March 25, 2020

Dan Zaich, Ed.D.
Senior Director – Capital Facilities
San Rafael City Schools
310 Nova Albion Way
San Rafael, CA 94903
dzaich@srcs.org

Supplemental Geotechnical Recommendations – New Gymnasium
Terra Linda High School
320 Nova Albion Way
San Rafael, Marin County, California

Dear Mr. Zaich:

This letter presents our supplemental recommendations for the proposed new gymnasium at Terra Linda High School (TLHS) in San Rafael, California. A3GEO, Inc. (A3GEO) previously provided preliminary and design-level geotechnical investigation and geologic hazard reports for then-planned TLHS improvements (including both the Student Commons and new gymnasium), which were summarized in our reports dated March 16, 2017[1] and February 16, 2018[2]. Since issuing these reports, construction for the Student Commons has commenced. Based on conversations with the project team, we understand that the new gymnasium project is currently in the design phase.

Since issuing our February 2018 design-level geotechnical investigation report[2], the following has occurred: (1) the location and configuration for the new gymnasium has been finalized, and is slightly different from what was assumed in our February 2018 report; (2) the 2019 California Building Code (CBC) was adopted, which includes updated seismic design requirements; and (3) new DSA/CGS Note 48 requirements were adopted in November 2019. Considering these developments, we have reviewed, and, where appropriate, revised our geotechnical recommendations for the new gymnasium from those contained in our February 2018 report. A discussion of our updated geotechnical recommendations is presented in the following sections.

1. OVERVIEW

Based on our review of the latest project schematics prepared by Quattrocchi Kwok Architects and dated October 23, 2019[3], the new gymnasium location and configuration has changed slightly since our February 2018 report was prepared. For our design-level report, we had assumed a rectangular shaped gym building in generally the same location as the current design. The new gymnasium location and shape is shown on the attached Figures 1 through 3. The design includes a one- to two-story structure, with a building footprint of approximately 20,800 square foot, which will house a gymnasium, lobby, offices, storage spaces, and mechanical areas. No below-grade space is planned. The project will also include reconfigurations to the driveway and parking areas, and landscaping improvements.

2. SUBSURFACE CONDITIONS

As part of the Phase 1 and Phase 2 subsurface investigations performed by A3GEO (summarized in our February 2018 report), numerous borings were performed in the vicinity of the proposed gymnasium, including

[1] A3GEO, 2017, "Preliminary Geotechnical Investigation and Geologic Hazards Study Report, Terra Linda High School, 320 Nova Albion Way, San Rafael, Marin County, California", 16 March
[2] A3GEO, 2018, "Design Level Geotechnical Investigation and Geologic Hazards Study Report, Terra Linda High School, 320 Nova Albion Way, San Rafael, Marin County, California", 16 February.
[3] BHM Construction., Inc, and Quattrocchi Kwok Architects, 2019, San Rafael City Schools, Statement of Proposal: BHM + QKA, Re: Terra Linda High School Gym + Frontage Project, RFP #19-08, 23 October.

A3-17-1, A3-17-2, A3-17-9, B-4, CPT-3, and CPT-4 (see Figure 2). Based on the updated location and configuration of the proposed new gymnasium, we judge that the aforementioned existing explorations are still sufficient to characterize subsurface conditions below the proposed gymnasium, and additional explorations are not required.

The Site Geologic Map shown on Figure 3 shows the geologic units we interpret to be present within the TLHS campus and their relationship to the location of the proposed gymnasium. Because changes to the location/configuration of the new gymnasium from the February 2018 location are relatively minor, the discussion of subsurface conditions within the footprint of the proposed gymnasium remains largely unchanged. Subsurface cross section C-C', shown on Figure 4, crosses through the proposed gymnasium footprint. Section C-C' indicates variable fill thicknesses in the area of the proposed gymnasium, ranging from approximately 3 feet on the northwest side of the proposed footprint, to approximately 10 feet in B-4, which was drilled along the alignment of the historic creek.

3. GEOLOGIC HAZARD ASSESSMENT

3.01 Liquefaction

Section 5.03.1 of our February 2018 report included an assessment of liquefaction hazards for the new gymnasium. Our liquefaction analysis indicated that though the potential for widespread liquefaction in the vicinity of the proposed gymnasium was absent, there was a possibility of liquefaction in thin, discontinuous pockets. Based on our review of the updated gymnasium configuration and location, we judge that this assessment is still valid.

