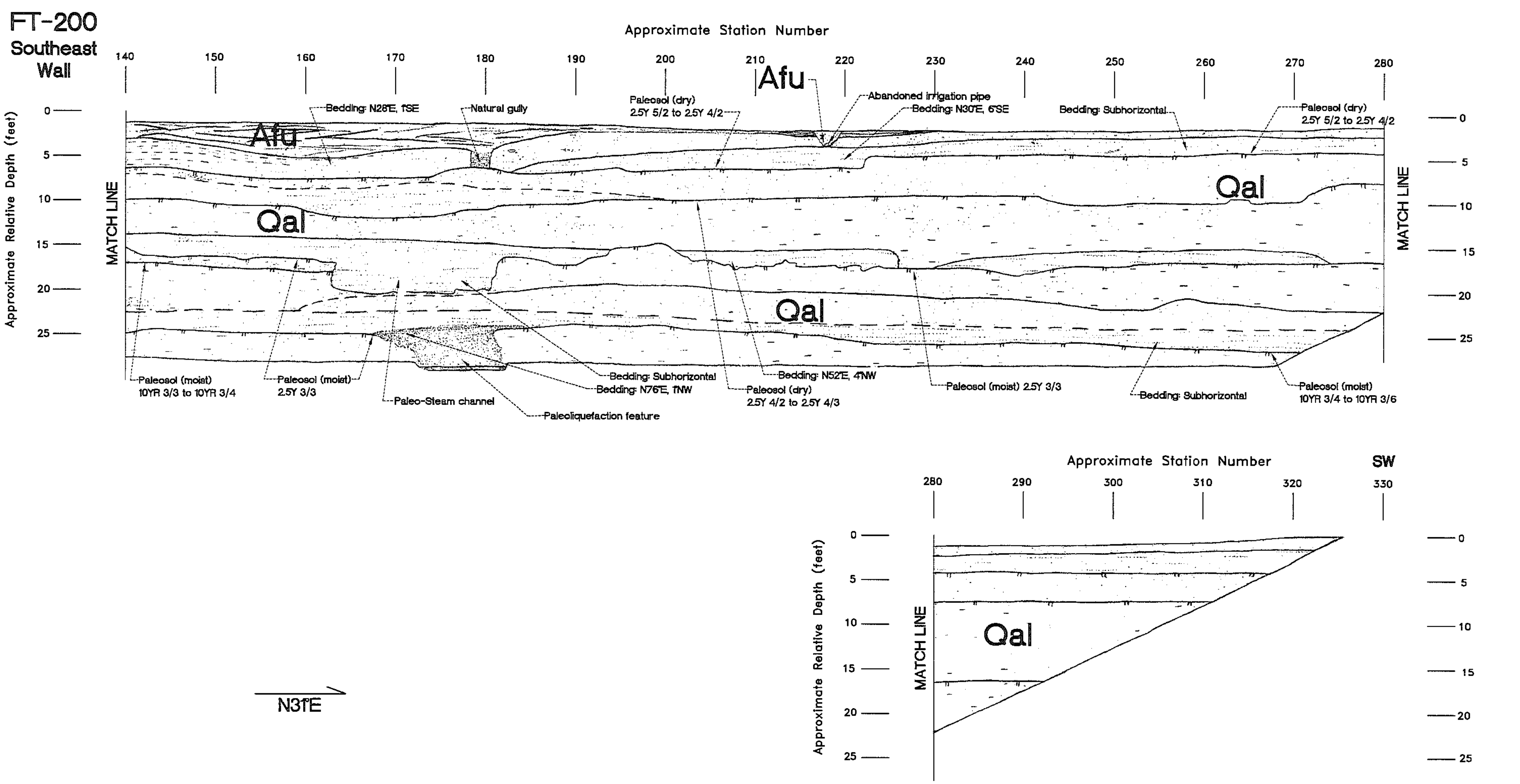
RIVERSIDE CO.
ORANGE CO.
SAN DIEGO CO.

FAULT TRENCH LOG FT-200

Plate 3 of 12

W.O. 5278-A-SC	DATE 02/07	SCALE 1"=5'

FT-200 Southeast Wall



SEE PLATE 3 FOR LEGEND

Scale: 0 5 10 20 Feet

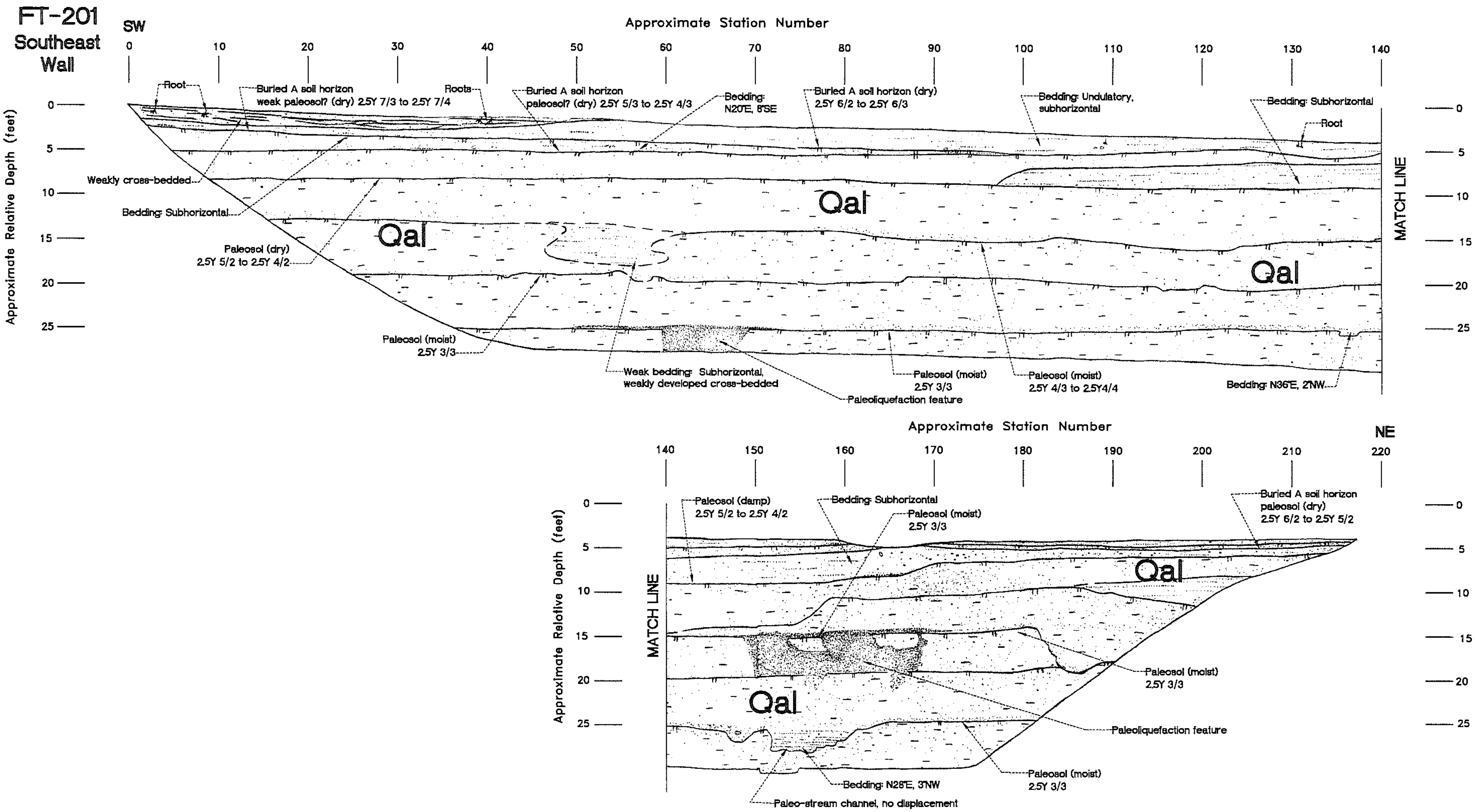
ALL LOCATIONS, STATION NUMBERS, AND DEPTHS ARE APPROXIMATE

GeoSoils, Inc. — RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.

FAULT TRENCH LOG FT-200

Plate 4 of 12

W.O. 5278-A-SC	DATE 02/07	SCALE 1"=5'



ALL LOCATIONS, STATION NUMBERS, AND DEPTHS ARE APPROXIMATE

LEGEND

Qal Quaternary alluvium: Fine- to coarse-grained sand (SW) and silty sand (SM) with trace sub-rounded to sub-angular pebble- to cobble-sized igneous and metamorphic clasts, grayish brown to dark olive brown (2.5Y 5/2 to 2.5Y 3/3 [parent]) dry to moist, poorly to moderately indurated; generally massive and thickly bedded with trace thin bedding and local cross-bedding, locally lenticular, fining upward sequences capped by discontinuous, regional, buried paleosols

Approximate location of paleosol

N27°E

0 5 10 20
Scale Feet

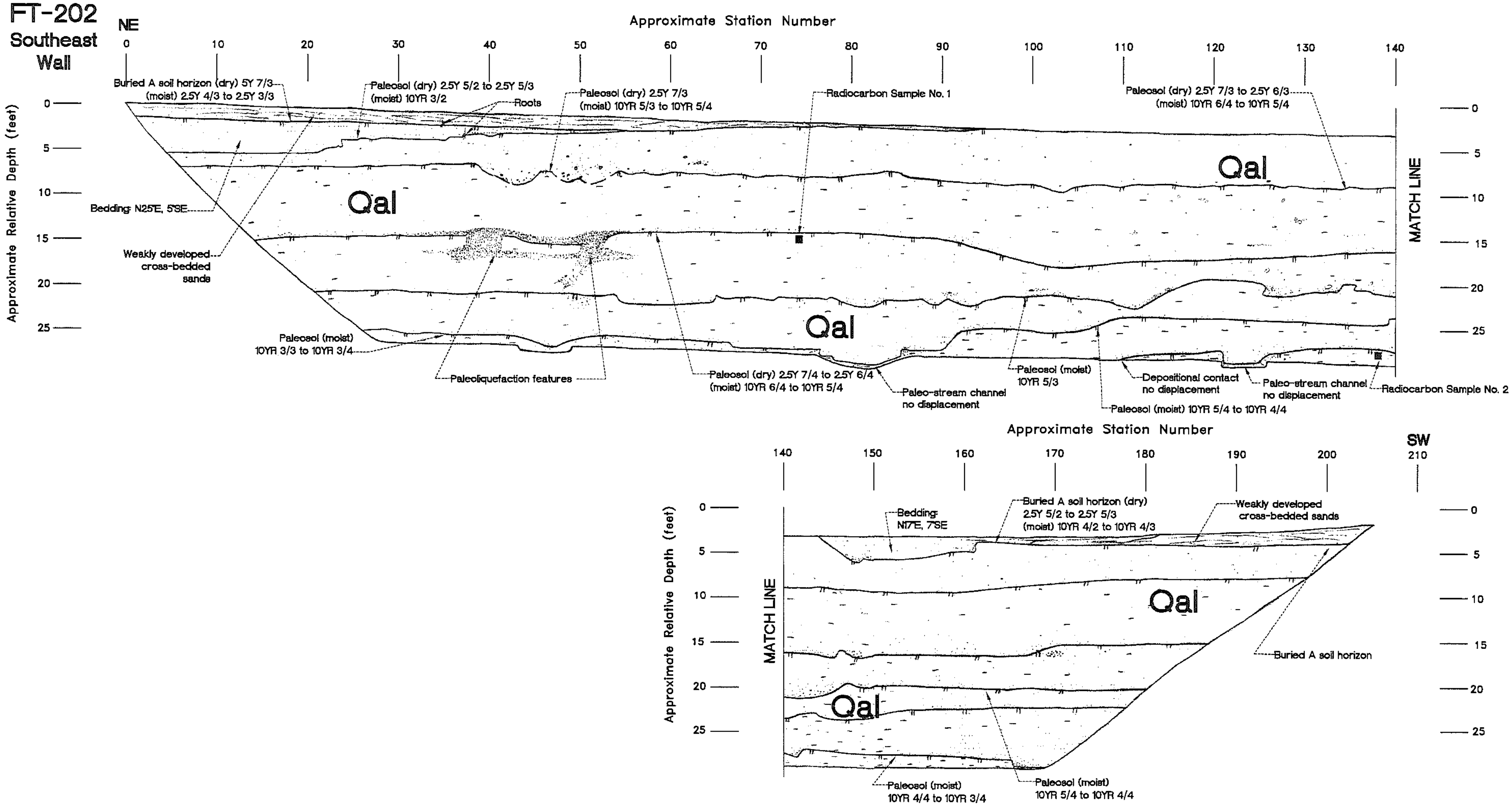
GeoSoils, Inc. — RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.

FAULT TRENCH LOG FT-201

Plate 5 of 12

W.O. 5278-A-SC	DATE 02/07	SCALE 1"=5'

FT-202
Southeast
Wall



ALL LOCATIONS, STATION NUMBERS, AND DEPTHS ARE APPROXIMATE

LEGEND

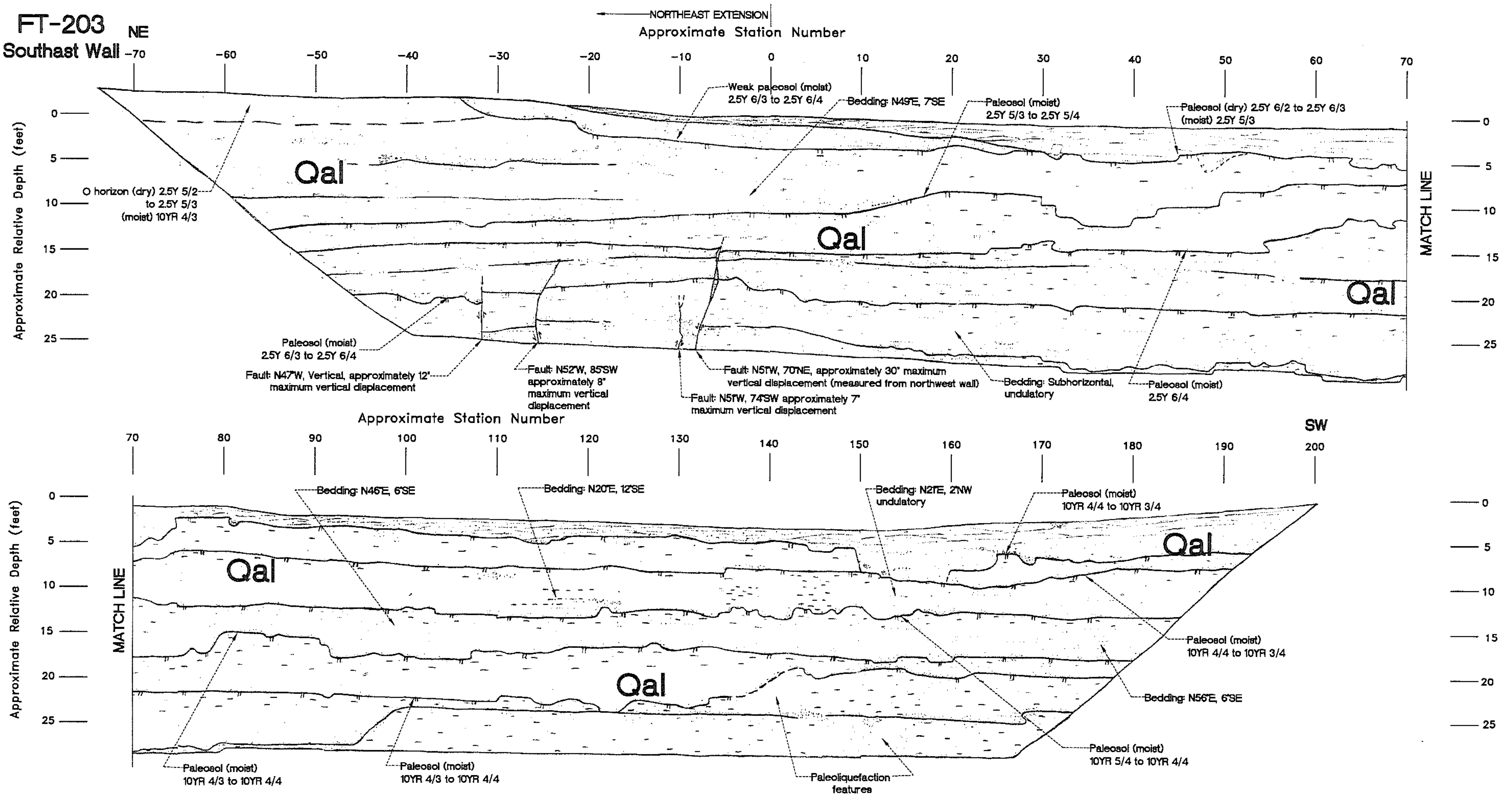
Qal — Quaternary alluvium: Fine- to medium-grained sand (SP) and silty sand (SM) with trace sub-rounded to sub-angular pebble- to cobble-sized igneous and metamorphic clasts, light gray to pale yellow (2.5Y 7/2 to 2.5Y 7/3 [parent]), dry to moist, poorly to moderately indurated; generally massive and thickly bedded with trace thin bedding and local cross-bedding, locally lenticular, abundant wavy laminae (Bt horizons) on the order of ½-inch thick or less, fining upward sequences capped by discontinuous, regional, buried paleosols

Approximate location of paleosol

N34°E

0 5 10 20
Scale Feet

GeoSoils, Inc.	RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.	
FAULT TRENCH LOG FT-202		
		Plate 6 of 12
W.O. 5278-A-SC	DATE 02/07	SCALE 1"=5'



ALL LOCATIONS, STATION NUMBERS, AND DEPTHS ARE APPROXIMATE

LEGEND

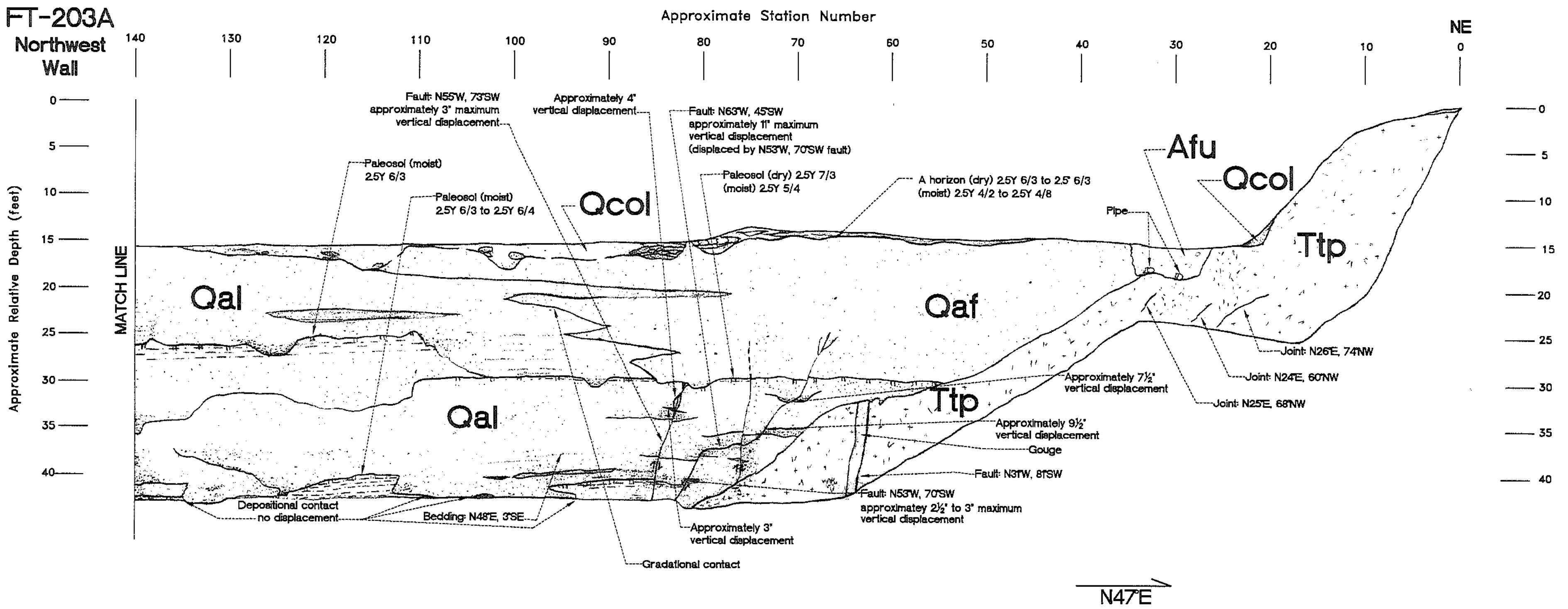
Qal Quaternary alluvium: Fine- to coarse-grained sand (SW) and silty sand (SM) with trace sub-rounded to sub-angular pebble- to cobble-sized clasts, light gray to pale yellow (2.5Y 7/2 to 2.5Y 7/3 [parent]), dry to moist, poorly to moderately indurated; generally massive and thickly bedded with trace thin bedding and local cross-bedding, locally lenticular, abundant wavy laminae (Bt horizons) on the order of ½-inch thick or less, fining upward sequences capped by discontinuous, regional, buried paleosols

