DEPARTMENT OF CONSERVATION

CALIFORNIA GEOLOGICAL SURVEY

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Mr. Nelson Cayabyab
Chief Facilities Official
Beverly Hills Unified School District
255 S. Laskey Drive
Beverly Hills, CA 90212

March 15, 2013

Subject: Second Fault Rupture Hazard Review
Beverly Hills High School
241 S. Moreno Drive, Beverly Hills, CA
CGS Application No. 03-CGS0960

Dear Mr. Cayabyab:

In accordance with your request and transmittal of additional documents, the California Geological Survey (CGS) performed a second review of the fault rupture study reports prepared for Beverly Hills High School. We reviewed the following consulting report, which we received on June 14, 2012, as a reply to our request for additional information:

2. **Initial Response to California Geological Survey Review Comments, Fault Rupture Hazard Review, Beverly Hills High School, 241 South Moreno Drive, Beverly Hills, CA:** Leighton Consulting, Inc., 10532 Acacia Street, #B-6, Rancho Cucamonga, CA, 91730, dated June 8, 2012, Project No. 603314-007, 6 pages, figures attached.

Subsequent to receiving Report 2, we also reviewed the following consulting reports that we received on December 31, 2012 and February 20, 2013, respectively, as additional replies to our original request for additional information:

3. **Second Response to California Geological Survey Review Comments, Fault Rupture Hazard Review, Beverly Hills High School, 241 South Moreno Drive, Beverly Hills, CA:** Leighton Consulting, Inc., 10532 Acacia Street, #B-6, Rancho Cucamonga, CA, 91730, dated December 28, 2012, Project No. 603314-008, 45 pages, appendices and figures attached.

4. **Addendum to Second Response to California Geological Survey Review Comments, Fault Rupture Hazard Review, Beverly Hills High School, 241 South Moreno Drive, Beverly Hills, CA:** Leighton Consulting, Inc., 10532 Acacia Street, #B-6, Rancho Cucamonga, CA, 91730, dated February 20, 2013, Project No. 603314-008, 4 pages, 1 attachment.

Previously, we reviewed the following report:

1. **Fault Hazard Assessment of the West Beverly Hills Lineament, Beverly Hills High School, 241 South Moreno Drive, Beverly Hills, CA:** Leighton Consulting, Inc., 10532 Acacia Street, #B-6, Rancho Cucamonga, CA, 91730, dated April 22, 2012, Project No. 603314-002, 23 pages, appendices and figures attached.

CGS initially reviewed Report 1 and submitted our findings regarding this project in our review letter dated May 21, 2012. Based on our first review, additional information was required regarding significant marker bed and geologic contact elevation changes noted in borings below trenches and spanning trench gaps, which might be evidence of faulting at the site.

For Report 1 the consultants had reviewed published geologic maps, literature, aerial photos, and a recent fault investigation report for the proposed MTA Westside Subway Extension, and performed a subsurface fault investigation to evaluate the potential for active faulting and fault rupture hazards associated with the West Beverly Hills Lineament (WBHL) at the school site. Their investigation consisted of 12 CPTs and 21 borings drilled on the school property. They also excavated and geologically logged four fault trenches.

CGS representatives met with the consultants and other members of the project team on July 5, 2012. Several issues related to our review comments and the general plans for the consultants' supplemental investigation were discussed.

Supplemental Fault Investigation and Discussion

Subsequent to this meeting the consultants drilled five additional borings (CB-22 through CB-26) in a linear transect along the northwestern perimeter of the site. CGS representatives visited the school site on July 12 and August 21, 2012 to review rock core samples taken from these borings. Based on the subsurface data collected from the borings, the consultants excavated a fault trench (FT-5) along the same transect. Detailed observations were made of the soil types, textures, and colors, as well as any fractures or other discontinuities. The consultants also provide estimated ages of the sedimentary deposits and paleosols exposed in the trenches and recovered core samples of the alluvium and underlying bedrock. Representatives from CGS visited the fault trench on September 13 and September 19, 2012.