Our February 2018 analysis used data from CPT-3 and CPT-4 (see Figure 2) and the CLiq program to estimate the magnitude of liquefaction and cyclic-softening induced surface settlement at each of the CPT locations. Generally, liquefaction-induced settlements on the order of up to 0.3 to 2.5 inches were calculated, depending on the location and analysis method utilized. Our February 2018 liquefaction analyses assumed a geometric mean PGA of 0.50g, based on ASCE 7-10. However, according to updated seismic guidance in ASCE 7-16 and requirements of the 2019 CBC, the geometric mean PGA at the site has increased slightly, to 0.57g. A3GEO re-analyzed liquefaction induced settlements at the new gymnasium accounting for a PGA of 0.57g and calculated very similar displacements to those reported in our February 2018 report, with liquefaction-induced settlements ranging from 0.4 to 2.5 inches, depending on the location and analysis method utilized.

As stated in our February 2018 report, based on the interpreted nature of the liquefiable deposits below the proposed gymnasium, we anticipate that the relatively small liquefaction-induced settlements will be associated with the portion of the gymnasium footprint underlain by or adjacent to the historic creek that runs along the northeast boundary of the site, where groundwater was encountered during A3GEO's subsurface investigation program. Previously, A3GEO judged that liquefaction-induced settlement effects could be effectively mitigated in engineering design of the project.

Based on our review of the updated gymnasium location/configuration, the assessments discussed above are still valid. However, as of November 2019, CGS Note 48 stipulates that an assessment of seismic differential settlement (in accordance with ASCE 7-16 Section 12.13.9) also be included as part of geologic hazard assessments. As discussed above, A3GEO estimates that maximum liquefaction-induced settlements will be experienced along the northeast edge of the proposed gymnasium, coincident with the location of the historic creek, with minimal-to-no liquefaction-induced settlements occurring on the southwest side of the structure, where minimal artificial fill is present and where groundwater is expected to be deeper. Accordingly, we expect that *without mitigation,* liquefaction-induced differential settlements of up to approximately 1¼ inches over 30 horizontal feet could be possible. Recommendations for supporting the building on drilled piers are provided to mitigate liquefaction-induced differential settlement concerns.

4. GEOTECHNICAL DESIGN RECOMMENDATIONS

4.01 California Building Code Seismic Parameters

Structures at the site should be designed to resist strong ground shaking in accordance with the applicable building codes and local design practice. Our February 2018 report provided California Building Code (CBC) seismic design parameters in accordance with the 2016 version of the Code, which was based on ASCE 7-10. The new gymnasium will be designed using the 2019 CBC, which is based on new seismic guidance outlined in ASCE 7-16. Accordingly, the seismic design parameters provided below supersede the values provided in Section 7.01.2 of our February 2018 report.

The seismic design parameters for the 2019 CBC include the following assumptions: (1) the fundamental period of the building is less than 0.5 second; (2) the structure will not contain a seismic isolation or damping system; and (3) the seismic response coefficient, Cs, will be determined as specified in Section 11.4.8 Exception 2 of ASCE 7-16. If the project structural engineer indicates that these assumptions are not valid, additional analysis may be needed to evaluate seismic design parameters. A summary of the 2019 CBC seismic design parameters is provided below:

Site Class
D = Stiff Soil

Latitude and Longitude
Latitude: 38.00001°N
Longitude: 122.5534°W

Mapped Maximum Considered Earthquake Spectral Response Accelerations
S_S = 1.50g (Mapped MCE spectral acceleration at short periods)
S_1 = 0.60g (Mapped MCE spectral acceleration at 1-second period)

Maximum Considered Earthquake Spectral Response Accelerations (for Site Class D)
S_{MS} = 1.50g (MCE spectral acceleration at short periods)
S_{M1} = 1.02g (MCE spectral acceleration at 1-second period)

Design Spectral Response Acceleration (for Site Class D)
S_{DS} = 1.00g (design spectral acceleration at short periods)
S_{D1} = 0.68g (design spectral acceleration at 1-second period)

4.02 Foundation and Slab Recommendations

Foundation and slab design recommendations presented in Section 7.04 of our February 2018 report remain unchanged. We recommend that the new gymnasium be founded on drilled piers in bedrock. Drilled piers will allow loads to be transferred below the artificial fill, mitigate surficial expansive soils concerns, accommodate higher column loads that may be associated with potential long-span design, and mitigate the effects of liquefaction related total and differential settlements.