Approximate location of paleosol

N38°E

Scale 0 5 10 20 Feet

GeoSoils, Inc.		RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.
FAULT TRENCH LOG FT-203		Plate 7 of 12
W.O. 5278-A-SC	DATE 02/07	SCALE 1"=5'



LEGEND

Afu — Artificial fill - undocumented: Fine- to coarse-grained sand (SW) and silty sand (SM) with trace sub-angular to sub-rounded pebble- to cobble-sized igneous and metamorphic clasts, pale yellow to light yellowish brown (2.5Y 8/4 to 2.5Y 6/3), dry, poorly to moderately indurated; trace debris

Qcol — Quaternary colluvium: Fine- to coarse-grained sand (SW) with angular to sub-angular pebble-sized igneous clasts, light gray (2.5Y 7/2), dry, poorly indurated

Qaf — Quaternary alluvial fan deposits: Fine- to coarse-grained sand (SW) and silty sand with trace angular to sub-angular pebble- to cobble-sized igneous and metamorphic clasts, light gray to light yellowish brown (2.5Y 7/2 to 2.5Y 6/3), dry to damp, poorly to moderately indurated

Qal — Quaternary alluvium: Fine- to coarse-grained sand (SW) and silty sand (SM) with trace sub-rounded to sub-angular pebble- to cobble-sized igneous and metamorphic clasts, pale yellow to light brownish gray (2.5Y 7/3 to 2.5Y 6/2 [parent]), dry to moist, poorly to moderately indurated; generally massive and thickly bedded with trace thin bedding and localized cross-bedding, locally lenticular, abundant wavy laminae (Bt horizons) on the order of ½-inch thick or less, fining upward sequences capped by discontinuous, regional, buried paleosols

Ttp — "Granodiorite of Telegraph Peak": Granodiorite, white to pale yellow (2.5Y 8/1 to 2.5Y 8/2), dry, moderately to well indurated; highly weathered, massive, highly fractured/sheared, medium-grained

Approximate location of paleosol

Scale: 0 5 10 20 Feet

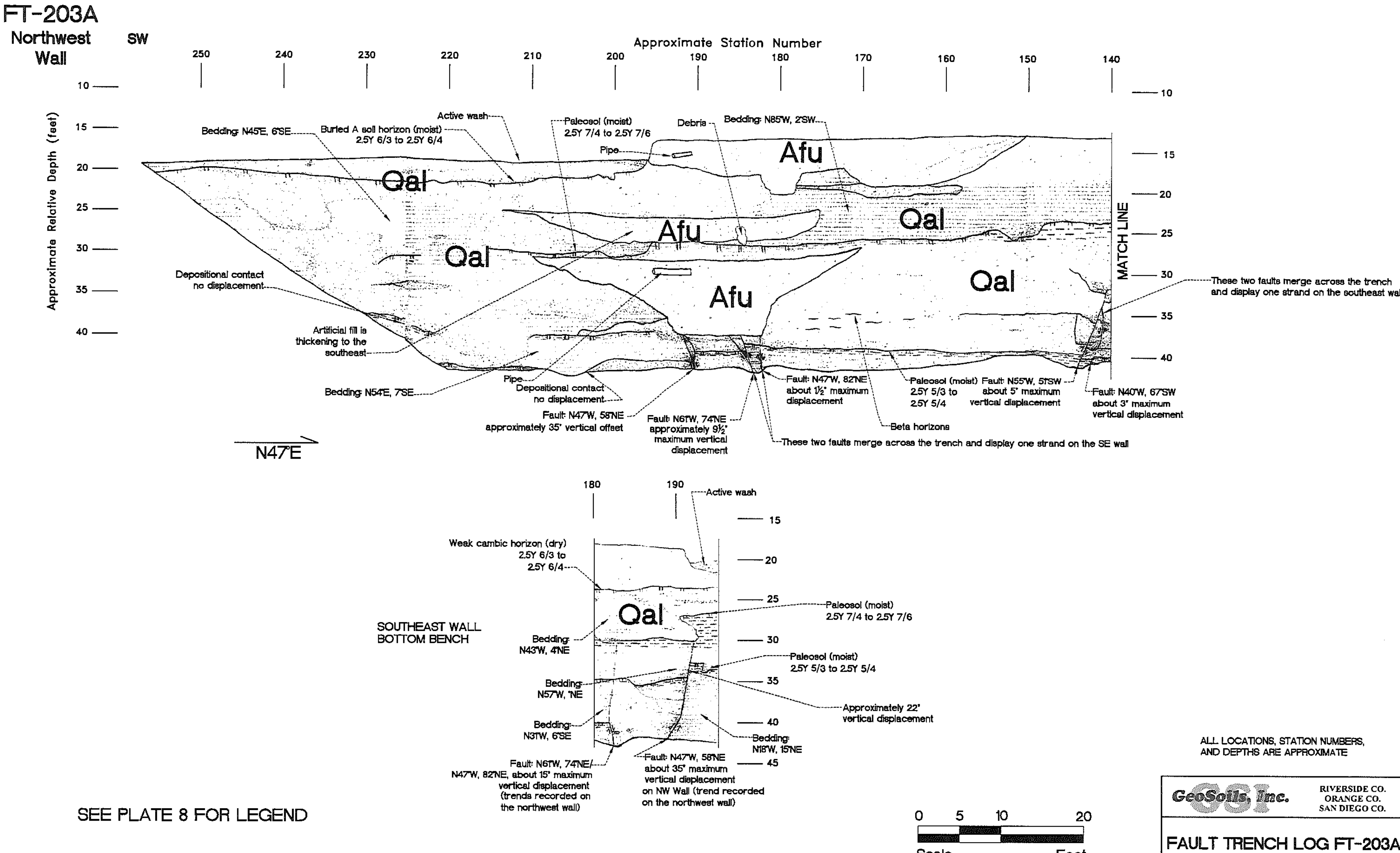
ALL LOCATIONS, STATION NUMBERS, AND DEPTHS ARE APPROXIMATE

GeoSoils, Inc. — RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.

FAULT TRENCH LOG FT-203A

Plate 8 of 12

W.O. 5278-A-SC	DATE 02/07	SCALE 1"=5'



ALL LOCATIONS, STATION NUMBERS, AND DEPTHS ARE APPROXIMATE

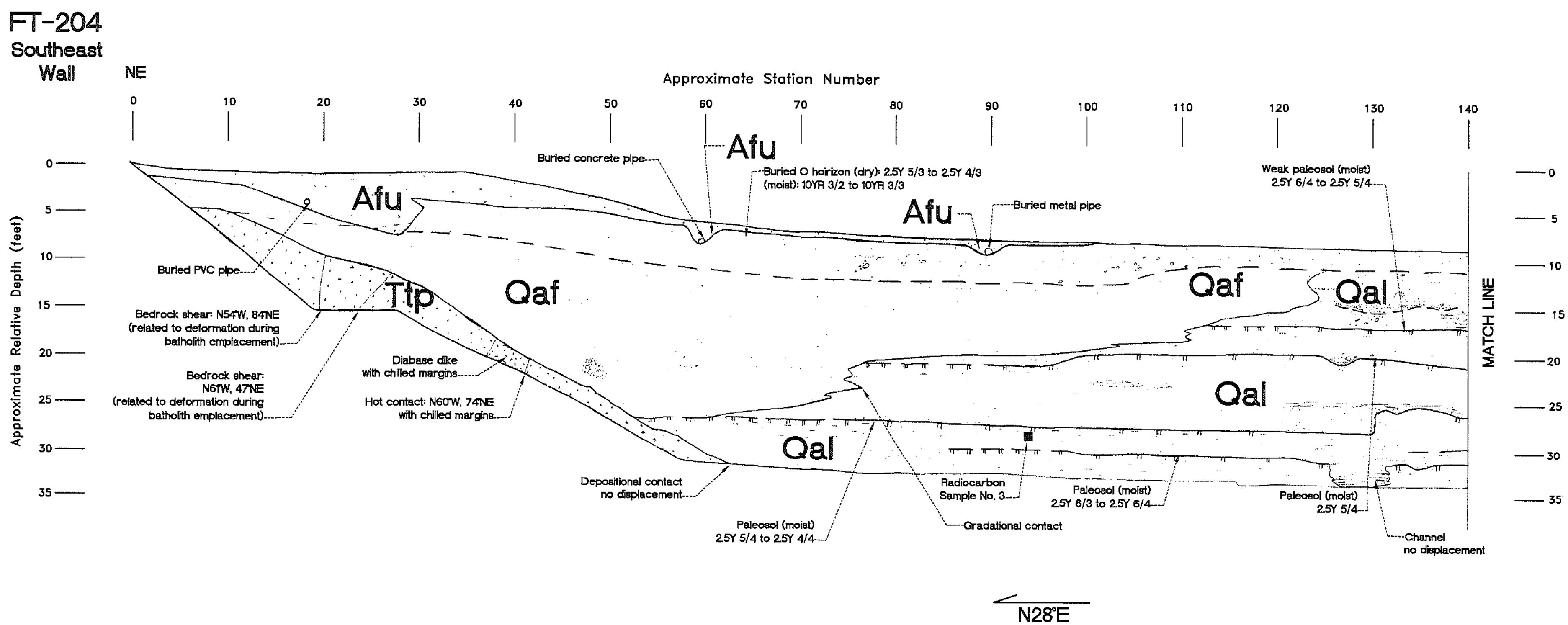
GeoSoils, Inc.

RIVERSIDE CO.
ORANGE CO.
SAN DIEGO CO.

FAULT TRENCH LOG FT-203A

Plate 9 of 12

W.O. 5278-A-SC	DATE 02/07	SCALE 1"=5'



LEGEND

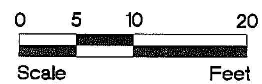
Afu Artificial fill - undocumented: Fine- to coarse-grained sand (SW) and silty sand (SM) with trace sub-angular to sub-rounded pebble- to cobble-sized igneous and metamorphic clasts, pale yellow to light yellowish brown (2.5Y 8/4 to 2.5Y 6/3), dry, poorly to moderately indurated; trace debris

Qaf Quaternary alluvial fan deposits: Fine- to coarse-grained sand (SW) and Silty Sand with trace angular to sub-angular pebble- to cobble-sized igneous and metamorphic clasts, light gray to light yellowish brown (2.5Y 7/2 to 2.5Y 6/3), dry to damp, poorly to moderately indurated

Qal Quaternary alluvium: Fine- to coarse-grained sand (SW) and silty sand (SM) with trace sub-rounded to sub-angular pebble- to cobble-sized igneous and metamorphic clasts, light gray to light yellowish brown (2.5Y 7/2 to 2.5Y 6/3 [parent]), dry to moist, poorly to moderately indurated; generally massive and thickly bedded with trace thin bedding (laminae) and localized cross-bedding, locally lenticular, abundant wavy laminae (Bt horizons) on the order of ½-inch thick or less, fining upward sequences capped by discontinuous, regional, buried paleosols

Ttp "Granodiorite of Telegraph Peak": Granodiorite, white to pale yellow (2.5Y 8/1 to 2.5Y 8/2), dry, moderately to well indurated; highly weathered, massive, highly fractured/sheared, medium-grained

Approximate location of paleosol



ALL LOCATIONS, STATION NUMBERS, AND DEPTHS ARE APPROXIMATE

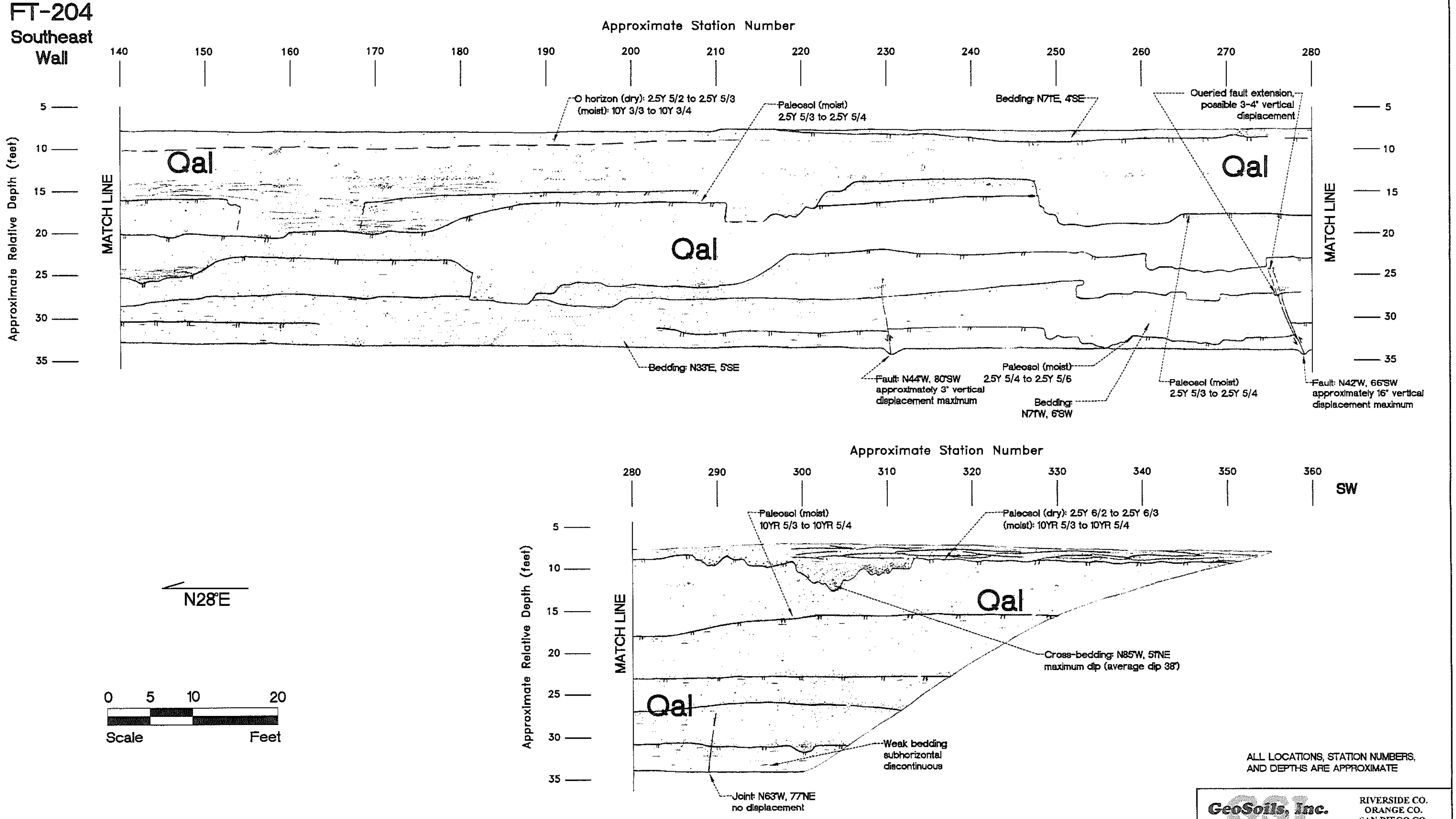
GeoSoils, Inc. — RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.

FAULT TRENCH LOG FT-204

Plate 10 of 12

W.O. 5278-A-SC	DATE 02/07	SCALE 1"=5'

FT-204 Southeast Wall



SEE PLATE 10 FOR LEGEND

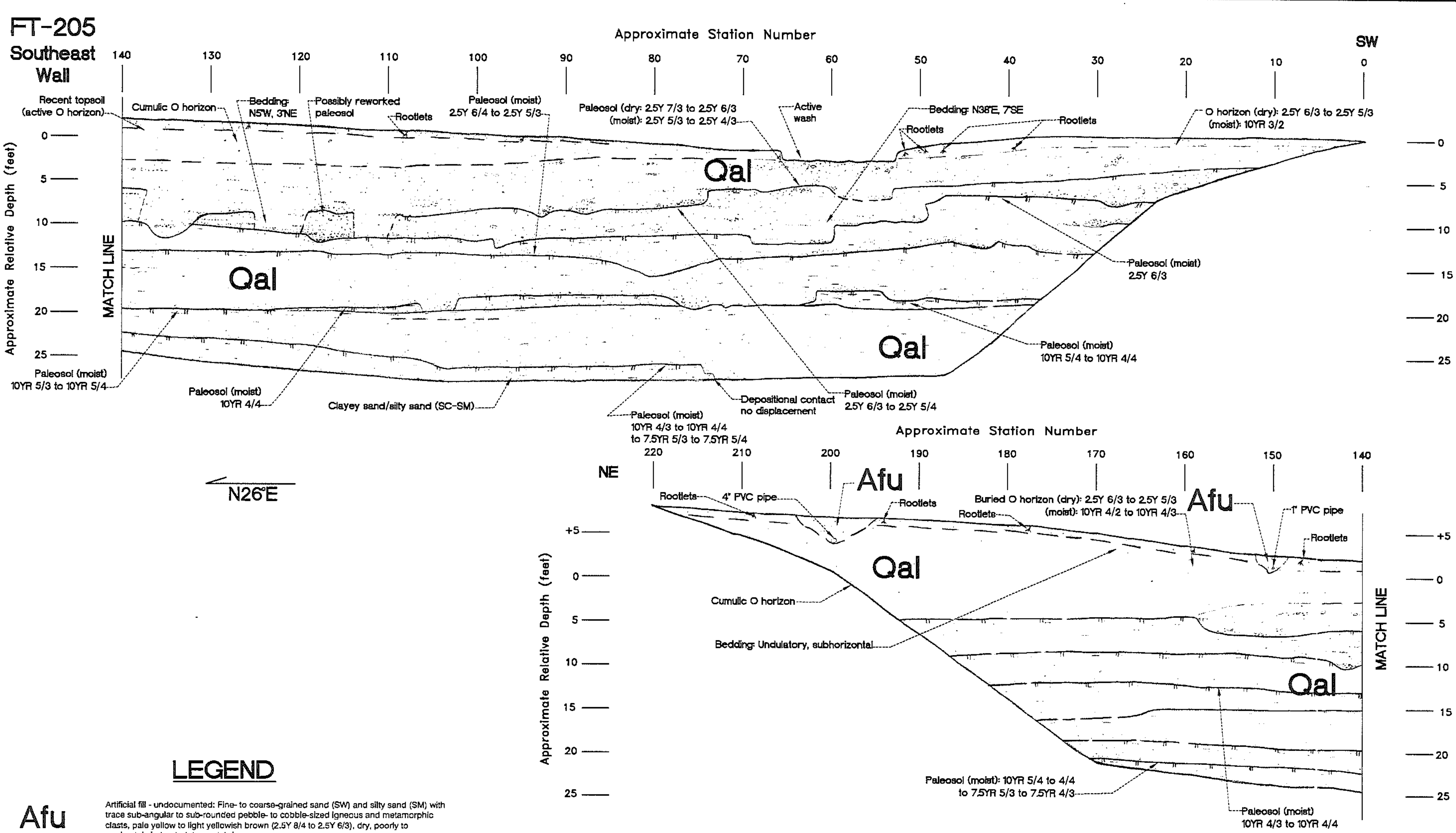
ALL LOCATIONS, STATION NUMBERS, AND DEPTHS ARE APPROXIMATE

GeoSoils, Inc. — RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.

FAULT TRENCH LOG FT-204

Plate 11 of 12

W.O. 5278-A-SC	DATE 02/07	SCALE 1"=5'



LEGEND

Afu — Artificial fill - undocumented: Fine- to coarse-grained sand (SW) and silty sand (SM) with trace sub-angular to sub-rounded pebble- to cobble-sized igneous and metamorphic clasts, pale yellow to light yellowish brown (2.5Y 8/4 to 2.5Y 6/3), dry, poorly to moderately indurated; trace debris

Qal — Quaternary alluvium: Fine- to coarse-grained sand (SW) and silty sand (SM) with trace sub-rounded to sub-angular pebble- to cobble-sized igneous and metamorphic clasts, light brownish gray to light yellowish brown (2.5Y 6/2 to 2.5Y 6/3 [parent]), dry to wet, poorly to moderately indurated; generally massive and thickly bedded with trace thin bedding and localized cross-bedding, locally lenticular, abundant wavy laminae (Bt horizons) on the order of ½-inch thick or less, fining upward sequences capped by discontinuous, regional, buried paleosols

Approximate location of paleosol

Scale: 0 5 10 20 Feet

ALL LOCATIONS, STATION NUMBERS, AND DEPTHS ARE APPROXIMATE

GeoSoils, Inc. — RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.