The consultants also responded to other requests for additional information by CGS.

In addition to the subsurface data provided by the consultants, CGS reviewed a fault trench excavated by others on the commercial property immediately offsite to the north of the school. The district's consultants also reviewed this trench separately. This trench was oriented subparallel to the district consultants' profile B-B' and exposed Pleistocene alluvium that was visibly unfaulted. This trench is referred to as the "Feffer/Geocon" trench in Report 3.

A-A' (central transect)

In the previous review letter, CGS noted an elevation change of three to five feet between marker beds in borings CB-8 and CB-9. Above this elevation change, in the vicinity of station 2+20 in FT-2, pedogenic features in the paleosols indicate tilting or folding. CGS commented these two observations are compatible with an interpretation of fault offset at depth and requested the consultants provide additional detailed logging or subsurface data to demonstrate an unbroken horizontal stratigraphic sequence below the fractures and tilted ped surfaces. Additionally, several fractures with up to one inch of apparent east-side down vertical offset were noted between stations 1+40 and 1+80.

To address CGS' concern that the tilted ped faces observed in the MB-1 argillic horizon may indicate fault-related folding, the consultants note sand layers above and below MB-1 are "still horizontal out to where it is terminated by the slope." Also, they state there is no similar folding in the younger alluvial sediments (i.e. Units 2 and 3 in FT-2) higher in the trench. Between stations 1+40 and 1+80 the consultants state the lack of evident offset of units and contacts between borings across this interval suggests the fractures observed in the trench along this interval are not related to active faulting. They interpret these fractures as surficial features related to slope extension and gravitational movement during strong seismic shaking.

CGS also visited the site to review the core samples from CB-8 and CB-9. Based on review of the boring and trench logs and our field observations it appears reasonable to conclude faulting does not affect the upper soils between these borings. Furthermore, the observed fractures to the west may also be reasonably ascribed to slope movement unrelated to faulting.

CGS was also concerned with the gaps between the fault trenches at the site. Particularly, we noted discrepancies in some sedimentary unit elevations in the core samples we reviewed from borings within the FT-1 and FT-2 gap, specifically, between CB-3 and CB-4. Based on additional field review of the core samples with the consultants, it appears reasonable to conclude faulting does not impact the upper soils, interpreted as late Pleistocene, between these borings.

The consultants conclude there are no active faults along transect A-A'. This interpretation appears reasonable based on the data and explanations provided in the referenced reports and no additional information is requested.

B-B' (northern transect)

Based on our review of the core samples and the data provided in the boring logs and cross section B-B' from Report 1, it appeared there were some anomalous vertical separations of the markers beds between borings. Various marker beds and the San Pedro Formation (Qsp_1) contact appeared to be offset between borings T-4 B-10 and CB-13, as well as between CB-17 and CB-18. In Report 3 the consultants note the alluvium-bedrock contact drops approximately 14 feet between borings CB-17 and CB-18. However, they state the marker beds identified above the bedrock are continuous and do not exhibit anomalous changes in elevation between borings. Instead they indicate these units dip gently to the east similar to strata in areas where no

faulting was observed. Also, the consultants note the Feffer/Geocon trench, in which no faulting was observed, is located immediately north and perpendicular to any potential fault that might exist between T-4 B-10 and CB-13. For these reasons, the consultants conclude the observed elevation changes in marker beds between these two borings are not related to active faulting. CGS observed the core samples and the Feffer/Geocon trench in the field and reviewed the boring logs from Report 1. The consultants' conclusion that the marker units above the San Pedro Formation contact between borings T-4 B-10 and CB-13 as well as CB-17 and CB-18 do not show evidence of active faulting seems reasonable. No additional information is requested.