5. CLOSURE

Other geotechnical design recommendations for the gymnasium and associated site improvements discussed in our February 2018 report and not further discussed in this letter remain unchanged.

6. LIMITATIONS

This letter was prepared for the exclusive use of San Rafael City Schools and their consultants for the specific application to the new gymnasium project at Terra Linda High School, as described herein. This letter was

prepared to present changes to design recommendations from our February 16, 2018 design-level geotechnical report and is not all-inclusive; relevant recommendations from our February 16, 2018 report are still valid.

The opinions presented in this report were developed in accordance with generally-accepted geotechnical engineering geologic principles and practices. No other warranty, expressed or implied, is made. In the event that changes in the nature or design of the new gymnasium project are planned, the conclusions and recommendations contained in this letter (and in our February 16, 2018 report) should not be considered valid unless the changes are reviewed, and the conclusions of the letter and report are modified or verified in writing.

The findings in this letter are valid as of their present date. However, the passing of time will likely change the conditions of the property due to the natural processes and works of man. In addition, due to legislation or the broadening of knowledge, changes in applicable or appropriate standards will occur. Accordingly, this letter should not be relied upon after a period of three years without being reviewed by this office.

Should you have questions or concerns regarding the contents of this letter, please do not hesitate to call.

Yours very truly,

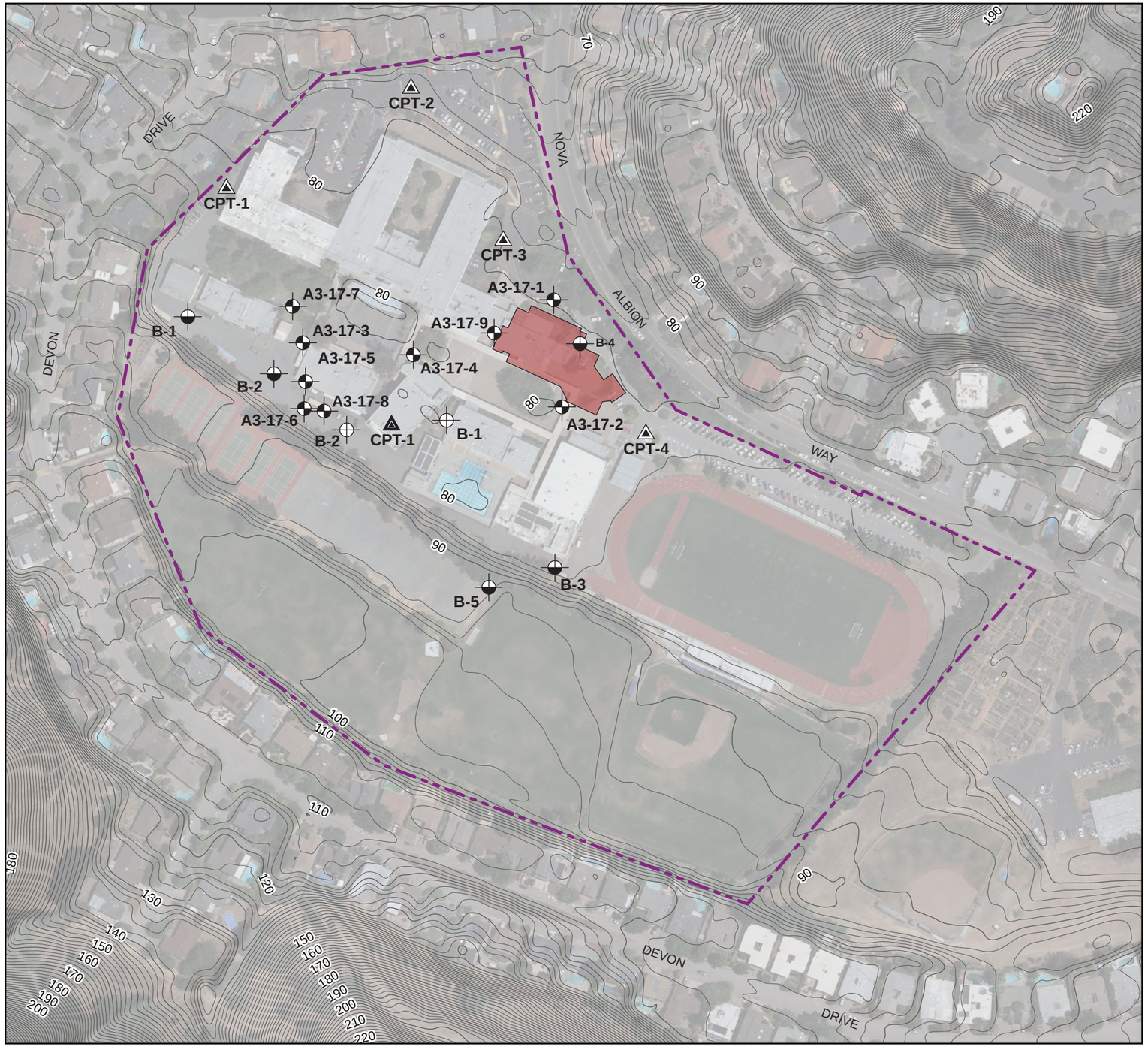
A3GEO, Inc.