FAULT TRENCH LOG FT-205

Plate 12 of 12

W.O. 5278-A-SC | DATE 02/07 | SCALE 1"=5'

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Appendix III-A-G

GeoSoils, Inc.
Fault/Seismic Investigation
Lytle Creek Ranch
Neighborhoods II and III
(Portions of Planning Areas 24, 54 55, 56, 58 and 59 and all of Planning Areas 60, 61, and 62)
Rialto, San Bernardino County, California
December 28, 2006

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FAULT/SEISMIC INVESTIGATION, LYTLE CREEK RANCH
NEIGHBORHOODS II AND III (PORTIONS OF PLANNING
AREAS 24, 54, 55, 56, 58, AND 59 AND ALL OF
PLANNING AREAS 60, 61, AND 62), RIALTO
SAN BERNARDINO COUNTY, CALIFORNIA

FOR

LYTLE DEVELOPMENT COMPANY
3281 E. GUASTI ROAD, SUITE 330
ONTARIO, CALIFORNIA 92808

W.O. 5049-A2-SC DECEMBER 28, 2006
REVISED

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GeoSoils, Inc.

Geotechnical • Geologic • Coastal • Environmental

5741 Palmer Way • Carlsbad, California 92010 • (760) 438-3155 • FAX (760) 931-0915

Revised
December 28, 2006

W.O. 5049-A2-SC

Lytle Development Company
3281 E. Guasti Road, Suite 330
Ontario, California 92808

Attention: Mr. Ron Pharris and Mr. Jan Dabney

Subject: Fault/Seismic Investigation, Lytle Creek Ranch, Neighborhoods II and III (Portions of Planning Areas 24, 54, 55, 56, 58, and 59 and All of Planning Areas 60, 61, and 62), Rialto, San Bernardino County, California

Dear Mr. Pharris and Mr. Dabney:

In accordance with your request and authorization, GeoSoils, Inc. (GSI) summarizes herein our fault/seismic investigation of the subject property. Portions of Planning Areas 24 (Neighborhood III), 54, 55, 56, 58, and 59, and all of Planning Areas 60, 61, and 62 (Neighborhood II) lie within an Alquist-Priolo Earthquake Fault Zone (APEFZ). Accordingly, this investigation evaluates onsite geologic conditions as they pertain to active faulting, and their effects on the proposed planning areas. The APEFZ Act, as summarized by Hart and Bryant (1997), requires that the State establish APEFZ's along well-located, active ("sufficiently active and well-defined") faults, and that local building officials shall not issue development permits for sites within the APEFZ until geologic investigations demonstrate that the sites are not likely adversely affected by surface displacements from future faulting. Typically, "sufficiently active" refers to faults that show evidence of surface displacement within about the last 11,000 years (Holocene Epoch). In addition, current professional standards-of-practice require identification and investigation of aerial-photographic lineaments or other geomorphic or geologic features reasonably suggestive of active faulting, whether they be within or outside of existing APEFZ's.

Geologic data from available published technical documents and reports, prior fault investigations, review of stereoscopic, aerial photographs (Appendix A), and independent, aerial-photographic lineament analyses were the basis for this investigation. Electronic copies of prior fault investigations (GSI, 1994 and 1995) are also included on the CD in Appendix A. GSI also retained Dr. Roy J. Shlemon to date soils (pedogenic profiles) exposed in the trenches, as well as to provide guidance for the investigation (Appendix B). Mr. Michael Mills, of Pacific Soils Engineering, Inc. (PSE), was an independent third-party reviewer for the governing agency. Mr. Mills attended field meetings and reviewed site geologic conditions and site geomorphology. Trench logging and trench/fault survey locations have been incorporated into this report. The trench/fault locations, as well as site geology, are provided on Plate 1 (Site Geologic Map [400-scale]), which has been modified from the topographic base map provided by The Otte-Berkeley Group, Inc. Trench logs are also included as Plates 2 through 18.

EXECUTIVE SUMMARY

Based on our current geologic analyses, the proposed project is feasible for its intended use, provided the recommendations in this report are properly implemented during planning, design, and construction. The most significant elements of our investigation are summarized below:

1. The study area lies within a region of faults known as the San Jacinto fault zone (SJFZ), which is active (i.e., movement within the Holocene Epoch), according to the State of California (Hart and Bryant, 1997). Holocene faults, likely associated with the SJFZ, were identified in trench exposures, as documented herein. Habitable structures will require setbacks from these active faults as shown on Plate 1. Distribution of primary and secondary faulting and fault-related deformation have been demonstrated to occur well within these recommended setback zones.

2. Previous fault investigations by Gary S. Rasmussen and Associates, Inc. (Rasmussen; 1980, 1982a, 1982b, 1994a, and 1994b) have occurred on the adjacent, El Rancho Verde Golf Course, located south of the current Neighborhood II study area. Rasmussen (1994b) identified Holocene activity associated with the SJFZ within the golf course and provided setbacks for human-occupied structures. It is our understanding that the Client is relying on Rasmussen's approved reports for the El Rancho Verde Golf Course area of Neighborhood II.

3. Active-fault trends, identified in this investigation, project toward Planning Areas 59 and 63, previously investigated by Rasmussen. This condition may require additional subsurface studies within the El Rancho Verde Golf Course area and/or setbacks for human-occupied structures may be necessary.

4. Although some joints and dry sand settlement cracks (i.e., no offset or displacement), presumably associated with near-field seismic activity, were noted in a few trenches within site sediments, our evaluation indicates that these features can be reasonably mitigated by use of properly designed post-tensioned or mat foundations and/or other engineering design.

5. The site lies in an area of potentially high seismic activity, and horizontal seismic accelerations are anticipated to be approximately 1g, should the design earthquake occur. The geotechnical consultant should therefore evaluate the potential for more

onerous near-field seismic effects (based on the type and size of the seismic source, distance, and geological aspects, etc.), and provide appropriate mitigation.

6. Historic well-water data (California Department of Water Resources [CDWR], 2006) indicate that regional groundwater depths, recorded between 1928 and 2000 in a well near Neighborhood II, have fluctuated between 25 and 171 feet below the recording station elevation (1,851 feet Mean Sea Level [MSL]). Historic well-water data also indicate that regional groundwater depths recorded in a well near Neighborhood III between January and July 1992 fluctuated between 237 and 267 feet below the elevation of the recording station (1,470 feet MSL). We also note that perched water may exist locally, during and after development, owing to a combination of high rainfall, irrigation runoff and seepage, broken utilities, improper drainage, and relatively impermeable subsoils.

7. We observed local paleoliquefaction features, indicating that liquefaction and possible ground deformation has previously occurred onsite. We therefore recommend that additional, site-specific investigations evaluate liquefaction potential, dry sand settlement, as well as other typical geotechnical conditions, such as remedial-removal depths, differential settlement, engineered slope stability, and design criteria. In view of the site, seismic setting and the potential for seismic settlement, post-tensioned and/or mat foundations appear particularly appropriate for this project.

8. Based on our current geological assessments, and excluding proposed setback zones, GSI concludes that active faults (i.e., "sufficiently active" and "well-defined") likely do not exist within the remainder of the study area; however, if present, are of such small displacement to be effectively mitigated by appropriate engineering design.

9. Major underground or above-ground utility lines should cross active faults at high angles approaching perpendicular. Cut-off valves should be located on either sides of active fault zones to facilitate repair.

10. As a result of strong ground shaking, seiching (periodic oscillation of an enclosed body of water) may occur in any planned lakes (if proposed), potentially topping the confining sides of the lake. Additionally, during a seiche, flooding adjacent to and down-stream of the lakes (if proposed) may occur.

11. Flooding may also occur during periods of heavy precipitation. The mid- to late-Holocene, alluvial sediments in the study area were primarily deposited by mud and debris flows emanating from the up-gradient wash, as evidenced by boulders up to about 18 inches to 36 inches (locally) in diameter on proximal, medial, and distal alluvial-fan segments. Therefore, the potential for flooding should be evaluated by the design civil engineer, and mitigation should be provided by the design civil engineer and geotechnical consultant, as warranted.

The opportunity to be of service is sincerely appreciated. If you should have any questions, please do not hesitate to contact the undersigned.

Respectfully submitted,

GeoSoils, Inc.

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Staff Geologist

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FIGURES:

ATTACHMENTS:

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FAULT/SEISMIC INVESTIGATION, LYTLE CREEK RANCH NEIGHBORHOODS II AND III (PORTIONS OF PLANNING AREAS 24, 54, 55, 56, 58, AND 59 AND ALL OF PLANNING AREAS 60, 61, AND 62), RIALTO SAN BERNARDINO COUNTY, CALIFORNIA

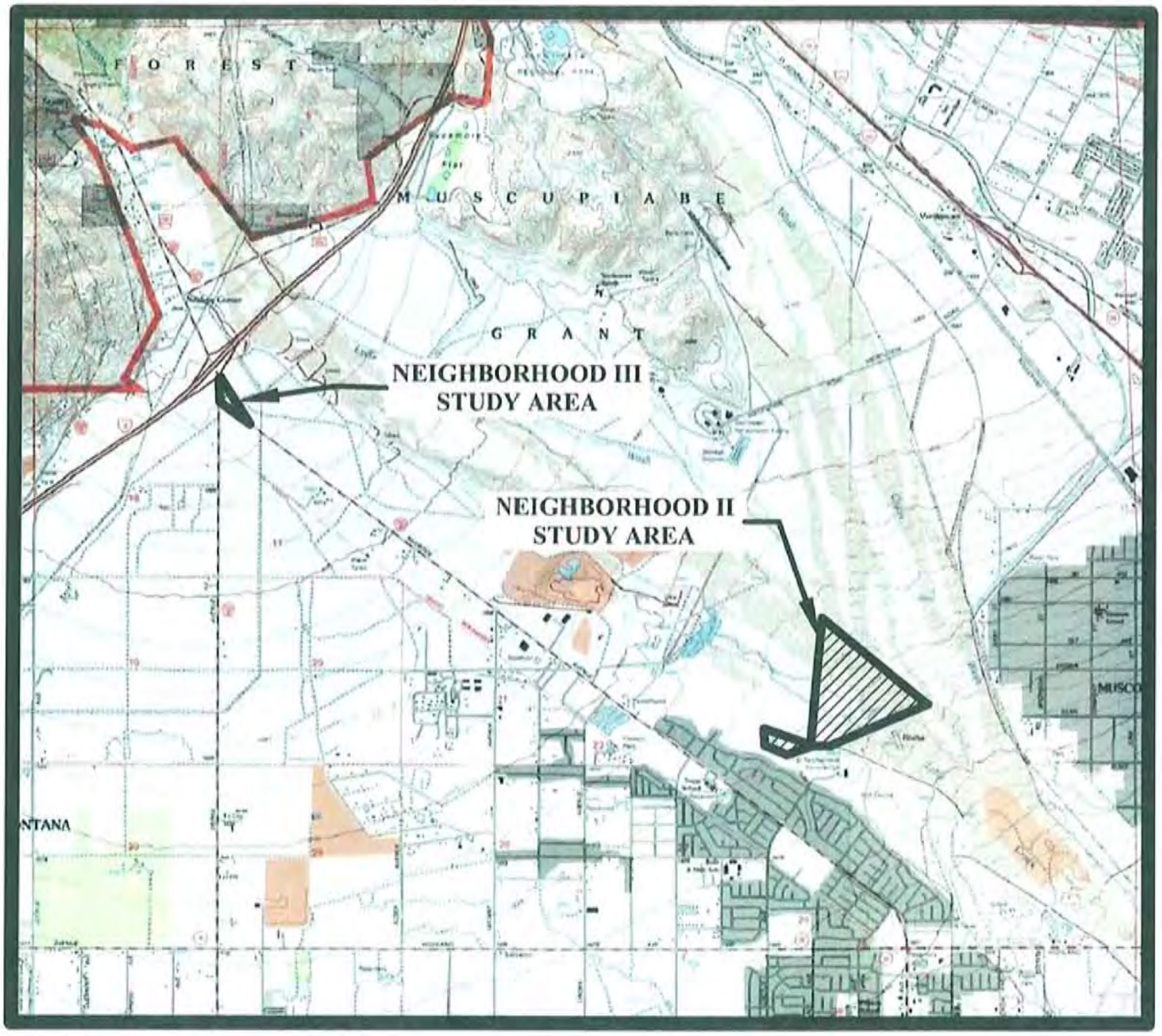
SCOPE OF SERVICES

The primary purpose of this investigation was to locate and assess the activity and style of possible onsite strands associated with the San Jacinto fault zone (SJFZ). The scope of our services included the following:

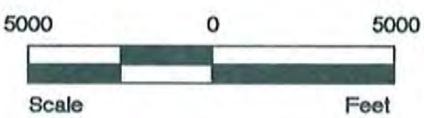
1. Review of available geologic data for the area (Appendix A) including stereoscopic, "false-color" infrared and black-and-white aerial photographs, and an associated aerial-photographic lineament analysis.
2. Geologic and geomorphic site reconnaissance.
3. Subsurface exploration consisting of the geologic logging of seven fault-finding/dating and/or locating trenches totaling approximately 4,322 linear feet. The locations of the trenches are shown on the Site Geologic Map, Plate 1. The logs of the trenches are included as Plates 2 through 18. Also completed was geologic reconnaissance of the north and south channel-banks of the Lytle Creek Wash, which revealed 15 feet, or greater, of exposed sediments.
4. Field meetings and reviewing site geologic and geomorphic conditions with independent geologic consultant, Dr. Roy J. Shlemon, and independent third-party reviewer, Mr. Michael Mills of PSE. A general geomorphic and soil-stratigraphy report by Dr. Shlemon is provided as Appendix B.
5. Deterministic, historical and probabilistic seismic analyses (Appendix C).
6. Geologic and geomorphic analysis of the data collected.
7. Preparation of this report and accompanying documents.

SITE DESCRIPTION AND CONDITIONS

The study area consists of portions of Planning Areas 24 (Neighborhood III), 54, 55, 56, 58, and 59, and all of Planning Areas 60, 61, and 62 (Neighborhood II), within the proposed Lytle Creek Ranch Project (see the Site Location Map, Figure 1). These Planning Areas and parts thereof primarily occupy portions of the outwash area of Lytle Creek Wash and to a lesser extent; Sycamore Canyon Wash, where they coalesce as they flow out of the San Gabriel Mountains toward Rialto, at about a 2 to 4 percent slope. The investigated portion of Planning Area 24 (Neighborhood III) is roughly triangular shaped and located north of Riverside Avenue, east of Sierra Avenue, and south of the northern APEFZ



Base Map: TOPO!® ©2003 National Geographic, U.S.G.S Devore Quadrangle (dated 1996, current 1996) and San Bernardino North Quadrangle (dated 1996, current 1996), California -- San Bernardino, 7.5 Minute.



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SITE LOCATION MAP Figure 1	

boundary. The portions of Planning Areas 54, 55, 56, 58, and 59, and all of Planning Areas 60, 61, and 62 that were evaluated are generally located north of the El Rancho Verde Golf Course and the existing, flood-control levee, west of Neighborhood II's eastern, property boundary (located north of the existing, flood-control levee), south of the northern, open-space boundary/northern, Neighborhood II property line, and east and south of the western APEFZ boundary. Gas, electric, and water utilities traverse portions of the study areas, and are generally associated with maintained and unmaintained roads.

Overall drainage, within the studied Planning Areas, is accommodated by sheet-flow to the southeast and is influenced by the southeastern-sloping terrain. Runoff is eventually discharged into the Lytle Creek Wash corridor via ephemeral drainages. Near the margins of Lytle Creek Wash, which transects most of Planning Area 54, point bars, natural levees, as well as berms and flood control levees exist. A retention pond for the El Rancho Verde Golf Course is located within Planning Area 59. An Eastern Municipal Water District water-storage tank is located west of Planning Area 58 and north of Planning Area 59.

Topographically, elevations within the study area range from a high of about 1,990 feet Mean Sea Level (MSL) in the extreme eastern portion of the Neighborhood III study area, to a low of about 1,405 feet MSL in the southeastern corner of the Neighborhood II study area yielding an overall relief of about 585 feet. The area currently has a light to moderate growth of weeds, grasses, bushes, and a few trees.

PROPOSED DEVELOPMENT

The land use plan by EDAW/AECOM (400-scale plans dated December 11, 2006), indicates that proposed development, within the study area, consists of single-family, residential (Planning Areas 55, 56, 58, 60, and 62) and mixed-use (Planning Area 24) construction, open space (Planning Area 54), and open space/recreational (Planning Areas 59 and 61) applications. If any changes are made to this plan, additional geologic review may be necessary.

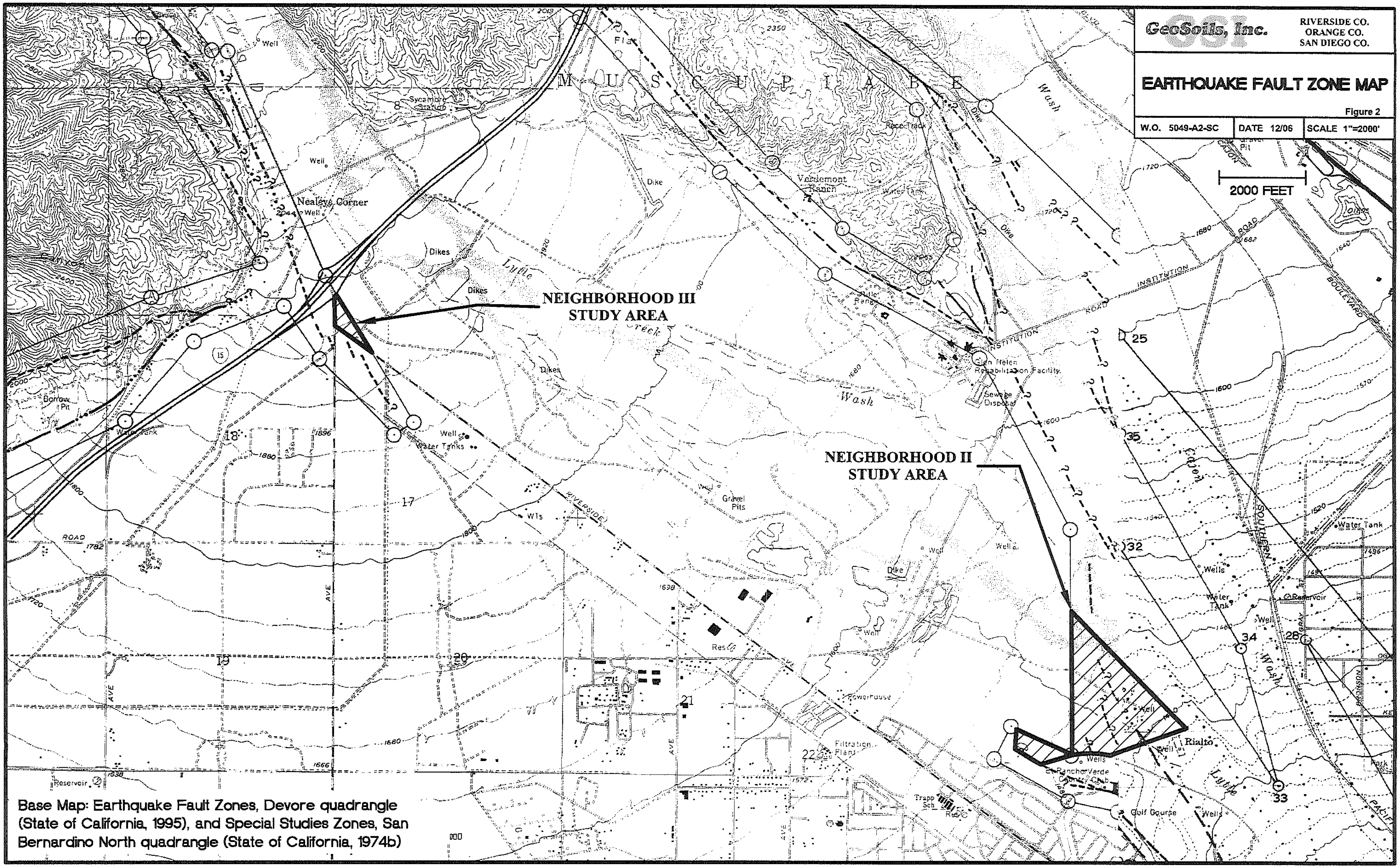
We understand that proposed buildings will be one- and/or two-story residential and commercial structures, utilizing typical wood-frame and tilt-up construction with slabs-on-grade and continuous footings and/or post-tension slabs or mat foundations. Building loads are assumed to be typical for this type of relatively light residential and commercial construction. Sewage disposal is assumed to be accommodated by tying into the regional, municipal system. The need for import soils is presently unknown.