C-C' (northwestern transect)

Along the northwestern perimeter of the campus, the consultants drilled five new continuous core borings and excavated a new fault trench (FT-5), which was approximately 125 feet long, along a northwest-southeast trending profile.

Section C-C' depicts the graphic log of FT-5, as well as the subsurface data and interpreted correlations from the core borings. According to the boring logs, going north from the south end of the profile, the elevation of the bedrock surface was relatively constant until it dropped approximately 34 feet between borings CB-26 and CB-23 and another 45 feet between CB-23 and CB-24. Fault trench FT-5 was excavated parallel to the boring transect between CB-24 and CB-26 to investigate the potential for faulting in near surface soils above this anomalous elevation drop.

Based on soil-stratigraphic age estimates, the consultants concluded the youngest sediments exposed in FT-5 (Unit 1) range from approximately 30,000 to 60,000 years old. The oldest unit (Unit 6) was estimated at 143,000 to 335,000 years old. Thus it appears this portion of the campus is underlain by late Pleistocene sediments, similar to some other areas explored onsite. The consultants also collected samples for optically stimulated luminescence (OSL) dating. The results of this testing and analysis indicate the youngest sediments in FT-5 (Unit 1) are approximately 59,000 years old, which is in general agreement with the soil-stratigraphic estimates and corresponding late Pleistocene age for this sedimentary package.

Based on geologic observations and logging of FT-5 it was determined the bedrock elevation change noted in the borings is due to faulting. Several faults were observed in the trench exposures between CB-26 and CB-23. These faults are related to the southern strand of the fault zone depicted on Profile C-C' (Plate 4 of Report 3). These faults were "expressed as an upwardly flowering and stepping zone of faults and fractures about 20 feet wide and having a cumulative ± 3 feet of north side down displacement, and some undetermined lateral offset." Attitudes on the faults ranged from N35°E to N43°E with dips between 65° to 75° north. Based on their detailed logging the consultants interpret at least two, and possibly three, distinct rupture events recorded in the trench exposures. The most recently active strand in the fault zone extends up from the bottom of the trench and appears to offset the base of Unit 2, although much of Unit 2 and presumably Unit 1 was previously removed due to erosion and/or grading making it difficult to determine how high the original rupture extended. The consultants state within Unit 2, the fault is expressed not as a distinct plane or aligned zone of fractures, but as "a series of discontinuous gleyed cracks…that all contain a dense matrix with no orientation of fabric or

sheared grains." Additionally, the consultants note the fault "loses expression within [Unit 2] interpreted as a lack of renewal of displacements and progressive destruction of the old fault fabric by weathering and time." Consequently, they conclude the most recent event "occurred when Unit 2 was the ground surface but before the development of the strong B_t that caps it, because the fault traces are only readily visible within the C horizon [Unit 3] beneath the B_t."

No clear fault plane was observed in the trench exposures above the northerly fault strand (i.e. between CB-23 and CB-24). The consultants note this area was characterized by numerous fractures within Units 2 and 3 with inconsistent attitudes. According to the consultants, these fractures did not offset Unit 1, which is dated between 30,000 and 60,000 years old and therefore these features, should they be considered faults, "are not active per the State's current definition." Correlations of units 1 and 2 to CB-13 to the north provide no indication of faulting beyond the trench.

The consultants provide a new soil microfabric analysis (Appendix D of Report 3), which consisted of collecting nine samples from the two distinct faults exposed in FT-5 and examining the material between the fault planes with a petrographic microscope. The consultants state the faults and fractures between stations 0+37 and 0+55, which are part of the southern fault strand, are lined with laminated clay, up to 0.3mm thick. This clay also lines the voids between sand grains and completely plugs tubular pores. The laminated nature of the clay suggests this material was deposited as water migrated down the fault plane and therefore, the consultants state it indicates the fault has not moved in any direction since clay deposition, otherwise the laminations would not be present and the clay would show evidence of shearing, which they note it does not. The consultants conclude these moderately thick to thick clay films take "tens of thousands of years to form" and therefore, the faults are not active by current State standards.