Laura Buchanan, PE
Senior Engineer
(510) 919-0280

Timothy P. Sneddon, PE, GE
Principal Engineer
(408) 499-1465

Attachments:

- Figure 1 – Site Plan
- Figure 2 – Exploration Location Plan
- Figure 3 – Site Geologic Map
- Figure 4 – Cross Section C-C'



LEGEND:

- PROPOSED GYMNASIUM
- A3-17-8 — PHASE 2 TEST BORING (A3GEO, NOVEMBER 2017)
- B-4 — PHASE 1 TEST BORING (A3GEO, FEBRUARY 2017)
- CPT-3 — PHASE 1 CPT (A3GEO, FEBRUARY 2017)
- B-2 — TEST BORING (MPEG, AUGUST 2003)
- CPT-1 — CPT (MPEG, AUGUST 2003)
- SITE BOUNDARY
- 100 — ELEVATION CONTOURS IN FEET

NOTES:

1. Topographic contours from Marin Map, A Geographic Information System for Marin County. Data are in California State Plane coordinates, NAD83 HARN, US Survey feet.
2. Elevations are in feet and reference North American Vertical Datum of 1988 (NAVD 88).
3. Proposed gymnasium location and configuration taken from a file titled "TLHS Gym - Conceptual Site Plan.jpg" dated 23 October, 2019 and prepared by Quattrocchi Kwok Architects.

(SCALE IN FEET)