DEFINITIONS

Portions of the site lie in an Alquist-Priolo Earthquake Fault Zone (Special Publication 42 [see Figure 2]), and pertinent definitions are appropriate. Special Publication 42 (Hart and Bryant, 1997), state: "A *fault* is defined as a fracture or zone of closely associated fractures along which rocks on one side have been displaced with respect to those on the other side." Hart and Bryant (1997) also indicate that: "an *active fault* is defined by the State Mining and Geology Board as one which has 'had surface displacement within Holocene time (about the last 11,000 years).'" Similarly, Neuendorf, *et al.* (2005) define a *fault* as: "A discrete surface or zone of discrete surfaces separating two rock masses across which one mass has slid past the other." Accordingly, the key criterion for determining whether a feature is a fault, is shear displacement. Fractures (including joints and cracks) with no shear displacement, are therefore, by definition, not classified as faults. Neuendorf, *et al.* (2005) also define a *joint* as: "A planar fracture, crack, or parting in a rock, without shear displacement...." A *crack* is defined by Neuendorf, *et al.* (2005) as: "A parting with crack-normal motion."

Further, for purposes of State definitions, faults should be "sufficiently active" and "well-defined" (Hart and Bryant, 1997). As summarized by Hart and Bryant (1997), "the more recent the faulting, the greater the probability for future faulting." The State also notes that, "A fault is deemed sufficiently active if there is evidence of Holocene surface displacement along one or more of its segments or branches....." and "A fault is considered well-defined if its trace is clearly detectable by a trained geologist as a physical feature at or just below the ground surface." Surface is defined by Neuendorf, *et al.* (2005) as: "... top of the ground...." The critical consideration by the State is that the fault, or some part of it, can be located in the field with sufficient accuracy and confidence to indicate that the required site-specific investigations would meet with some success.

If a fault that clearly demonstrates Holocene activity crosses an area proposed for human occupancy, the State of California requires an appropriate setback distance. This distance depends on uncertainty in fault character and trend. Thus, several closely spaced, well-documented trenches, may provide sufficient geologic information to reduce setbacks to ~10 feet. In contrast, faults that step, flower upward or have other "uncertain" characteristics, require a greater setback distance. The setback distance is therefore determined by the geologist based mainly on site-specific data and sound professional judgement. A *structure for human occupancy* is defined by Hart and Bryant (1997) "as any structure used or intended for supporting or sheltering any use or occupancy, which is expected to have a human occupancy rate of more than 2,000 person-hours per year."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EARTHQUAKE FAULT ZONE MAP
Figure 2
W.O. 5049-A2-SC
DATE 12/06
SCALE 1"=2000'
2000 FEET
NEIGHBORHOOD III
STUDY AREA
NEIGHBORHOOD II
STUDY AREA
M U S C U P I A B E
Nealeys Corner
Verdemont Ranch
Glen Helen Rehabilitation Facility
Lytle Creek
Wash
Cajon Wash
Gravel Pits
Filtration Plant
Rialto
Rancho Verde Country Club
Golf Course
INSTITUTION ROAD
RIVERSIDE
SOUTHERN PACIFIC
Base Map: Earthquake Fault Zones, Devore quadrangle (State of California, 1995), and Special Studies Zones, San Bernardino North quadrangle (State of California, 1974b)

FIELD STUDIES AND INVESTIGATIVE PROCEDURES

Consistent with present, professional standards-of-practice, our field studies consisted of the following:

1. Geologic and geomorphic site reconnaissance.
2. Review of pertinent literature.
3. Aerial-photographic lineament analysis.
4. Subsurface exploration consisting of the geologic logging of seven fault-finding/dating and/or locating trenches totaling approximately 4,322 linear feet. Trench locations and selected outboard or controlling faults, and/or faults exhibiting the largest vertical displacements in each trench were surveyed by Dawson Surveying, Inc.
5. Geologic reconnaissance of the north and south channel banks of the Lytle Creek Wash which exposed 15 feet, or greater, exposure of sediments.
6. Field meetings and assessment of site geologic and geomorphic conditions with Dr. Shlemon and independent third-party reviewer, Mr. Michael Mills of PSE.

Our subsurface investigation was constrained by the locations of the aforementioned retention pond, flood-control levees, underground utilities and environmentally/biologically sensitive areas. The GSI fault trenches were logged by geologists from our firm. Trench locations and fault setback zones are indicated on Plate 1. Logs of the GSI trenches are presented as Plates 2 through 18. Dr. Shlemon's soil age-dating report is provided as Appendix B.

Geologic and Geomorphic Site Reconnaissance

Prior to commencing field work, a reconnaissance was performed to evaluate general site geologic and geomorphic conditions. This field review noted features possibly indicative of faulting and thus where trenches might be placed to gain the most information. Additionally, existing improvements and environmentally/biologically sensitive areas were noted that could potentially affect the location of the proposed exploratory work.

Review of Pertinent Literature

Readily available soils, geologic, hydrogeologic, and related literature were reviewed to evaluate prior work on the site and region that could bear on the proposed explorations and overall evaluation of the site, including previously mapped faults. Pertinent references are listed in Appendix A.

Aerial-Photographic Lineament Analysis

In order to identify possible unmapped faults and to evaluate topographic expressions of published fault traces, a lineament analysis was performed. Stereoscopic, "false-color," infrared aerial photographs at a scale of approximately 1:40,000 and stereoscopic black-and-white aerial photographs at a scale ranging from approximately 1:12,000 to 1:24,000 were utilized for the analysis.

Lineaments are generally classified as strong, moderate, or weak. A strong lineament is a well defined feature which can be continuously traced several hundred feet to a few thousand feet. A moderate lineament is less well defined, somewhat discontinuous, and can be traced for only a few hundred feet. A weak lineament is discontinuous, poorly defined, and can be traced for a few hundred feet or less.

Several weak to moderate photo-lineaments were observed in Neighborhood II. The trends of these photo-lineaments are sub-parallel with the SJFZ and therefore were investigated by emplacement of FT-1 (Plate 1). Where intercepted by FT-1, these lineaments were not associated with any active faulting. Owing to the young, low-lying, near-surface, alluvial sediments in this particular area, the lineaments primarily reflect Holocene and historic channels, and thus are not inherent indicators of active faults.

Subsurface Exploration

Based on the published information, including State maps of faulting, site reconnaissance, and aerial-photographic lineament analysis, initial fault-finding trenches appropriately covered potential faulting within APEFZ's. Based on trench exposures, additional explorations were subsequently emplaced. A photograph of a typical trench is attached as Figure 3. The type of excavating equipment used for this investigation is displayed in Figure 4. As indicated above, the trench locations are shown on Plate 1, and logs of the fault finding trenches are included as Plates 2 through 18.

Outside Consultation

The trenches were observed by Dr. Shlemon, who provided independent geologic consultation and guidance for investigative techniques. Soil stratigraphy of the trenches was also evaluated by Dr. Shlemon, based on pedogenic profiles developed on the parent sediments in order to evaluate recency of fault movement. Sediments amenable to Carbon-14 dating were not encountered in our trenches. A summary by Dr. Shlemon is included in Appendix B.

REGIONAL GEOLOGIC SETTING

The study area is located at the northeastern end of the Perris Block of the Peninsular Ranges Geomorphic Province, which is characterized by northwest-trending, steep, elongated ranges and valleys (Norris and Webb, 1990). The Peninsular Ranges Geomorphic Province extends north to the base of the San Gabriel Mountains along the southern side of the Transverse Ranges Province, and south into Baja California. The province is bounded by the Transverse Ranges Geomorphic Province to the north and northeast, by the Colorado Desert Geomorphic Province to the southeast, and by the Continental Borderlands Geomorphic Province to the west. The Perris Block is part of the Peninsular Ranges and is considered to be a relatively stable structural block lying between the Elsinore and San Jacinto fault zones (Morton and Matti, 2005).

The Transverse Ranges geomorphic province is so named because of the conspicuous east-west alignment of the mountain ranges that contrast to most mountain ranges in North America. The Transverse Ranges province is characterized by major mountain ranges with intervening alluviated, broadly synclinal valleys and narrow stream canyons. A regional geologic map and legend (Morton and Matti, 2001; Miller, *et al.*, 2001) are provided as Figure 5.

The Perris Block is bounded on the northeast by the SJFZ, on the north by the Cucamonga fault zone and the San Gabriel Mountains, and on the southwest by the Elsinore fault zone and the Santa Ana Mountains. The Perris Block is bounded by two grabens, the Elsinore Trough on the west (part of the Elsinore fault zone) and the Salton Trough on the east (Sharp, 1975). The Perris Block is less uplifted than the bounding mountain ranges, resulting in lower relief. Within the Perris block, Dibblee (1982b) considered part of the site to be located within the Cucamonga Block, a smaller area with somewhat different characteristics. The Cucamonga Block (Dibblee, 1982b), is bounded on the south by the north-dipping Cucamonga reverse or thrust fault, on the northeast by the right-lateral strike-slip SJFZ in Lytle Canyon, and on the northwest by the left-lateral San Antonio fault, which may ultimately connect with the Chino and Elsinore faults to the south. Cramer and Harrington (1987) indicated that the movements of the Cucamonga block are aligned with the Peninsular Ranges Province, which is apparently being forced northward into the Transverse Ranges by plate tectonic motion causing the northern edge of the province to be thrust under the San Gabriel Mountains.

SITE TECTONIC FRAMEWORK

The San Andreas Fault Zone

The proposed Lytle Creek Ranch development lies within the SJFZ, a major active component of the San Andreas fault system. The San Andreas fault zone (SAFZ) extends into California at Point Arena, north of San Francisco. It then extends southeast through and along the Coast Ranges to the Transverse Ranges where it bends and extends

Fault Trench FT-1: Example of a typical fault trench. Benches are about ±4½ to 5 feet high (see Plate 1 for location).

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SITE PHOTOGRAPH

Figure 3

DATE 12/2006	W.O. NO. 5049-A2-SC

Geotechnical · Geologic · Coastal · Environmental

Fault Trench FT-5: Excavating equipment used for this investigation.

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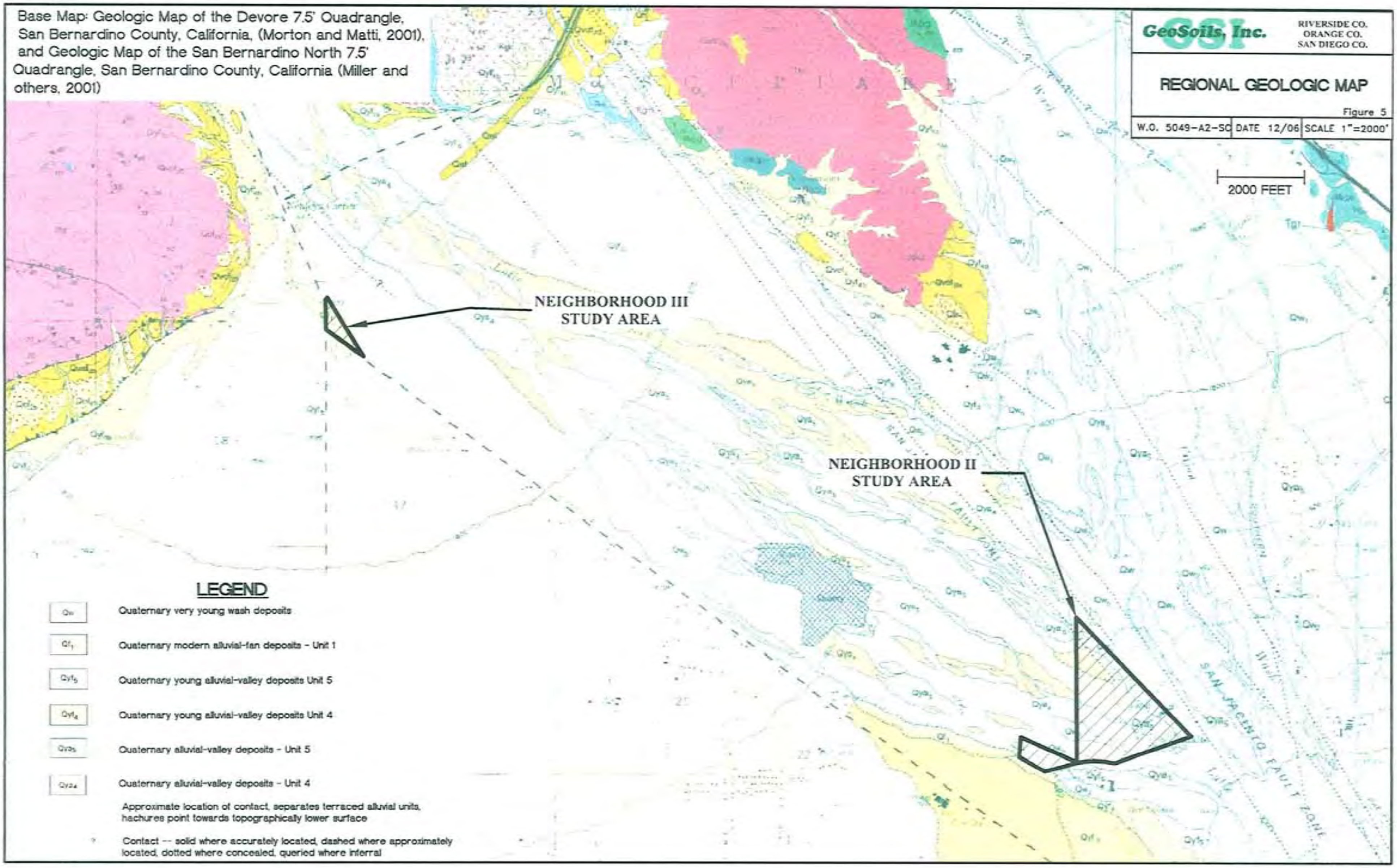
SITE PHOTOGRAPH

Figure 4

DATE 12/2006	W.O. NO. 5049-A2-SC

Geotechnical · Geologic · Coastal · Environmental


Base Map: Geologic Map of the Devore 7.5' Quadrangle, San Bernardino County, California, (Morton and Matti, 2001), and Geologic Map of the San Bernardino North 7.5' Quadrangle, San Bernardino County, California (Miller and others, 2001)
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REGIONAL GEOLOGIC MAP
Figure 5
W.O. 5049-A2-SC
DATE 12/06
SCALE 1"=2000'
2000 FEET
NEIGHBORHOOD III STUDY AREA
NEIGHBORHOOD II STUDY AREA
SAN JACINTO FAULT ZONE
LEGEND
Qw Quaternary very young wash deposits
Qf1 Quaternary modern alluvial-fan deposits - Unit 1
Qyf5 Quaternary young alluvial-valley deposits Unit 5
Qyf4 Quaternary young alluvial-valley deposits Unit 4
Qya5 Quaternary alluvial-valley deposits - Unit 5
Qya4 Quaternary alluvial-valley deposits - Unit 4
Approximate location of contact, separates terraced alluvial units, hachures point towards topographically lower surface
Contact -- solid where accurately located, dashed where approximately located, dotted where concealed, queried where inferral

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obliquely across the Cajon Pass-San Gorgonio Pass region. From there, north and south branches along with the Banning fault, diverge southeastward and form a complex system in the Salton trough (Sharp, 1975), as illustrated on the California Fault Map (Figure 6).

The SAFZ is relatively straight and continuous throughout much of its length in California, and these characteristics are generally recognized as hallmarks of steeply dipping strike-slip faults throughout the world. The San Jacinto fault, part of the San Andreas Transform-Fault System, trends southeastward to the Gulf of California from the nearby Cajon Pass area (Crowell, 1975). Matching displaced rocks on either side of all of the combined faults indicates that right slip on the combined faults began in the Miocene, about 12 million years ago. Other studies (Matti, *et al.*, 1992) indicate the inception of the modern San Andreas fault occurred 4 or 5 million years ago in the latest Miocene to early Pliocene. Movement on the SAFZ continues to the present. As summarized by Matti, *et al.* (1992), the traces of most recent movement on the San Andreas fault are commonly discontinuous en-echelon strands.

As also summarized by Matti, *et al.* (1992), in central California, displacement has occurred mainly along the San Andreas fault proper. In southern California, however, the total displacement has been taken up by several discrete fault strands, including the San Andreas, San Jacinto, Punchbowl, San Gabriel, and Banning faults, as well as other less well-known structures (Morton and Matti, 1993). The average slip rate on the SAFZ in the general region has been about 15 mm/year. In contrast, the southern branch (Coachella segment) of the SAFZ has an average slip rate of 23 to 35 mm/year near Indio, and 5 to 14 mm/year on the southern-most SAFZ (Keller, *et al.*, 1982; Shifflett, *et al.*, 2002). The Mojave segment has an average slip rate of about 35 millimeters/year. Recurrence intervals for large earthquakes of about 7.0M and 8.0M generating surface rupture average about 215 years ±25 years for the Coachella segment. The elapsed time since the most recent similar large event in the Coachella area is 326 years ±35 years (Fumal, *et al.*, 2002). The California Geological Survey ([CGS], 1996 and 2003) judge the slip rate on the San Bernardino segment of the San Andreas fault near the study area as about 24 mm/year, 25 mm/year for the Coachella segment of the San Andreas, and 35 mm/year for the Mojave segment.

Matti, *et al.* (1992) view the Quaternary tectonic framework of the central Transverse Ranges north of the study area as a regionally integrated response to an evolving left step in the San Andreas transform-fault system. During latest Quaternary time, right-slip on the SAFZ stepped left from the northern Coachella Valley segment, westward to the Banning fault and thence into San Gorgonio Pass, where right-slip is absorbed by convergence with the San Gorgonio Pass Fault zone. Some slip may step farther west to the SJFZ near the San Jacinto Valley, where accelerated right-slip may have contributed to subsidence of the San Jacinto graben. Ultimately, slip steps back from the San Jacinto fault to the modern San Andreas fault, giving rise to the San Bernardino strand by reactivation of the Mission Creek fault. This right step has created a right-lateral shear couple and extensional strain field in the greater San Bernardino Valley, with extension giving rise to normal dip-slip faults like those in the Crafton Hills horst-and-graben complex and the Tokay Hill and

CALIFORNIA FAULT MAP
LYTLE DEVELOPMENT COMPANY

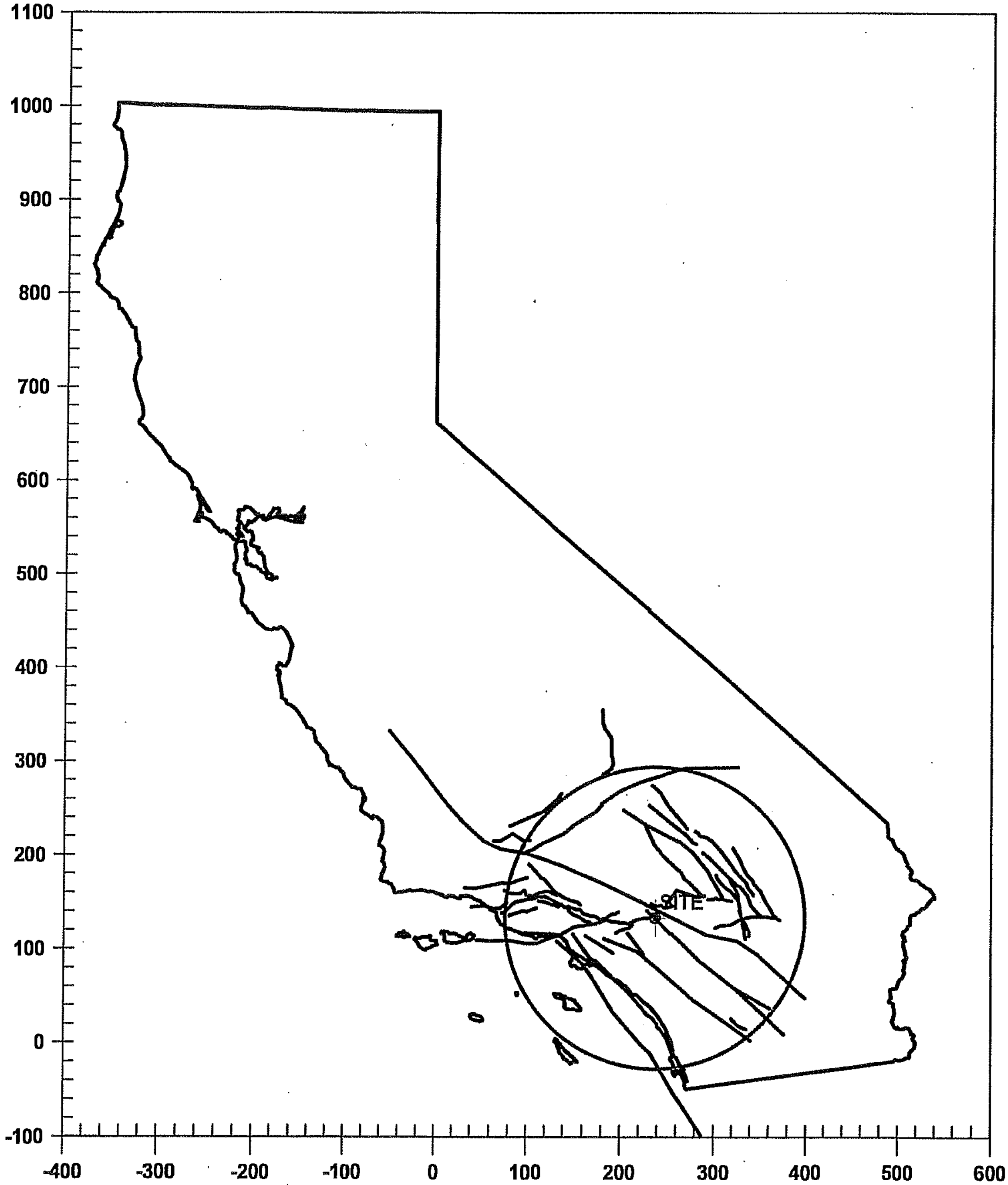

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Figure 6

Peters faults (Matti, *et al.*, 1992). This is illustrated on Figure 7, "Relations between Faults and Crustal Blocks."