These conclusions appear reasonable based on the data provided in the referenced reports. No additional information is necessary.

Trenches FT-3 and FT-4 (southern transect)

No additional information was requested with respect to trench FT-3, but CGS previously noted several clay-filled fractures with apparent vertical offset were observed between stations 0+58 and 0+68 in FT-4. The consultants note while these features did offset gravel beds within Unit 6, they did not offset the contact with the unit below Unit 6. Since these fractures have apparent east-side up displacement and are found near a pre-existing slopeface, the consultants postulate they formed as a result of dilation and downslope movement associated with strong seismic shaking, similar to their model for those fractures near the pre-existing slope in FT-2. Based on lithologic characteristics and similarities to other dated soils at the site, the consultants infer Unit 4, which overlies Unit 6, is on the order of 100,000 years old. Thus they conclude the fractures observed in FT-4 are not active faults. This conclusion appears reasonable based on the data provided in the reports.

General

Various offset layers observed in the fault trenches appeared to have thickness variations on either side of the fault/fracture. CGS commented this may be indicative of lateral offset and

therefore, requested the consultants provide additional data to address the potential for strike-slip faulting at the site. The consultants calculated the strike and dip of the Qsp_1/Qsp_2 contact as approximately N71°W with a dip of 2° northeast. They note the alluvial marker beds above the bedrock show similar dips to the east-northeast and the postulated faults in the MTA study and those measured in FT-3 all trend obliquely to this general strike, which would result in vertical separation of strata if strike-slip faulting occurred. The consultants reviewed the core log data and conclude it is consistent enough they are able "to correlate strata across the site with vertical resolution to within a foot or two, and at this scale, there is no geological evidence from which to interpret a fault." No additional information is requested.

With regard to the observations in FT-2 specifically, the consultants state the noted thickness variations across the trench could reasonably be related to fluvial sedimentary features (i.e. bar deposits, incised channel geomorphology, migrating channel deposits, etc.), which by nature are laterally variable in thickness and continuity. To explain the noted thickness variations across the faults/fractures in FT-2 they suggest these fractures formed as the result of downslope movement possibly associated with strong seismic shaking. They note fractures related to this type of slope extension are rarely perfectly parallel to the slope and typically form arcuate fractures on the slopeface. They posit the lateral slip observed in FT-2 is reasonably explained by this arcuate morphology. In light of other evidence of slope movement, this conclusion appears reasonable and no additional information is needed.

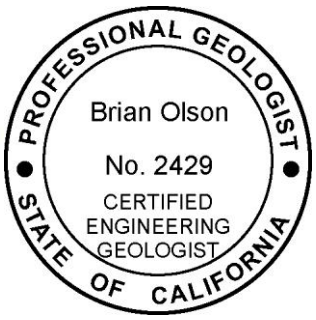
CGS also commented that the fault investigation by the consultants focused on the central and northern portions of the school property only and further studies should be performed, which include the southern portion of the school if the purpose of the investigation is to address the fault hazard potential for the entire campus. On Plate 1 of Report 3, the consultants provide a line that delineates the area covered by this investigation, which excludes the athletic fields to the south and limits the focus of the fault study to the classroom buildings in the northern portion of the campus. No additional information is requested.

Conclusion

The consultants performed a thorough fault investigation program at the subject site and it appears evidence for active faulting related to the West Beverly Hills Lineament or the Santa Monica Fault Zone was not encountered within the limits of this investigation as shown in Report 3. CGS has reviewed the interpretations and much of the original data provided by the consultants and finds that their conclusions are consistent with the available data.

In conclusion, ***the fault rupture hazard issues in the area covered by this investigation are adequately addressed in the referenced reports prepared by the consultants***, and no additional information is requested at this time. If you have any questions about this review letter, please telephone the reviewer at (213) 239-0876.

Respectfully submitted,



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