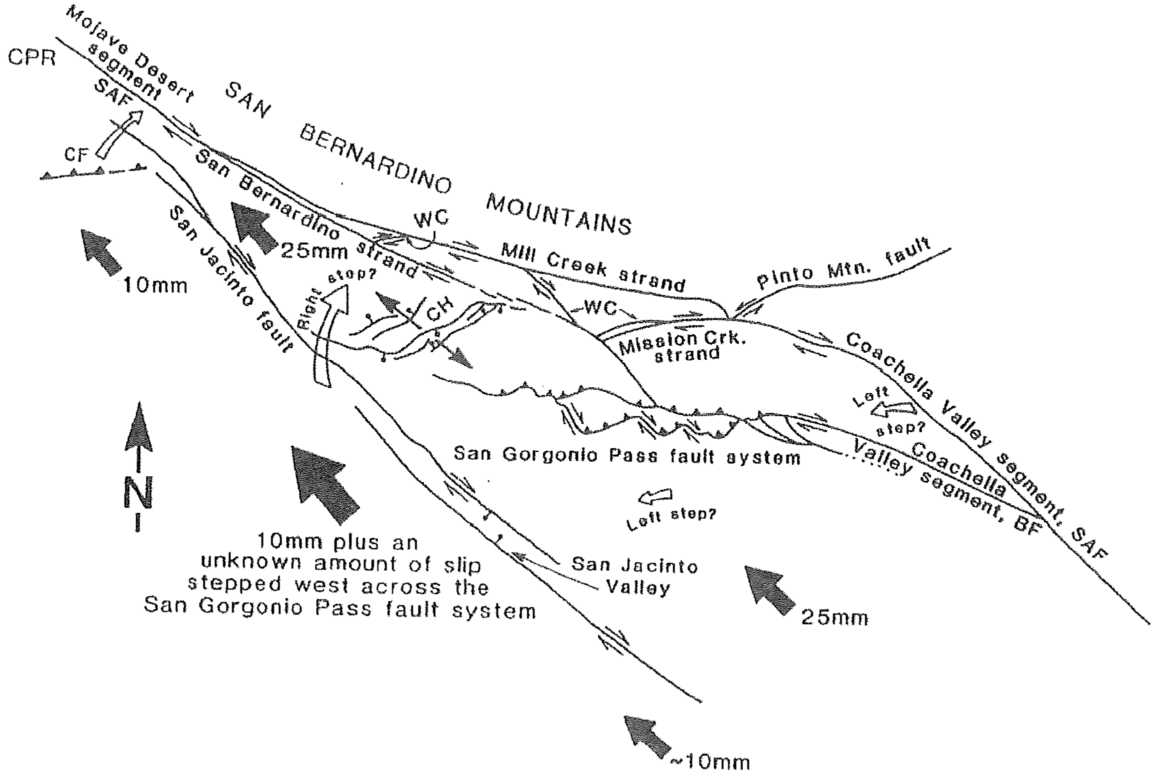
San Jacinto Fault Zone

The San Jacinto fault zone (SJFZ) forms several en-echelon fault patterns among its member strands. The Glen Helen-Claremont and Claremont-Casa Loma fault pairs (Figure 8) probably define zones of shallow crustal extension or elongation beneath San Bernardino and San Jacinto, respectively, as indicated by Sharp (1975). The SJFZ contrasts strongly with the SAFZ with respect to the continuity of its strands, despite the fact that the zone as a whole is fairly linear. Not only are en-echelon fault relations more numerous along the SJFZ, but also the length of individual strands, in en-echelon pairs, and the distance between the overlapping elements are both, much larger than those described along the San Andreas (Sharp, 1975), possibly indicating a higher level of activity.

The Claremont fault is clearly the dominant trace of the SJFZ immediately southeast of San Bernardino Valley (Figure 8). At the north edge of the valley, the zone includes two major strands, one nearly on line with the Claremont fault, and the other, the Glen Helen fault (Sharp, 1975). Between the San Jacinto Valley and the San Gabriel Mountains, the SJFZ traverses Quaternary alluvial units and sedimentary rocks. The fact that the Glen Helen fault shows scarps and sag ponds in young Holocene alluvium, whereas the Claremont fault does not at the northern edge of the valley, suggests that transfer of displacement by crustal extension between en-echelon fault pairs might be occurring (Sharp, 1975). Southeast of metropolitan San Bernardino, the main trace displaces Quaternary units, but southeast and northwest of this break the youngest floodplain deposits of the Santa Ana River and Cajon and Lytle Creeks are not broken (Matti, *et al.*, 1992).

Matti, *et al.* (1992) indicated the name "San Jacinto" traditionally has been applied to a northwest-oriented fault zone developed in crystalline rocks east of the mouth of Lytle Creek canyon (Figures 5 and 6). There, the zone consists of two or three or more, vertically oriented, closely spaced faults with shear zones in crystalline bedrock up to 300 meters wide, but do not displace Quaternary deposits (Morton and Matti, 1987). To the east, the Glen Helen fault forms scarps and sag ponds in alluvial deposits that probably are as young as Holocene (Sharp, 1975; Morton and Matti, 1993), and to the west, the Lytle Creek fault forms a scarp in alluvial materials that are latest Pleistocene in age (Morton and Matti, 1987). Metzger and Weldon (1983) indicated a late Quaternary right-slip rate of about 2 mm/year for the Lytle Creek fault. Matti, *et al.* (1992), concluded that the Glen Helen fault probably is the active strand of the SJFZ in the San Gabriel Mountain region.

Morton and Matti concluded that the San Jacinto fault cannot be mapped into either the Punchbowl or San Andreas faults; instead, faults attributed to the San Jacinto zone appear to splay into several branches that curve west into the San Gabriel Mountains without joining the San Andreas fault at the surface (Matti, *et al.*, 1992).



Schematic diagram illustrating relations between faults and crustal blocks in the vicinity of the south-central Transverse Ranges. Large solid arrows indicate the relative motion of crustal blocks; large hollow arrows indicate lateral transfer of slip. Small solid arrows indicate crustal extension in the Crafton Hills horst-and-graben complex. BF, Banning fault; CF, Cucamonga fault; CH, Crafton Hills; CPR, Cajon Pass region; SAF, San Sandreas fault; WC, Wilson Creek strand, San Andreas fault. Ten millimeters of annual slip on the San Jacinto fault is assumed from data of Sharp (1981).

From: Matti, J.C., et al., 1992

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RELATIONS BETWEEN FAULTS AND CRUSTAL BLOCKS

Figure 7

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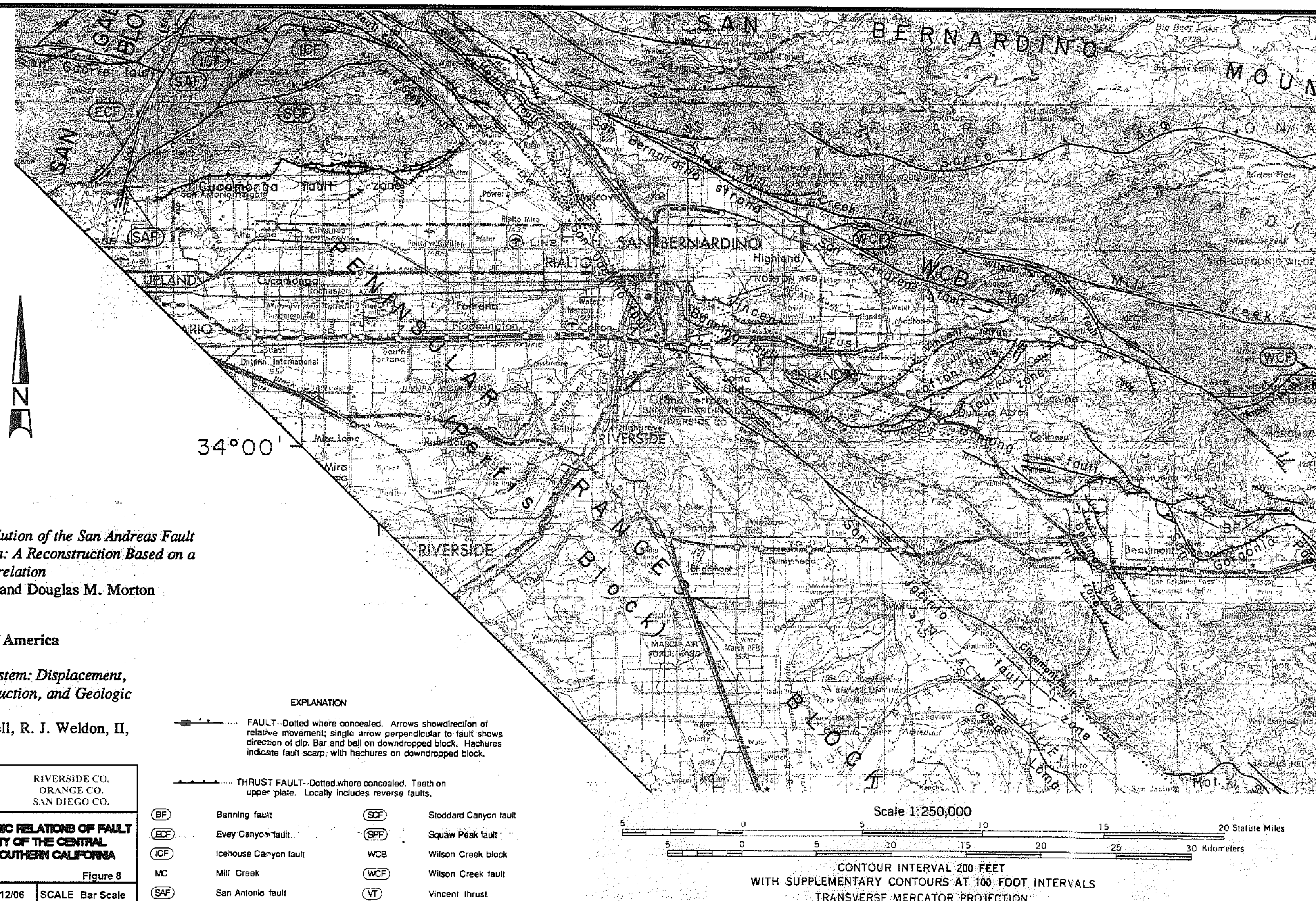

Chapter 2
Paleogeographic Evolution of the San Andreas Fault in Southern California: A Reconstruction Based on a New Cross-Fault Correlation
by Jonathan C. Matti and Douglas M. Morton

Geological Society of America
Memoir 178
San Andreas Fault System: Displacement, Palinspastic Reconstruction, and Geologic Evolution
Edited by R. E. Powell, R. J. Weldon, II, and J. C. Matti, eds.

EXPLANATION

FAULT--Dotted where concealed. Arrows showdirection of relative movement; single arrow perpendicular to fault shows direction of dip. Bar and ball on downdropped block. Hachures indicate fault scarp, with hachures on downdropped block.

THRUST FAULT--Dotted where concealed. Teeth on upper plate. Locally includes reverse faults.

BF	Banning fault	SCF	Stoddard Canyon fault
ECF	Evey Canyon fault	SPF	Squaw Peak fault
ICF	Icehouse Canyon fault	WCB	Wilson Creek block
MC	Mill Creek	WCF	Wilson Creek fault
SAF	San Antonio fault	VT	Vincent thrust

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DISTRIBUTION AND GEOLOGIC RELATIONS OF FAULT SYSTEMS IN THE VICINITY OF THE CENTRAL TRANSVERSE RANGES, SOUTHERN CALIFORNIA

Figure 8

W.O. 5049-A2-SC	DATE 12/06	SCALE Bar Scale

Matti, *et al.* (1992) proposed that the east- to northeast-oriented Evey Canyon, Icehouse Canyon, and Stoddard Canyon faults are segments of thoroughgoing structures that formerly were regionally connected, namely the middle Miocene left lateral Malibu Coast-Raymond-Banning fault and the late Miocene San Gabriel-Banning fault. They further indicated that these older faults separate rocks of San Gabriel Mountains-type on the west, north, and east from rocks of Peninsular Ranges-Type on the south. These structures trend essentially eastward until they enter the Lytle Creek drainage, where they converge and trend southeastward down Lytle Creek Canyon. There, they are represented by the fault zone that occurs east of the mouth of Lytle Creek Canyon. They concluded that the name "San Jacinto fault" in Lytle Creek Canyon has been applied to an ancient fault zone that has witnessed multiple episodes of strike-slip faulting - only the latest of which can be attributed to the movement history of the "San Jacinto" that traverses the Peninsular Ranges Province to the southeast (Matti, *et al.*, 1992). Morton and Matti (1993) proposed that the trace of the "San Jacinto fault" in Lytle Creek Canyon once was part of the previously discussed middle Miocene left lateral Malibu Coast-Raymond-Banning fault and the late Miocene San Gabriel-Banning fault, and shared their sequential left- and right-slip histories, in addition to episodes of Quaternary right-slip related to the San Jacinto fault farther south in the Peninsular Ranges.

Morton and Matti (1993) indicate that the feature generally identified as the "San Jacinto fault zone" where it penetrates the southeastern corner of the San Gabriel Mountains near the mouth of Lytle Creek, consists of three near vertical faults. Soils offset by the Lytle Creek fault are reportedly in the 50,000 to 60,000 years old range (Metzger and Weldon, 1983).

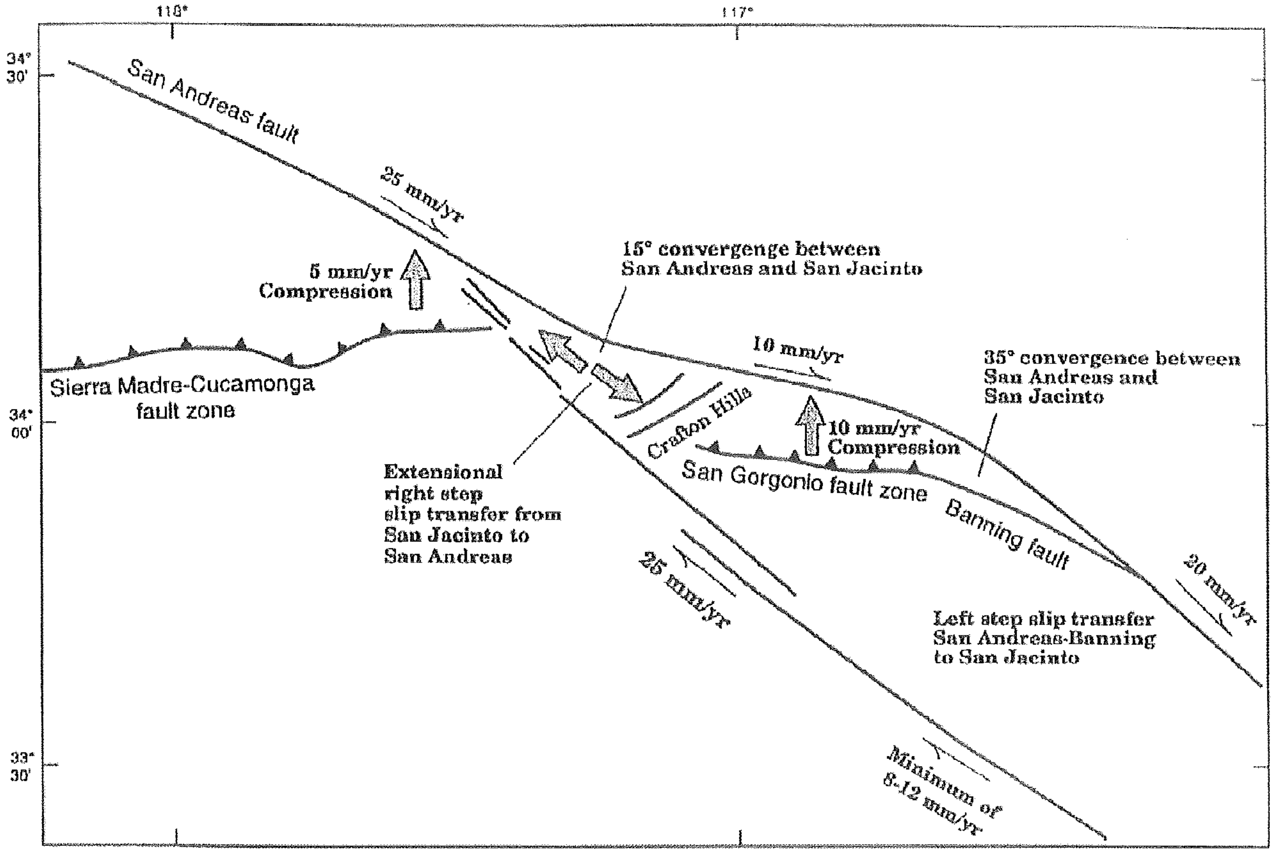
The slip rate for the SJFZ (Glen Helen and Claremont segments) is approximately 10 to as much as 20 mm/year (Morton and Matti, 1993). The Southern California Earthquake Center (SCEC, 2006a) indicates that the slip rate for the SJFZ is typically between 7 and 17mm/year. Kendrick, *et al.* (2002), have suggested that the slip rate on the SJFZ may be greater than 20 mm/year. According to Bennet, *et al.* (2004), the slip rate on the San Jacinto fault has varied from about 0 to 26 $\pm$4 mm/year since its inception approximately 1.5 million years ago and the current slip rate is about 9 $\pm$2 mm/year. Bennet, *et al.* (2004) also concluded that the change in slip rate on the San Jacinto fault is matched by an equal and opposite change in the rate on the San Andreas fault. SCEC (2006a) indicates that the interval between surface ruptures is between 100 and 300 years per segment for magnitudes of between 6.5M and 7.5M. Fault investigations by Kendrick and Fumal (2005) within the SJFZ, near Colton and San Bernardino, California, reported return intervals between approximately 100 and 266 years. Morton and Matti (1993) summarize that the recent evolution of the San Andreas system between Cajon Pass and Coachella Valley was characterized by a complex history of fault strand development, strand switching, and strand abandonment related to the creation of a structural knot in the San Gorgonio Pass area. Two major structural features resulted from progressive development of the structural knot. For the SAFZ, it resulted in the apparent lack of a thoroughgoing fault, at least at the surface. In terms of strand development, the SJFZ represents the most recent phase in this mechanistic evolution and simply bypasses the San Gorgonio knot, since its inception about 2.5 to 1.5 million years ago. In the area of convergence between the San Andreas and San Jacinto faults, the Glen Helen fault is the northernmost fault characteristic of the faults within the SJFZ in the Peninsular Ranges (Morton and Matti, 1993). Contraction and uplift occurring in the eastern San Gabriel Mountains, between the Cucamonga fault zone and the San Andreas fault, is interpreted as strain that has accumulated in response to the transfer of slip between the San Jacinto and San Andreas fault zones. This relationship is indicated on Figure 9, Slip Transfer Schematic.

Cucamonga Fault Zone

The Cucamonga fault is discussed for context. Our review and prior work indicates that the Cucamonga fault is not expressed on the site at, or near, the surface. However, its trend and associated APEFZ project toward proposed Neighborhoods I and IV. Additionally, ICBO (1998) indicates that portions of the Lytle Creek Ranch development lie within the Cucamonga fault near-source zone.

The Cucamonga fault is the southern margin of the eastern San Gabriel Mountains and marks the eastern end of the frontal fault system of the San Gabriel Mountains (Morton and Matti, 1993). The Cucamonga fault is a compressional zone of Quaternary reverse and thrust faults that separates crystalline rocks of the San Gabriel Mountains from alluviated lowlands of the upper Santa Ana River valley (Morton; 1975a, 1975b, 1976a, and 1976b; Morton and Matti, 1987), as well as thrust faults entirely within alluvium (Morton and Matti, 1987). The Cucamonga fault zone consists of several anastomosing east-striking and north-dipping thrust faults. Morton and Matti (1993) projected the Cucamonga fault zone down-dip 13 km to merge with the San Andreas fault. They also conclude that the Cucamonga fault zone has been displaced 5 km farther north than the San Gabriel mountain front to the west of San Antonio Canyon.

Geologic investigations and mapping by Morton (1976a and 1976b) show the Cucamonga as a system of fault scarps between Lytle Creek and San Antonio Canyons. Holocene surface rupture has only been established west of Lytle Creek Canyon (Morton and Matti, 1987). Epicenters of microseismic activity do fall near the surface trace of the Cucamonga fault, but their focal depths (6 to 12 km) are too deep for this activity to be on the Cucamonga fault (Cramer and Harrington, 1987). Cramer and Harrington (1987) further conclude that internal deformation is occurring within the Cucamonga block. In the western part, deformation is largely vertical, while in the eastern part, it is largely horizontal shearing under the influence of the San Jacinto fault system. Morton and Matti (1987) suggest that faulting within the Cucamonga fault zone may have migrated southward during late Pleistocene and Holocene time. The average north-south convergence across the Cucamonga fault zone is an estimated 3 mm (Weldon, 1986) to 6 mm/year (Matti, *et al.*, 1985; Morton and Matti, 1987). Latest episodes of strain release may have occurred mainly in the eastern 15 km of the fault zone and not throughout its entire 25 km length (Matti, *et al.*, 1992).



Schematic map (modified from Matti and others, 1985) showing interpretation of slip transfer between some of the faults in the area of the San Bernardino basin and southeastern San Gabriel Mountains.

From: Morton, D.M. and Matti, J.C., 1993

GeoSoils, Inc.	RIVERSIDE CO. ORANGE CO. SAN DIEGO CO.	
SLIP TRANSFER SCHEMATIC		Figure 9
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The intervals between major ruptures are about 600 to 700 years (SCEC, 2006b). Matti, *et al.* (1992), concluded that major earthquakes with vertical displacement of about 2 meters had an average recurrence of about 625 years. Only minor or ambiguous evidence of present day seismicity is documented (Morton and Yerkes, 1987).

BACKGROUND AND NEARBY REGIONAL GEOLOGIC INVESTIGATIONS

Regional Studies

Much of the original, overall Lytle Creek Ranch project area (then referred to as the "Villages at Lytle Creek") was encompassed by Alquist-Priolo Earthquake Fault Zones (APEFZ), established by the State of California (1974a and 1974b) as shown on the Devore and San Bernardino North 7.5 minute Quadrangles. This included postulated traces of active faults associated with the San Jacinto and Cucamonga fault zones. A preliminary engineering geology investigation for the site was previously performed by Gary S. Rasmussen & Associates (Rasmussen) in 1988. That study concluded that a large portion of the overall project area could be developed, in light of geologic constraints including active faulting and flood hazards, and that severe seismic shaking and possibly surface ground rupture could occur during the next 100 years. Rasmussen (1988) also concluded that the potential for liquefaction was low, owing to the coarseness of onsite sediments and depth to groundwater. Additionally, Rasmussen (1988) recommended subsurface geologic investigations, including trenching aerial-photographic lineaments.

Rasmussen (1994a and 1994b) also investigated fault-rupture hazards within the El Rancho Verde Country Club (now a part of the overall, development plan) since the El Rancho Verde Country Club site lies almost entirely within an APEFZ for the SJFZ. Along with previous Rasmussen studies (1980, 1982a, 1982b, and 1993), Rasmussen (1994a) concluded that Holocene activity has occurred at the site and the San Jacinto fault steps to the west, and may "die out" on the golf course. That report further indicated that following periods of high precipitation, temporary artesian conditions may occur in and adjacent to the golf-course driving range. In addition, Rasmussen (1994a) pointed out that several utilities crossing the San Jacinto fault are vulnerable to breakage and/or deformation owing to surface rupture during a large earthquake on the San Jacinto fault and recommended that utilities should cross fault traces at a high angle in order to minimize the amount of damage, should movement occur. A restricted use setback zone was recommended in Rasmussen (1994b) for traces of the active faults, as well as for a projection of a suspected fault trend.

Background Investigations and Data

GSI's Preliminary Geologic Investigation, "The Villages"

In addition to the Rasmussen investigations, GSI preliminarily studied the previously proposed master-plan development for "The Villages at Lytle Creek" (GSI, 1994). This study included almost all the currently proposed Lytle Creek Ranch development area excepting the entire Sycamore Canyon and most of the Sycamore Flat areas of current Neighborhood I, and the El Rancho Verde Golf Course area of current Neighborhood II. Areas investigated by GSI (1994) that have been removed from the current development plan include Tract 15900 and the sand, gravel, and clay products plant located between Neighborhoods II and III. Subsurface investigations, performed for GSI (1994), included the geologic logging of approximately 19,840 linear feet of existing exposures in open pit-mines located within the sand, gravel, and clay products plant, eight fault finding/dating and/or locating trenches totaling approximately 3,855 linear feet, and one calibration test pit. In addition, unpublished fault-finding/dating trenches (approximately 2,775 linear feet) previously excavated within the southern Sycamore Flat area by Eberhart & Stone (E&S) were evaluated by exposing another 785 linear feet of trenches. Fault investigations were augmented by photo-lineament analyses and radiocarbon dating. Field meetings, review, and geologic/geomorphic analyses were also provided by Dr. Shlemon.

GSI (1994) concluded that, in general, development of the project was feasible from a geologic and geotechnical viewpoint. That study indicated that the zone of faulting within the San Jacinto fault along the northeast margin of the original site boundaries is active (i.e., movement within the Holocene epoch, or last ±11,000 years). Structural setbacks from the faulting in this area would be warranted. Most of this area is no longer a part of the current development plan. Thus, GSI-setback zones, located outside the current property boundaries, are no longer applicable to the currently proposed development.

According to GSI (1994), except for the extreme northeast corner of the site (i.e., within and south of Neighborhood I), strong aerial-photographic lineaments and/or geomorphic or geologic features, indicative of active faulting, were not observed. GSI concluded that the model for slip transfer between the San Jacinto and San Andreas fault zones proposed by Matti, *et al.* (1992), and Morton and Matti (1993) was largely correct.

With regard to the remainder of the original site indicated on PBR (1994), including a majority of the North Village, the East Village, and the South Village (now referred to as Neighborhoods I, II, and III, respectively), evidence for active faulting was not encountered. Evidence of faulting associated with the onsite groundwater barriers was not observed in the field or on the aerial photographs. GSI's review of available data and literature, subsurface investigation and soil stratigraphy concluded that active faults, as defined by the State, likely did not exist within the remainder of the property, and that the APEFZ zones (as mapped at that time by the State) were largely unwarranted, and portions should be considered to be removed.

GSI (1994) indicated that severe seismic shaking and possible ground lurching may occur throughout the site should an earthquake occur on one of the nearby active faults. Mitigation in accordance with the recommendations of the project geotechnical engineer were therefore needed. Also requiring evaluation was flooding potential during periods of heavy precipitation. Similarly, hydrocollapse and liquefaction needed further evaluation on a site specific basis by the project geotechnical engineer, should groundwater levels rise as a result of urbanization or other natural means. Should subsidence occur within the study area, it would likely be associated with the active fault within the APEFZ northeast of the site (GSI, 1994) and mitigated by the recommended setback zone. Any utility crossings in the fault zone need to be constructed at high angles to the fault trace in order to minimize the amount of damage. should movement occur. Appropriately located up-stream and down-stream cut-off valves for the utilities, to facilitate repair, would need to be considered. Any proposed slopes of significance, also need further evaluation by the project geotechnical engineer and engineering geologist.

Subsequent to GSI (1994), the State (California Division of Mines and Geology [CDMG]) published their revised official earthquake fault zones map of the Devore Quadrangle (State of California, 1995), which was based on their Fault Evaluation Report No. 240 and its supplements (CDMG, 1994, 1995a, and 1995b). Supplement No. 1 (CDMG, 1995b) specifically included a review and commentary on GSI (1994). These reports are discussed further below. The APEFZ mapping changed significantly across the project area, with much reduced zones. It should be noted that CDMG is now named the "California Geological Survey" (CGS).

San Bernardino County Review and Response Report by GSI

Following submission of the GSI (1994) report to the County of San Bernardino, the County Geologist, Mr. Wessly A. Reeder, provided a review (County of San Bernardino, 1995a). Several issues were raised and responded to, and clarified by GSI (1995). Mr. Reeder then indicated that, "the response report and initial report appear to be adequate as a general feasibility investigation" (County of San Bernardino, 1995b). Mr. Reeder and GSI recognized the need for future additional site specific geotechnical studies, including slope stability and liquefaction evaluations, and supplemental fault investigations for those portions of the site remaining within APEFZ's.

GSI's Geotechnical Investigation, 50-Acre School Site

GSI (1997) prepared a geotechnical investigation and liquefaction evaluation for a proposed 50-acre school site within a portion of current Neighborhood III, along Riverside Avenue. This investigation included subsurface exploration consisting of the advancement and sampling of five manually excavated test pits. Also sampled were similar alluvial fan deposits at various depths in the geologically similar environment of the nearby open-pit mines. GSI (1997) documented that the proposed school site is underlain by alluvial-fan deposits consisting of sandy gravel and gravelly sand typical of this geologic environment. These materials were locally overlain by undocumented fill.

A liquefaction analysis concluded that liquefaction potential was low at that site and did not constitute an unacceptable risk even if the regional groundwater table should rise as a result of urbanization (irrigation) or perched groundwater. On a preliminary basis, GSI also indicated that dynamic settlements caused by the "design earthquake," were about 1 inch, with differential settlement of about ½-inch. GSI ultimately concluded that the proposed school site appeared suitable for its intended use provided the conclusions and recommendations presented were properly implemented. It should be noted that this investigation pre-dates Special Publication 117, which provides currently accepted guidelines for evaluating liquefaction in California.

GSI's Compilation Reports, Tract 15900

GSI (1999b and 2003) compiled reports for Tract 15900 (previously part of "North Village") focusing on the geologic and geotechnical backgrounds for the overall project area, as well as this specific tract. The two reports are similar in scope and content; the latter provided updated seismic parameters and conclusions and recommendations for future tract development. In addition to review and summary of the older report, GSI (1999b) also excavated 30 test pits within the tract to evaluate near-surface geotechnical conditions.

GSI (2003) concluded that, from a geologic viewpoint, Tract No. 15900 was compatible and favorable with respect to onsite geologic constraints. That study indicated that active faults were present in the northeastern portion of the site (adjacent to Sycamore Flat). Structural setbacks were therefore warranted, should habitable structures be proposed in this area. Subsidence would be inherently mitigated by the recommended setbacks. Based on review of available data and literature, subsurface investigations, and soil stratigraphy, GSI concluded that active faults likely did not exist within the remainder of that property. Additional studies by GSI on the Sycamore Flat property north of Tract No. 15900 (GSI, 1999a), and an independent evaluation by the State (CDMG, 1995b) generally corroborated these conclusions. Other conclusions and recommendations regarding geotechnical aspects of development (e.g., remedial removals/grading procedures, seismic design parameters, foundation and wall designs, etc.) were also provided.

GENERAL SITE GEOLOGY AND GEOMORPHOLOGY

Most of the study area is underlain by fluvial sediments emanating from Lytle Creek, and to a lesser extent, from Sycamore Canyon and the Cajon Wash. These sediments may reach depths of 120 to 950 feet before basement rock is encountered (Geoscience, 1992). The heads of Lytle Creek and Sycamore Flat are located within the San Gabriel Mountains. Coalescing sediments deposited primarily from Lytle Creek have created a large alluvial fan that reaches from Ontario on the southwest, east to Colton, and north to the base of the San Gabriel Mountains (Figures 2 and 5). Some sediments onsite may also have been deposited by Cajon Wash. As pointed out by Rasmussen (1994a), the distal edges of the Lytle Creek and Cajon Wash fans overlapped and interfingered during the Pleistocene and early Holocene. Alluvium was entirely deposited by Lytle Creek, and to a lesser extent by Sycamore Flat, after drainage shifted eastward and the fan was beheaded owing to continued incision and uplift along the San Jacinto fault during the mid-Holocene. Geomorphically, the alluvial-fan deposits exhibit characteristics associated with young to intermediate development, likely corresponding to sediments of Holocene to late Pleistocene-age (Shlemon, 1978).

Terraces developed on older, alluvial-fan deposits, north of the site, have geomorphic characteristics associated with the development of older, alluvial fans and may be older than 500,000 years (Christenson and Purcell, 1985), assuming no uplift on bounding faults. Alternatively, these terraces may have also been uplifted on the bounding faults, suggesting geomorphic characteristics indicative of the development of intermediate-age alluvial fans, and are likely pre-Holocene in age (Shlemon, 1978). As pointed out by Rasmussen (1994a), the Rialto Bench, a relatively high terrace, located south of the site, has been assigned a late Pleistocene-age.

Dutcher and Garrett (1963) mapped most of the study area as consisting of both older alluvium (located adjacent to the San Jacinto fault) and younger alluvium. Matti and Carson (1983 and 1991) mapped most of the site as younger and older Holocene alluvial deposits. Morton and Matti (2001), and Miller, *et al.* (2001), depict the site as underlain by late Pleistocene to Holocene alluvial-valley and wash deposits. Morton and Miller (2003) also show the site as underlain by late Holocene wash, alluvial-fan, and alluvial-valley deposits, and middle Holocene alluvial-valley deposits. Dibblee (2003 and 2004) mapped the study area as underlain by unconsolidated, undissected, Holocene stream-channel and outwash gravel and sand and alluvial fan/alluvial gravel and sand of valley areas. In general, the site and adjacent area are underlain by coalescing late Pleistocene to Holocene alluvial-fan deposits, with proximal (Holocene) and distal (late Pleistocene) facies. A regional geologic map has been included previously as Figure 5. A geologic map of the site is provided as Plate 1. For this report, GSI does not differentiate between younger alluvial-fan deposits and younger alluvium, as these units are of relative age, and were observed to interfinger.

SITE GEOLOGY

The site geologic units were observed during our reconnaissance and subsurface exploration and previously described in GSI (1994). Site geologic units are: undocumented artificial fill, Quaternary colluvium, undifferentiated Quaternary Alluvial-Fan Deposits/Alluvium, and undifferentiated Older Quaternary Alluvial-Fan Deposits/Alluvium (Plate 1). Supplemental descriptions for units encountered in the subsurface explorations for this study are shown on Plates 2 through 18. The major geologic units are generally described, from youngest to oldest:

Artificial Fill - Undocumented (Map Symbol - Afu)

Undocumented artificial fill was observed in areas associated with levees and berms and existing structures. The fill generally consists of brown to brownish gray gravelly, fine- to coarse-grained sands and fine- to coarse-sandy gravels with varying amounts of silt. The Army Corp of Engineers levee along the southern property line of Neighborhood II was observed to be gunite faced. The fill is generally dry and loose at the surface, and ranges in thickness from 2 to possibly 10 feet. End-dumped fill and debris were also observed in various areas. The fill is anticipated to have a low to possibly medium expansion potential based on visual observation; however, a high expansion potential may exist in clayey materials. As existing, the undocumented fill is potentially compressible and may settle appreciably under additional fill or foundation or improvement loadings.

Colluvium (Not Mapped)

Colluvium was observed to discontinuously mantle portions of the site. Some of these sediments may be alluvial-overbank deposits; however, for this report are not differentiated. As observed during this investigation, the colluvium ranges in thickness from about 1 to as much as 10 feet. The colluvium is generally silty, fine- to coarse-grained sands. These materials are dry to damp with depth, and loose and porous near the surface. Typically, colluvium has a low to medium expansion potential; however, a high expansion potential may exist in clayey sediments. These materials are unsuitable for support of structures and/or improvements in their existing state. The colluvium is Holocene in age.

Undifferentiated Quaternary Alluvial Fan Deposits/Alluvium (Map Symbol - Qaf)

As previously indicated, the alluvial-fan deposits and alluvium locally interfinger. Therefore, it is impractical to separate these deposits into two distinct units. Undifferentiated, alluvial fan-deposits and alluvium discontinuously overlie the older sedimentary units. These sediments generally consist of silty, fine- to coarse-grained sands, fine- to coarse-grained sands, and sand and gravel mixtures. The gravel ranges from numerous pebbles and cobbles to rare boulders. These sediments are loose to medium dense, and dry to damp. The alluvial-fan deposits and alluvium are typically massive to thickly bedded, and thin- to medium-bedded. These sediments generally dip toward the south. However, local topset, foreset, and bottomset beds dip to the north. These sediments typically have a very low to low, and possibly medium expansion potential; however, a high expansion potential may exist in clayey sediments. The undifferentiated, alluvial-fan deposits and alluvium are judged to be no older than mid-Holocene in age. This unit is shown and further described on Plates 2 through 18.

Undifferentiated Older Alluvial-Fan Deposits/Alluvium (Map Symbol - Qafo)

Separated by an erosional unconformity, undifferentiated, older alluvial-fan deposits and alluvium discontinuously underlie the younger alluvial-fan deposits and alluvium. Where observed in Trench FT-4, these sediments are moderately to well indurated silty fine- to coarse-grained sands with rare pebble-sized clasts and slightly plastic silty clays to clayey silts. These deposits are generally flat lying and massive to thickly bedded and have a low to perhaps medium expansion potential, and locally may be highly expansive depending on clay content. The older alluvial-fan deposits and alluvium are pre-Holocene in age. This unit is further described on Plate 14.

SUMMARY OF LYTLE CREEK CHANNEL-BANK EXPOSURE AND DOCUMENTATION

Observations of the north and south channel banks of the Lytle Creek Wash, located to the north of the study area (Plate 1), also evaluated possible faults entering the site from the east or northeast. Only channel banks exposing at least 15 feet of sediments were documented, similar to the depth of nearby fault trenches. The banks exposed Holocene, fining-upward, undifferentiated alluvial-fan deposits and alluvium. No displaced or deformed beds were observed.

SUMMARY OF TRENCH EXPOSURES AND DOCUMENTATION

A general discussion of the findings of each fault-locating trench are provided below. Additional descriptions are provided on the Trench Logs, Plates 2 through 18. The trench locations, as well as selected controlling faults were surveyed by Dawson Surveying, Inc., and are shown on Plate 1. There is a small error between surveyed trench lengths and those indicated on the trench logs, owing to slight sagging of the measuring tape and curvature of the trenches. Controlling, outboard faults and faults that exhibited the largest vertical displacements within the fault zones were surveyed. Other faults have been plotted from information on the trench logs, and are shown in tables provided in this section of the report. Surveyed and selected faults are indicated on Plate 1.

Fault Trench 1 (FT-1)

As indicated on Plate 1, Fault Trench FT-1 was emplaced within a portion of Neighborhood II to intercept the approximately located, inferred, queried, and concealed faults recognized by the State of California (State of California, 1995 and 1974b [Figure 2]) as well as a mapped fault trace postulated by Rasmussen (1988). FT-1 also extended across most of the APEFZ, and intercepted photo-lineaments noted by GSI. At the beginning of the investigation, GSI did not have permission to trench across a 100-foot wide easement, north of the El Rancho Verde Golf Course's northern, property line, which was controlled by the West Valley Water District. Therefore, trenching for FT-1 initiated approximately 250 northeast of the golf course's northern property line. Once permission was granted by the West Valley Water District, GSI extended FT-1 to the southwest (Plate 1). However, because of the direction of trenching, FT-1 was terminated approximately 15 feet from the northern property line of the El Rancho Verde Golf Course to avoid encroachment of the trenching equipment into the golf course. FT-1 also terminated near the southern open-space boundary owing to a concrete structure in that area. Accordingly, FT-2 and FT-3 overlap FT-1, the northern golf course property line, the southern open-space (Planning Area 54) boundary and the entire APEFZ within the study area.

FT-1 exposed undifferentiated, Holocene alluvial-fan deposits and alluvium consisting primarily of two to three discrete packets of sediments. The stratigraphic continuity was excellent (see Plates 2 through 11), exhibiting fining-upward sequences, channel and overbank fluvial deposits, with localized topset, foreset and bottomset cross-bedding, as well as localized eolian deposits. Localized ground cracks, with no shear displacement, were also observed within these deposits. Within the southwestern end of the trench, two discontinuous but regionally extensive paleosols were observed. Dr. Shlemon assigned 1,000 to 1,500 years of weathering to the uppermost paleosol (Bwb) and 4,000 to 5,000 years of weathering to the lower paleosol (Btj). Therefore, the age of the deposits within this portion of the trench is reasonably estimated at approximately 5,000 to 6,500 years old, or mid-Holocene. The lower paleosol was observed to be erosionally truncated near Station No. 421, constraining the age of the deposits exposed in the remaining portion of the trench to about 1,500 to 2,000 years (Plate 4). Two faults were observed near the southwest end of the trench. A fault located at Station No. -165 (N 27°W @ 61°SW) exhibited reverse movement as well as likely horizontal movement. The maximum vertical displacement on this fault is about 12 inches (Plate 2). Displacement increases with depth, suggesting recurrence. Photo documentation of this fault at the bottom of FT-1 is provided as Figure 10. The fault at approximate Station No. -182 (N 22°W @ 48°SW) appeared to exhibit normal movement, but possible horizontal movement cannot be ruled out (Plate 2). The amount of vertical movement could not be readily determined, for matching beds on either side of the fault were not observed. Neither fault displaced the uppermost paleosol imprinted on the sediments. This paleosol is reasonably estimated to have required approximately 1,000 to 1,500 years of weathering. Last displacements, therefore, occurred prior to about 1,000 to 1,500 years ago. A summary of faulting in this trench is provided in Table 1:

TABLE 1

FAULT TRENCH 1 (FT-1)			
APPROXIMATE STATION NO. AS INDICATED ON FIELD LOG	FAULT ATTITUDE (STRIKE, DIP)	MAXIMUM VERTICAL DISPLACEMENT (INCHES)	FAULT NO. INDICATED ON GEOLOGIC MAP (SURVEYED AT THE SURFACE PROJECTION OF FAULT)
-165	N27°W, 61°SW	12	1
-182	N22°W, 48°SW	N/D*	2
* N/D = Not Determined			

Fault Trench 2 (FT-2)

Fault Trench 2 (FT-2) overlaps FT-1 and the northern property line of the El Rancho Verde Golf Course within a portion of Neighborhood II and intercepts the trends of the Holocene faults in the southwest end of FT-1. This trench exposed

Fault Trench FT-1: Fault at approximate Station No. -165 was observed trending N27°W/61°SW and displaying a reverse sense of movement. Approximately 12 inches of vertical displacement [illegible]

SITE PHOTOGRAPH

Figure 10

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fining-upward, Holocene, undifferentiated, alluvial-fan deposits and alluvium. Also identified was one discontinuous, regionally extensive, cambic paleosol (Bwb), which Dr. Shlemon estimated to reflect approximately 1,000 to 2,000 years of weathering. An approximately 100-foot wide fault zone, consisting of 13 Holocene fault splays, occurs between about Station Nos. 18 and 118 (Plate 12). Faults within this trench are mostly normal; however, faults at Station Nos. 18 and 21 also show reverse movement. Horizontal movement is indicated by unmatched lithologies on the east and west sides of some faults. The largest vertical displacement (i.e., 50 inches) was documented at Station No. 58 (N 40° W @ 68° NE). Fault recurrence was evident based upon increasing vertical displacement with depth. Photo-documentation of selected faults within FT-2 is shown on Figure 11. FT-2 was shallowed to between 12 and 15 feet, for the faults exposed in this trench and in FT-1 were readily visible at these depths. GSI also extended FT-2 to the northeast an additional 60 feet beyond the eastern outboard fault to evaluate the width of the zone. A summary of faulting in this trench is provided in Table 2:

TABLE 2

FAULT TRENCH 2 (FT-2)			
APPROXIMATE STATION NO. AS INDICATED ON FIELD LOG	FAULT ATTITUDE (STRIKE, DIP)	MAXIMUM VERTICAL DISPLACEMENT (INCHES)	FAULT NO. INDICATED ON GEOLOGIC MAP (SURVEYED AT THE SURFACE PROJECTION OF FAULT)
21	N42°W, 84°NE	2	3 NS
20.5	N51°W, 67°NE	20	11
21.5	N47°W, 66°NE	1	NS
22.5	N35°W, 44°NE	4	NS
20.5	N7°W, 85°NE	5	NS
29	N43°W, 69°NE	5	NS
28	N15°W, 75°NE	7	NS
45	N31°W, 48°NE	12	13 NS
58.5	N40°W, 68°NE	50	12
102.5	N7°W, 68°NE	14	4
114	N19°W, 69°NE	1½	NS
115	N32°W, 54°NE	4½	NS
118	N15°W,45°NE	6	5
NS = Not Surveyed			

Fault Trench 3 (FT-3)

Also within a portion of Neighborhood II, Fault Trench 3 (FT-3) overlaps FT-1 and the southern open-space boundary (Planning Area 54) and thus covers the remainder of the APEFZ within the Neighborhood II study area, located north of the El Rancho Verde Golf Course.

FT-3 exposed fining-upward, undifferentiated, Holocene alluvial-fan deposits and alluvium. Additionally exposed was one continuous, cambic paleosol (Bwb), estimated to reflect approximately 1,000 to 1,500 years of weathering. One discrete Holocene fault was observed at about Station No. 66½ (Plate 13). This fault exhibited reverse movement, with 36 inches of maximum vertical displacement near the bottom of the trench.

Horizontal displacement was also presumed, for unmatched lithologies were observed across the fault on the bottom bench. Vertical displacement was observed to increase with depth, providing evidence for recurrence. The paleosol in this trench was not displaced, implying that last displacement occurred prior to about 1,000 to 1,500 years ago.

The fault flowers into two strands with about 6 to 18 inches of vertical offset near its apex, suggesting youthfulness. Figure 12 provides photo documentation of this fault. A summary of faulting in this trench is provided in Table 3:

TABLE 3

FAULT TRENCH 3 (FT-3)			
APPROXIMATE STATION NO. AS INDICATED ON FIELD LOG	FAULT ATTITUDE (STRIKE, DIP)	MAXIMUM VERTICAL DISPLACEMENT (INCHES)	FAULT NO. INDICATED ON GEOLOGIC MAP (SURVEYED AT THE SURFACE PROJECTION OF FAULT)
66.5	N27°W, 73°SW	36	6

Fault Trench 4 (FT-4)

FT-4 intercepted fault trends observed in FT-2, within a portion of Neighborhood II. This trench exposed older (pre-Holocene), undifferentiated, alluvial-fan deposits and alluvium, which were unconformably overlain by undifferentiated, Holocene alluvial-fan deposits and alluvium. The pre-Holocene deposits are fine- to coarse-sand and silty clay and clayey silt. The Holocene deposits are fining-upward channel and overbank fluvial deposits, with localized topset, foreset and bottomset cross-bedding, as well as localized eolian deposits. Dr. Shlemon observed that the paleosol developed upon the pre-Holocene alluvial-fan deposits and alluvium was "moderately developed" and required at least 35,000 to 40,000 years to form. The age of the underlying parent material may therefore be about 60,000 years (Appendix B). A continuous, regional cambic horizon also occurs within the Holocene deposits. Based on relative profile development, this soil reflects approximately 2,000-years of weathering. This paleosol, combined with the age of the deposits overlying the paleosol, conservatively brings the approximate cumulative age of the younger fan deposits to at least 3,000 years. The pre-Holocene deposits were faulted with increasing displacements and flowering toward the southwestern end of the trench (Plates 14 and 15). However, these faults did not extend into, and offset, the overlying Holocene deposits. Photo documentation of selected faults displacing the undifferentiated, pre-Holocene deposits is given as Figure 13. Because the unfaulted, sediments may be no older than 3,000 years, it is possible that last displacement of the trench-exposed faults occurred in Holocene time. Therefore, additional trenching, northwest of FT-4, was deemed necessary (see FT-6). A summary of the faults in FT-4 are provided in Table 4:

TABLE 4

FAULT TRENCH 4 (FT-4)			
APPROXIMATE STATION NO. AS INDICATED ON FIELD LOG	FAULT ATTITUDE (STRIKE, DIP)	MAXIMUM VERTICAL DISPLACEMENT (INCHES)	FAULT NO. INDICATED ON GEOLOGIC MAP (SURVEYED AT THE SURFACE PROJECTION OF FAULT)
14	N31°W, 65°NE	3	7
15.5	N10°W, 90°	2	NS
18	N10°W, 85NE	1	NS
25.5	N21°W, 90°	4	NS
34	N20°W, 90°	5	NS
48.5	N9°W, 88°NE	12	8
72.5	N6°W, 90°	1	NS
77	N8°W, 77°NE	2 - 3	NS
105	N16°W, 90°	3 - 4	14 NS
108	N12°W, 90°	1 -2	NS
111.5	N7°W, 90°	1	NS
112.5	N16°W, 90°	2	NS
125.5	N7°W, 90°	4	NS
130.5	N4°W, 90°	1	9
NS = Not Surveyed			

Fault Trench 5 (FT-5)

FT-5 was emplaced southeast of FT-3 within a portion of Neighborhood II to confirm that the fault observed in FT-3 is through-going and to further evaluate its trend. This trench exposed fining-upward, Holocene alluvial deposits that contain one continuous, cambic paleosol (Bwb) representing about 1,000 to 1,500 years of weathering (Appendix B). One discrete Holocene fault was observed at approximate Station No. 47 (Plate 14). This fault had 1½ inches of maximum vertical displacement near the bottom of the trench. Horizontal displacement was also indicated, for unmatched lithologies were observed across the fault on the bottom bench. Vertical displacement increased with depth, implying recurrence. The paleosol in this trench was not displaced, thus suggesting an approximately

1,000- to 1,500-year recurrence interval. A summary of faulting in this trench is provided in Table 5:

TABLE 5

FAULT TRENCH 5 (FT-5)			
APPROXIMATE STATION NO. AS INDICATED ON FIELD LOG	FAULT ATTITUDE (STRIKE, DIP)	MAXIMUM VERTICAL DISPLACEMENT (INCHES)	FAULT NO. INDICATED ON GEOLOGIC MAP (SURVEYED AT THE SURFACE PROJECTION OF FAULT)
47	N23°W, 90°	1½	10

Fault Trench 6 (FT-6)

FT-6 was emplaced to intercept the trends of possible Holocene faults as observed in the pre-Holocene alluvial deposits in FT-4 (Plate 1). FT-6 exposed fining-upward, undifferentiated, Holocene alluvial-fan deposits and alluvium with fluvial channel and overbank deposits and localized eolian deposits (Plate 16). One cambic horizon, imprinted on these deposits, reflects an estimated 2,000 years of weathering. When combined with the age of the overlying deposits, the approximate cumulative age of the sediments in this trench is a conservative 3,000 to 4,000 years. No faults or tectonic disruption of bedding was observed in this trench, suggesting that the FT-4 faults "die out" and step over to the west prior to reaching FT-6.

Fault Trench 7 (FT-7)

FT-7 was excavated to investigate the portion of Planning Area 24 (Neighborhood III) located within a State-defined APEFZ (Plate 1). This trench was excavated from or near the southern property line of Planning Area 24 and continued northeast for approximately 450 feet to cover and extend just beyond the northern boundary of the APEFZ. An east-west trending, 18-inch water main transected portions of the property near the southern property line. GSI therefore started the trench approximately 10 feet north of the delineated (by WVWD) water main. The trench exposed undifferentiated, Holocene alluvial-fan deposits and alluvium discontinuously overlain by colluvium and undocumented fill (Plates 17 and 18). These alluvial deposits are coarse grained with boulders up to 36 inches in diameter, most likely reflecting proximity to the San Gabriel Mountain front. One weak cambic horizon was observed and estimated at approximately 2,000 to 2,500 years old (Appendix B). The late Holocene deposits in this trench were demonstrably unbroken to the depths explored.

Fault Trench FT-2: Faults, trending N40°W/68°NE (approximate Station No. 58.5) and N31°W/48°NE (approximate Station No. 45) exhibited normal movement

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SITE PHOTOGRAPH

Figure 11

DATE 12/2006 | W.O. NO. 5049-A2-SC

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Fault Trench FT-3: Fault at approximate Station No. 66.5 was observed trending N27°W/73°SW and displaying a reverse sense of movement. Note: Spray paint cans at lower left for scale.

GeoSoils, Inc.

SITE PHOTOGRAPH

Figure 12

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Fault Trench FT-4: Faults at approximate Station No. 111.5 and 112.5. Note: Coarse-grained sand beds in the older alluvial fan deposits and alluvium have been displaced. However the faults do not extend upward into the younger

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SITE PHOTOGRAPHS

Figure 13

DATE 12/2006	W.O. NO. 5049-A2-SC

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In summary, GSI identified two distinct fault zones (Fault Zones 1 and 2), as indicated on Plate 1. The faults observed within these zones have both horizontal and vertical movement (normal and reverse). Except for the faults in FT-4, the faults within these zones are demonstrably active and well defined near the surface as they displace Holocene deposits. The FT-4 faults are less defined, for they displace approximately 35,000 to 40,000 (possibly up to 60,000) year old deposits, but not the overlying Holocene deposits. Nevertheless, because the unbroken overlying sediments are probably no older than approximately 2,000 to 3,000 years old, for reasonable conservatism, these faults are provisionally deemed as active and therefore warrant appropriate setback zones. A discussion of the two distinct fault zones is provided below.

Fault Zone 1

As shown on Plate 1, Fault Zone 1 occurs within a portion of Neighborhood II, north of the northern, El Rancho Verde Golf Course property line and was delineated based on the trends of outboard faults observed in Fault Trenches 1, 2, and 4 (FT-1, FT-2, and FT-4). Here, GSI interprets these faults as the product of classic "wrench tectonics" wherein fault trends parallel or subparallel the main trace of the SJFZ as well as display Riedel shears. The Zone 1 faults are short and discontinuous, for they appear to die or step over prior to reaching adjacent trenches. This may be the result of partitioning of slip along en-echelon tears. The vertical displacement of fault splays within this zone increases to the southeast, consistent with the absence of faulting in T-6 (GSI, 1994) and FT-6 (this investigation), as well as the relatively small vertical displacements in FT-4 when compared to the displacements observed in FT-1 and FT-2. The faults within FT-1, FT-2 and FT-4 also "flowered" more near the western end of these trenches, suggesting that the recency of faulting increases offsite to the west, likewise consistent with the findings of Rasmussen (1994a), who concluded that the San Jacinto fault steps west within the adjacent El Rancho Verde Country Club, and may "die out" on the golf course. The trends of the faults in Zone 1 project toward the El Rancho Verde Golf Course area of Neighborhood II (Planning Area 59) which may require further subsurface studies and/or conservative setbacks for human-occupied structures in that area.

Fault Zone 2

Fault Zone 2 is near Neighborhood II's northern property line (Plate 1), and was delineated based on the trend of a discrete fault splay observed in Trenches FT-3 and FT-5. GSI documented that the magnitude of vertical displacement increases to the northwest and decreases to the southeast. The difference in vertical offset in FT-3 and FT-5 may also indicate that Fault Zone 2 dies out to the south. Based on FT-3 and FT-5 exposures, vertical displacement "die-out" is an estimated 12-inch reduction of vertical displacement for every 1,680 inches of horizontal distance (1 foot per 140 feet) to the southeast. Based on this estimate, this fault may cease to exist approximately 17 feet southeast of FT-5 which could be verified by additional trenching, southeast of FT-5, if desired. However, the trend of this fault projects toward the El Rancho Verde Golf Course area of Neighborhood II (Planning Areas 59 and 63). This may require further subsurface studies and/or conservative setbacks for human-occupied structures.

Based on the regional tectonic framework and our site-specific investigation, we postulate that there is a divergent, right step between Fault Zones 1 and 2. The trench exposures show that such a step over is not accompanied by cross faults. According to Rogers (1980), basins associated with major strike-slip fault zones, such as the San Andreas fault zone, are generally elongate parallel to the strike of the fault zone. Regionally, the site is within the San Bernardino Valley, which is elongate parallel or subparallel to the major fault zones in the region (the Elsinore, San Jacinto, and San Andreas). Locally, the ephemeral washes associated with Lytle Creek are parallel or subparallel to the nearby San Jacinto Fault and its associated splays (Glen Helen and Lytle Creek faults).

As previously indicated, vertical displacements in Fault Zone 1 decrease to the north and increase to the south. Additionally, alluvial sediments in FT-6 and T-6 (GSI, 1994) were not displaced or deformed, thus corroborating that Fault Zone 1 diminishes to the northwest. Conversely, vertical displacement in Fault Zone 2 decreases to the south and increases to the north, suggesting that horizontal slip is being transferred from Fault Zone 1 to Fault Zone 2 (e.g., transtension). Secondary faulting, commonly associated with divergent "step-overs," was not observed. Elsewhere in the site, any other, "deep" faults are likely pre-Holocene in age, or not sufficiently active, or well-defined, to satisfy Alquist-Priolo criteria for an active fault. Further, any such hypothetical faults with inherently small displacements, are effectively mitigated by proper engineering design.

RATIONALE FOR FAULT SETBACK ZONES

The recommended fault setback zones, as indicated on Plate 1, are based on observations of active faults exposed in the GSI trenches. Within Fault Zone 1, active faults were noted in trenches FT-1, FT-2, and FT-4. Conversely, faulting was not observed in FT-6 or T-6 (GSI, 1994). These identified faults (see FT-1, FT-2, and FT-4), when projected to the northwest along trend from their location of initial observation, were not identified in successive trenches at any reasonable point of interception. Additionally, fault trends and width varied from trench to trench. Accordingly, it is reasonable to conclude that the faults "die out" or "step over" prior to reaching the adjacent trench. Therefore, the western and eastern limits of Fault Zone 1 were based on the trends of the western and eastern outermost faults in FT-1, FT-2, and FT-4. The northwestern extent of Fault Zone 1 was terminated at the southeast sides of FT-6 (this investigation) and T-6 (GSI, 1994) because unbroken sediments were documented in these trenches. Owing to the Army Corp of Engineers levee, trenching southeast of FT-1 was not feasible. Therefore, the conservative limit of Fault Zone 1 is the adjacent northern property boundary of the El Rancho Verde Golf Course. Fault Zone 2 is comprised of a discrete fault splay, identified in trenches FT-3 and FT-5. Although the trends of these faults varied slightly where recorded in each trench, it is highly likely that this fault is through-going (although it appears to die or step to the west just southeast of FT-5). Therefore, the strike of this fault was reasonably projected from its vertical terminus in FT-3 to its vertical terminus in FT-5, yielding a trend of N 27°W. Consistent with current standards of practice, for this trench spacing, 50-foot setbacks for habitable structures are recommended for Fault Zones 1 and 2, as delineated on Plate 1. As previously indicated, the trends of these zones project toward Planning Areas 59 and 63 in the El Rancho Verde Golf Course area of Neighborhood II. Thus, additional subsurface studies and/or setbacks for human-occupied structures may be required in this area by the controlling authorities.

Due to the presence of existing roadways and underground utilities, the entire APEFZ within Planning Area 24 (Neighborhood III) could not be trenched (Figure 2 and Plate 1). Thus, active faulting cannot be entirely precluded in this area, and thus warrants a setback for structures for human occupancy, should such structures be proposed here. This setback zone, as indicated on Plate 1, is 50 feet northeast of the southwestern end of Fault Trench No. 7 (FT-7) and parallels the northern APEFZ boundary. The setback zone terminates at the property boundaries.

RECURRENCE INTERVALS OF FAULT RUPTURE (FAULT ZONES 1 AND 2)

The Holocene faults in Fault Zones 1 and 2 are most likely associated with the SJFZ based on their northwest trends. The faults parallel or subparallel other SJFZ faults such as Lytle Creek, Glen Helen, Claremont and other faults identified by GSI (1994) and Rasmussen (1994b). Although "active," the on-site faults are not "main splays" of the SJFZ. According to CDMG (1994, 1995a, and 1995b), the most active branch of the SJFZ is the western branch or Claremont fault. However, as theorized by Sharp (1975), transfer of displacement by crustal extension between the Claremont fault and the closely aligned Glen Helen Fault may be occurring at the northern edge of the San Bernardino Valley. Here the Glen Helen fault appears to be the dominant trace of the SJFZ, for the Glen Helen fault has scarps and sag ponds in young Holocene alluvium, whereas the Claremont fault does not.

SCEC (2006a) indicates that surface-rupture recurrence for the Glen Helen and Claremont faults is between 100 and 300 years for earthquake magnitudes 6.5M and 7.5M. CDMG (1996) reported that recurrence for the San Jacinto fault (San Bernardino Segment) is 100 years. Fault investigations, within the SJFZ, at two sites near Colton and San Bernardino, California by Kendrick and Fumal (2005) reported approximately 100 and 266 year return periods, respectively. However, onsite faults have much longer recurrence, as discussed in the following sections.

Fault Zone 1

The well defined, near-surface Holocene faults in Fault Zone 1 are recurrent, for apparent vertical displacement increases with depth. The fault with the largest vertical displacement is the "governing" fault and probably partitions slip to others with less vertical offset. The governing fault for Fault Zone 1 (N 40°W @ 61°SW [FT-2, Station No. 58½]) has approximately 50 inches of vertical displacement near the bottom of the trench, decreasing to 29 inches above. This suggests that at least two episodes of faulting took place with approximately 25 inches of vertical offset per event. The last event fault did not displace a buried paleosol that records at least 1,000 to 2,000 years of weathering. It is therefore reasonable that the recurrence interval estimate for Fault Zone 1 is at least 1,000 to 2,000 years.

Fault Zone 2

Fault Zone 2 also shows recurrence as vertical displacement increases with depth. As documented by the largest vertical offset, (N27°W @ 73°SW [FT-3, Station No. 66½]) at least three events with approximately 10 inches of vertical slip per event took place in Fault Zone 1. This fault does not displace an approximately 1,000 to 1,500 year old paleosol. Therefore, the Fault Zone 2 recurrence is at least 1,000 to 1,500 years, based on the data.

In summary, Fault Zones 1 and 2 display longer recurrence intervals than recognized by SCEC, CDMG, and Kendrick and Fumal for the SJFZ. Accordingly, it is reasonable that possible surface fault rupture over the lifetime of any proposed structure is low to very low. Nonetheless, setbacks for structures for human occupancy are warranted for Fault Zones 1 and 2, for the faults are well defined near the surface. Setbacks for structures for human occupancy are shown on Plate 1. Additionally, owing to the site's proximity to active seismic sources, structures for human occupancy and supporting infrastructure should be designed for strong ground motion (~1g) produced by nearby earthquakes.

SEISMICITY AND SEISMIC HISTORY

The possibility of ground shaking at the site is generally similar to the entire southern California region. The acceleration-attenuation relations of Campbell and Bozorgnia (1994 and 1997), Bozorgnia, Campbell, and Niazi (1999), and others, have been incorporated into EQFAULT (Blake, 2000a). EQFAULT is a computer program that performs deterministic seismic hazard analyses using digitized California faults as earthquake sources. For this study, peak horizontal ground accelerations anticipated at the site were based on the mean and mean plus 1 - sigma attenuation curves. The program estimates the closest distance between each fault and a given site. If a fault occurs within a user-selected radius, the program estimates the peak horizontal ground acceleration that may occur at the site from the "upper bound" or "maximum credible" earthquakes. Site acceleration (g) is computed by any of a number of user-selected acceleration-attenuation relations that are contained in EQFAULT. Based on the EQFAULT program, peak horizontal ground accelerations from an upper bound event may be on the order of 0.48g to 1.17g. The computer printouts of pertinent portions of the EQFAULT program are provided in Appendix C.

Table 6 lists the major faults and fault zones in southern California (within 100 kilometers of the site) that could significantly affect the site. The faults and distances have been generated by the EQFAULT program. The approximate geographical center between the Neighborhoods II and III was used for this analysis. Thus, the distances from the faults, listed below, depends on the coordinates within the site (i.e., latitude and longitude) entered into the program.

TABLE 6

ABBREVIATED FAULT NAME	APPROX. DISTANCE MILES (KM)	ABBREVIATED FAULT NAME	APPROX. DISTANCE MILES (KM)
Burnt Mtn.	58.0 (93.4)	North Frontal Fault Zone (East)	35.7 (57.5)
Calico-Hidalgo	61.5 (99.0)	North Frontal Fault Zone (West)	12.5 (20.1)
Chino-Central Ave.	21.8 (35.1)	Northridge (E. Oak Ridge)	57.2 (92.0)
Clamshell - Sawpit	26.3 (42.3)	Palos Verdes	56.9 (91.5)
Cleghorn	8.3 (13.3)	Pinto Mountain	40.5 (65.2)
Compton Thrust	41.5 (66.8)	Raymond	33.9 (54.5)
Cucamonga	3.5 (5.6)	San Andreas - 1857 Rupture	11.7 (18.8)
Elsinore - Glen Ivy	25.4 (40.8)	San Andreas - Coachella	56.9 (91.6)
Elsinore - Julian	59.7 (96.0)	San Andreas - Mojave	11.7 (18.8)
Elsinore - Temecula	36.8 (59.2)	San Andreas - San Bernardino	5.5 (8.8)
Elysian Park Thrust	29.7 (47.8)	San Andreas - Southern	5.5 (8.8)
Emerson So. - Copper Mtn.	56.1 (90.3)	San Gabriel	50.4 (81.1)
Eureka Peak	58.7 (94.4)	San Jacinto - Anza	41.4 (66.6)
Gravel Hills - Harper Lake	56.0 (90.1)	San Jacinto - San Bernardino	0.0 (0.0)
Helendale - S. Lockhardt	32.4 (52.2)	San Jacinto - San Jacinto Valley	15.0 (24.1)
Hollywood	46.7 (75.1)	San Jose	16.4 (26.4)
Johnson Valley (Northern)	48.8 (78.6)	Santa Monica	57.2 (92.1)
Landers	53.5 (86.1)	Sierra Madre	17.5 (28.2)
Lenwood - Lockhardt - Old Woman Springs	45.4 (73.1)	Sierra Madre (San Fernando)	51.0 (82.1)
Newport - Inglewood (LA Basin)	48.0 (77.3)	Verdugo	38.7 (62.3)
Newport - Inglewood (Offshore)	49.2 (79.2)	Whittier	25.4 (40.8)

The possibility of ground shaking at the approximate geographic center between Neighborhoods II and III may be considered similar to the southern California region as a whole. The relationship of the selected, site location to these major mapped faults is indicated on Figure 6. In the event of a "maximum probable" or upper bound ("maximum credible") earthquake on any of the nearby major faults, strong ground shaking would impact the site. Potential damage to any structure(s) would likely be greater from the vibrations and impelling force caused by the inertia of a structure's mass than from the hazards explained above. This potential would be no greater than that for other existing structures and improvements in the immediate vicinity.

Locating earthquake epicenters is often inaccurate. Estimates of magnitude and epicenter locations for earthquakes prior to recording instruments were usually based on description of the earthquakes by individuals in different areas. Seismic instrumentation did not become available until about 1932, and these earlier instruments were imprecise. Nevertheless, historical site seismicity has been evaluated with the acceleration-attenuation relations of Bozorgnia, *et al.* (1999) and the computer program EQSEARCH (Blake, 2000b). This program searches historical earthquake records for magnitude 5.0 to 9.0 seismic events within a 100-mile radius between 1800 to June 2006. Based on the selected acceleration-attenuation relation, a peak horizontal ground acceleration has been estimated, which may have affected the site during specific seismic events in the past. Based on the available data and attenuation relationship used, the estimated maximum (peak) site acceleration between 1800 to June 2006 was about 0.39g. In addition, a seismic recurrence curve and a historic earthquake epicenter map has also been estimated from the historical data (see Appendix C).

A probabilistic seismic-hazards analyses was also performed using FRISKSP (Blake, 2000c) which models earthquake sources as 3-D planes and evaluates the site specific probabilities of exceedance for given peak acceleration levels or pseudo-relative velocity. These data suggest that the site could be subject to a peak horizontal site acceleration (PHSA) of ~1g. This value corresponds to a 10 percent probability of exceedance in 50 years (or a 475-year return period). Computer printouts of the FRISKSP program are included in Appendix C.

The site is located on the SJFZ, as well as near-field to the CFZ and SAFZ. It is therefore potentially subject to ~M7 seismic events (CDMG, 1996). Accordingly, appropriate engineering mitigation for both buildings and infrastructure is mandatory.

SEISMIC SHAKING PARAMETERS

The site is located within the SJFZ (San Bernardino Segment) and now has documented Holocene displacements (see Plate 1). Fault splays or segments associated with the Cucamonga Fault Zone (CFZ) were not observed during this or previous investigations. However, the International Conference of Building Officials ([ICBO] 1998), which indicates

Active Fault Near-Source Zones to be used to determine near-source factors such as directivity and fling (Abrahamson, 2005) for seismic design, has designated that portions of the Lytle Creek Ranch project lie within the Cucamonga Fault Near-Source Zone as well as the San Jacinto/San Bernardino Fault Near-Source zone. Therefore, according to code, we provide the following minimal seismic design parameters for both the Cucamonga Fault and San Jacinto/San Bernardino Fault Near-Source Zones for preliminary planning. This inherently excludes the effects of earthquake induced liquefaction. Based on site conditions, and Chapter 16 of the Uniform Building Code ([UBC], ICBO, 1997), the minimal seismic parameters are provided in Table 7.

TABLE 7

PRELIMINARY FAULT NEAR-SOURCE DATA		
Seismic Zone (per Figure 16-2*)	4	4
Seismic Zone Factor Z (per Table 16-I*)	0.40	0.40
Soil Profile Types (per Table 16-J*)	S_D (Fan deposits)	S_D (Fan deposits)
Seismic Coefficient C_a (per Table 16-Q*)	0.44 N_a	0.44 N_a
Seismic Coefficient C_v (per Table 16-R*)	0.64 N_v	0.64 N_v
Near Source Factor N_a (per Table 16-S*)	1.3	1.2
Near Source Factor N_v (per Table 16-T*)	1.6	1.55
Seismic Source Type (per Table 16-U*)	B	A
Distance to Seismic Source	0.0 km	5.6 km
Upper Bound Earthquake	San Jacinto fault M_w = 6.7**	Cucamonga fault M_w = 7.0**
Probabilistic Horizontal Site Acceleration (PHSA) - 10% in 50 years	~1g	
*Figure and table references from Chapter 16 of ICBO (1997) ** ICBO (1998)		

In case of conflict, the most conservative values in the above table should likely govern design. These values will likely vary depending upon the selected location within the site and the corresponding soil profile that underlies the selected location. These parameters will require revision during 40- or 100-scale grading plan reviews and at the conclusion of grading.

GROUNDWATER

Several groundwater barriers have been mapped as transecting the site (Fife, *et al.*, 1976; and Geoscience, 1992). These possible groundwater barriers all appear to be greater than 50 to 75 feet deep. A review of the groundwater barrier locales suggests that some of these groundwater barriers may be fault related. Based on the levels of the nearby open-pit mines (GSI, 1994), groundwater appears to be deeper than 75 to 100 feet in the site area. Fife, *et al.* (1976) indicated that study-area groundwater depths are about 100 to 200 feet deep. Historic groundwater levels reported by CDWR (2006) in a well near Neighborhood III, ranged from 25 and 171 feet deep between the years 1928 and 2000. CDWR (2006) also reports that historic groundwater depths, in a well near Neighborhood II between January and July 1992 fluctuated between 237 and 267 feet. In the site area, well data (Geoscience, 1992; Rasmussen, 1994a) indicated that the groundwater depth is more than 100 feet. Artesian conditions apparently existed within the El Rancho Verde Golf Course area of Neighborhood II in the early 1900's and in October 1993 (Rasmussen, 1994a). It is therefore possible that periods of high precipitation may result in perched groundwater or artesian conditions. However, in view of the general permeability of the alluvial sediments, this is considered unlikely.

No evidence for artesian springs were noted during our investigation. Subsurface water was not encountered in on-site excavations. These observations reflect site conditions at the time of our investigation and do not preclude changes in local groundwater conditions in the future stemming from irrigation, precipitation, or other factors not obvious at the time of our field work. Perched groundwater may occur in the future owing to increased precipitation or increased irrigation and runoff from urbanization, or along zones of contrasting permeabilities. (i.e., younger and older alluvial fan deposit contacts).

SUBSIDENCE

Our experience in the site vicinity and review of readily available data indicate that the project area is not subsiding. Lu and Danskin (2001) suggest that, in fact, the site may actually be uplifting, based on rising groundwater levels. Subsidence typically occurs due to down-faulting along bordering fault zones and although unlikely, to regional groundwater withdrawal.

The effects of areal subsidence generally occurs at the transition between sediments with substantially different engineering properties. Based on available data, bedrock underlies all alluvial deposits throughout the site; therefore, this potential is considered low. The stereoscopic, aerial photographs (Appendix A) also show no features generally associated with areal subsidence (i.e., radially-directed drainages flowing into a depression(s), linearity of depressions associated with mountain fronts).

Ground fissures are generally associated with rapid groundwater withdrawal and associated subsidence, or active faults. Our review did not indicate that rapid groundwater withdrawal is occurring at this time. In the site, should fault induced subsidence (or uplift) occur, it would be inherently mitigated by the recommended setback zones indicated on Plate 1.

LIQUEFACTION POTENTIAL

Seismically induced liquefaction is a phenomenon in which cyclic stresses, produced by earthquake-induced ground motion, create excess pore pressures in soils. The soils may thereby acquire a high degree of mobility and lead to lateral movement, sliding, sand boils, consolidation and settlement of loose sediments, and other damaging deformation. This phenomenon occurs only below the water table; but after liquefaction has developed, it can propagate upward into overlying, non-saturated soil as excess pore water dissipates. Typically, liquefaction has a relatively low potential at depths greater than 50 feet and is unlikely and/or will produce vertical strains well below 1 percent for depths below 60 feet when relative densities are 40 to 60 percent and effective overburden pressures are two or more atmospheres, i.e., 4,000 psf (Seed, 2005).

Liquefaction has two principal effects. One is the consolidation of loose sediments with resultant settlement of the ground surface. The other is lateral sliding. Significant permanent lateral movement generally occurs only when there is considerable differential loading on susceptible soils, such as fill or natural ground slopes on alluvium.

Liquefaction susceptibility is related to many factors and the following conditions should be present for liquefaction to occur: 1) sediments must be relatively young in age and not be strongly cemented; 2) sediments generally consist of medium- to fine-grained, relatively cohesionless sands; 3) the sediments must have low relative density; 4) free groundwater must be present in the sediment, and; 5) the site must experience a seismic event of a sufficient duration and magnitude to induce straining of soil particles.

Currently, the study area has the potential for three or four of these five concurrent conditions necessary to produce liquefaction. Therefore, the potential for earthquake induced liquefaction to affect the study area is considered low. However, a paleoliquefaction feature was observed in pre-Holocene deposits within a portion of Neighborhood II, providing evidence that liquefaction has occurred in the past (see FT-4).

Liquefaction induces excess pore water pressure in relatively clean sands (0 to 10 percent fines, 0.075 mm). These sediments may, thereby, acquire high mobility, leading to damaging deformation. This phenomenon only occurs below the water table; but after liquefaction has developed, it can propagate upward into overlying, non-saturated soil as excess pore water escapes. The onsite alluvial sediments are generally coarse-grained, massively to weakly bedded, and density becomes greater with depth.

FT-4 exposed evidence for an upward-directed hydraulic force that was suddenly applied, and was of short duration. This was manifested as a gravel dike, presumably caused by seismically induced liquefaction (Plate 14). This feature is expected if the site area had been subject to past liquefaction (Obermeier, 1996). Inasmuch as site future liquefaction performance should be similar to the past, it is imperative that potential for liquefaction be further evaluated in accordance with Special Publication 117, particularly in light of the possibility of future rises in groundwater levels resulting from urbanization or precipitation.

OTHER GEOLOGIC HAZARDS

Evidence for major active debris flows that may impact the subject development was generally not noted on the property and on aerial photographs. However, the potential for large debris flows within drainages is moderate to high under present soil cover, vegetation and excessive precipitation conditions. Further, the low-lying areas of the site are underlain by alluvial deposits that owe their origin, at least in part, to irregular flooding, as evidenced by boulders up to 36 inches in diameter. In consideration of the potential for prolonged rainfall, possible brush fires and vegetation denudation, we recommend that the project civil engineer consider using debris/desilting/detention basins and/or debris impact walls with sufficient freeboard, where swales or their watershed intersect the proposed development.

The low-lying alluvial areas of the site have local potential for dry sand settlement, and differential settlement (both static and seismic). This will need to be evaluated by the geotechnical consultant, and should be considered not only for buildings, but also critical infrastructure.

CONCLUSIONS AND RECOMMENDATIONS

Based on our field exploration, and engineering and geologic analyses, it is our opinion that the project site is suited for the proposed use from a geologic viewpoint, provided the recommendations presented in this report are properly implemented during planning, design, and construction. The conclusions and recommendations presented below should therefore be incorporated in planning for the design, grading, and construction.

1. The study area lies within the SJFZ, which is active (i.e., movement within the Holocene Epoch), according to State of California criteria (Hart and Bryant, 1997). Holocene faulting, likely associated with the SJFZ, was identified in trench exposures as documented herein. Habitable structures will require setbacks from these active faults. Recommended habitable structure setback zones are shown on Plate 1. Distribution of primary and secondary faulting and fault-related deformation have been demonstrated to occur well within these recommended setback zones.

2. Previous fault investigations by Gary S. Rasmussen and Associates, Inc. (Rasmussen [1980, 1982a, 1982b, 1994a, and 1994b]) have occurred on the adjacent, El Rancho Verde Golf Course, located south of the current Neighborhood II study area. Rasmussen (1994b) identified Holocene activity associated with the SJFZ within the golf course and provided setbacks for human-occupied structures. It is our understanding that the Client is relying on Rasmussen's data for the El Rancho Verde Golf Course area of Neighborhood II.

3. Active-fault trends, identified in this investigation, project toward Planning Areas 59 and 63 previously investigated by Rasmussen. This condition may require additional sub-surface studies within the El Rancho Verde Golf Course area or conservative setbacks for human-occupied structures may be necessary.

4. Although some ground cracks (i.e., no offset or displacement) were documented in a few trenches throughout pre-Holocene and Holocene deposits, our evaluation indicates that these features can be reasonably mitigated by use of properly designed post-tensioned or mat foundations and/or other appropriate engineering design.

5. The study area is in an area of potentially high seismic activity. Horizontal seismic accelerations are anticipated to be approximately 1g, should the design earthquake occur. The geotechnical consultant should evaluate the potential for other near-field seismic effects (based on the type and size of the seismic source, distance, and geological aspects, etc.), and provide appropriate mitigation.

6. Historic well-water data (California Department of Water Resources [CDWR], 2006) indicate that regional groundwater depths, recorded between 1928 and 2000 in a well near Neighborhood II, have fluctuated between 25 and 171 feet below the recording station elevation (1,851 feet Mean Sea Level [MSL]). Historic well-water data also indicate that regional groundwater depths recorded in a well near the Neighborhood III between January and July 1992 fluctuated between 237 and 267 feet below the elevation of the recording station (1,470 feet MSL). We also note that perched water may exist locally, during and after development, owing to a combination of high rainfall, irrigation runoff and seepage, broken utilities, improper drainage, and relatively impermeable subsoils.

7. We observed local paleoliquefaction features, indicating that liquefaction and possible ground deformation occurred onsite. We therefore recommend that additional, site-specific investigations evaluate liquefaction potential, dry sand settlement, as well as other typical geotechnical conditions, such as remedial-removal depths, and differential settlement. In view of the site seismic setting and the potential for seismic settlement, post-tensioned and/or mat foundations appear particularly appropriate for this project.

8. Based on our current geological assessments, GSI concludes that active faults (i.e., "sufficiently active" and "well-defined") do not likely exist within the remainder of the study area; however, if present, are of such small displacement to be effectively mitigated by appropriate engineering design.

9. Major underground or above-ground utility lines should cross active faults at high angles approaching perpendicular. Cut-off valves should be located on either sides of the zone of active faulting to facilitate repair, as warranted.

10. As a result of strong ground shaking, seiching (periodic oscillation of an enclosed body of water) may occur on any proposed lake(s), potentially topping the confining sides. Additionally, during a seiche, flooding adjacent to and down-stream of any proposed lake(s) may occur.

11. Flooding may also occur during heavy precipitation. Inasmuch as the mid- to late-Holocene alluvial sediments in the study area were primarily deposited by mud and debris flows emanating from steep gradient canyons (as evidenced by boulders up to about 36-inches in diameter), mitigation should be provided by the design civil engineer and geotechnical consultant. The design civil engineer should also evaluate the potential for flooding and recommend appropriate mitigation.

LIMITATIONS

The materials encountered on the project site and utilized for our analysis are believed representative of the area; however, soil materials vary in character between excavations and natural outcrops or conditions exposed during mass grading. Site conditions may vary due to seasonal changes or other factors.

Inasmuch as our study is based upon our review and engineering analyses and laboratory data, the conclusions and recommendations are professional opinions. These opinions have been derived in accordance with current standards of practice, and no warranty, either express or implied, is given. Standards of practice are subject to change with time. GSI assumes no responsibility or liability for work or testing performed by others, or their inaction; or work performed when GSI is not requested to be onsite, to evaluate if our recommendations have been properly implemented. Use of this report constitutes an agreement and consent by the user to all the limitations outlined above, notwithstanding any other agreements that may be in place. In addition, this report may be subject to review by the controlling authorities. Thus, this report brings to completion our scope of services for this portion of the project. All samples will be disposed of after 30 days, unless specifically requested by the Client, in writing.

APPENDIX A

REFERENCES CITED

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APPENDIX A

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