0 200 400

TERRA LINDA HIGH SCHOOL
NEW GYMNASIUM
SAN RAFAEL, CA

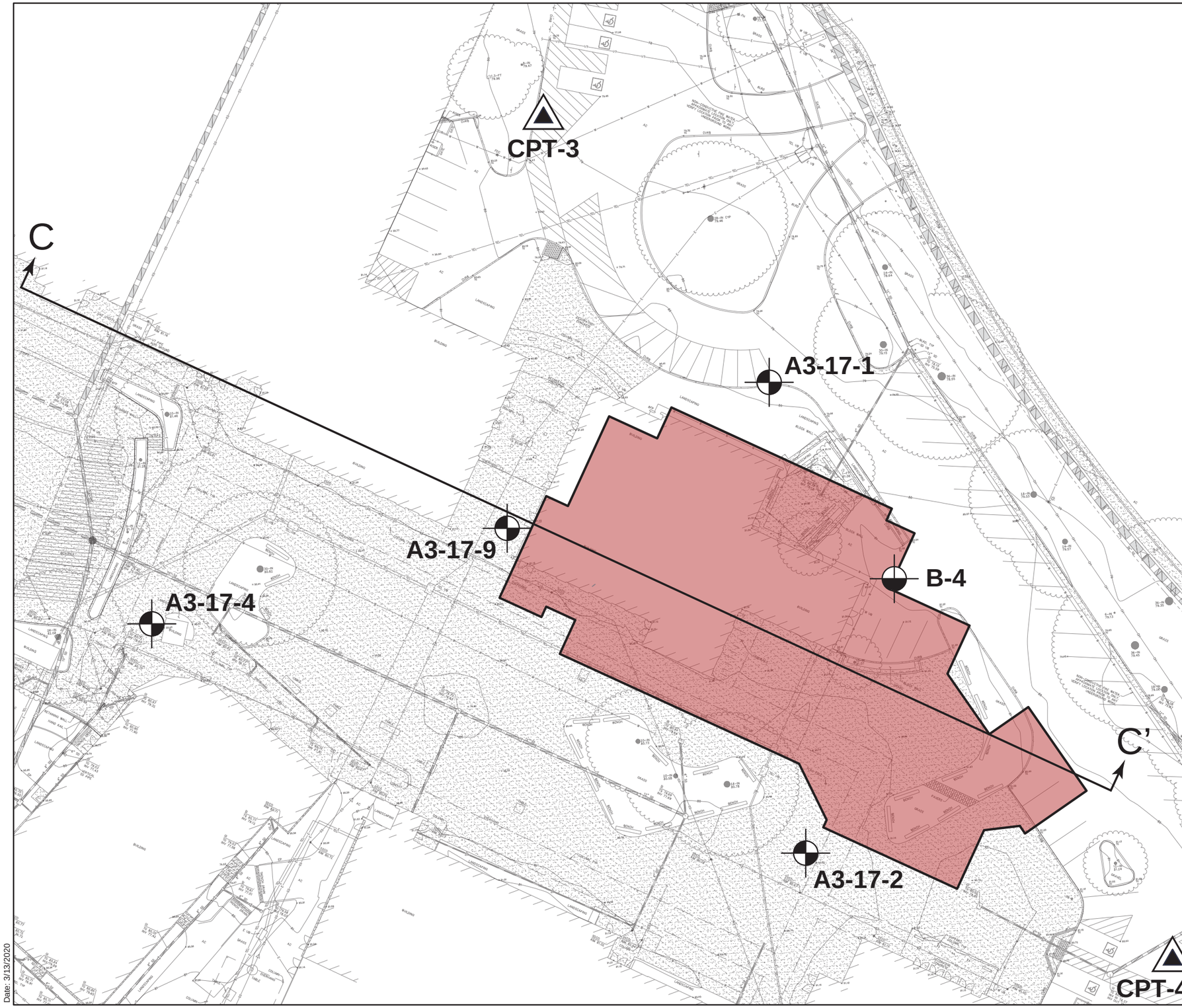
Project No. 1150-1E

SITE PLAN

A3GEO

FIGURE 1

Date: 3/8/2020



LEGEND:

PROPOSED GYMNASIUM

A3-17-8 — PHASE 2 TEST BORING (A3GEO, NOVEMBER 2017)

B-4 — PHASE 1 TEST BORING (A3GEO, FEBRUARY 2017)

CPT-4 — PHASE 1 CPT (A3GEO, FEBRUARY 2017)

C — C' LINE OF CROSS SECTION

NOTES:

1. Base plan taken from a file titled "169133_Topo_TLHS_R_2000.dwg", provided to A3GEO via email on 9 October 2017.
2. Elevations are in feet and reference North American Vertical Datum of 1988 (NAVD 88).
3. Proposed gymnasium location and configuration taken from a file titled "TLHS Gym - Conceptual Site Plan.jpg" dated 23 October, 2019 and prepared by Quattrocchi Kwok Architects.

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TERRA LINDA HIGH SCHOOL
NEW GYMNASIUM
SAN RAFAEL, CA

Project No. 1150-1E

EXPLORATION LOCATION PLAN

A3GEO

FIGURE 2

Date: 3/13/2020

LEGEND:

AF	ARTIFICIAL FILL
Qa/Qc	ALLUVIUM/COLLUVIUM (QUATERNARY)
fsr	CRETACEOUS/JURASSIC FRANCISCAN MÉLANGE
	GEOLOGIC CONTACT APPROXIMATELY LOCATED
	FAULT CONTACT CONCEALED
C C'	LINE OF CROSS SECTION
A3-17-8	PHASE 2 TEST BORING (A3GEO, NOVEMBER 2017)
B-4	PHASE 1 TEST BORING (A3GEO, FEBRUARY 2017)
CPT-3	PHASE 1 CPT (A3GEO, FEBRUARY 2017)
B-2	TEST BORING (MPEG, AUGUST 2003)
CPT-1	CPT (MPEG, AUGUST 2003)
	PROPOSED GYMNASIUM
	SITE BOUNDARY

NOTES:

1. Geology from Marin Map, A Geographic Information System for Marin County. Data are in California State Plane coordinates, NAD83 HARN, US Survey feet.
2. Qaf and Qa/Qc contact based on conditions observed in test borings, and drawing A1A, dated 16 December 1958, prepared by Grommé Mulvin & Priestly Architects of San Rafael, CA for the New High School, San Rafael High School District for the Terra Linda Area, Marin County, California.
3. Fault location from USGS Miscellaneous Field Study MF-2337 for parts of Marin, San Francisco, and Contra Costa Counties, 2000.

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TERRA LINDA HIGH SCHOOL
NEW GYMNASIUM
SAN RAFAEL, CA

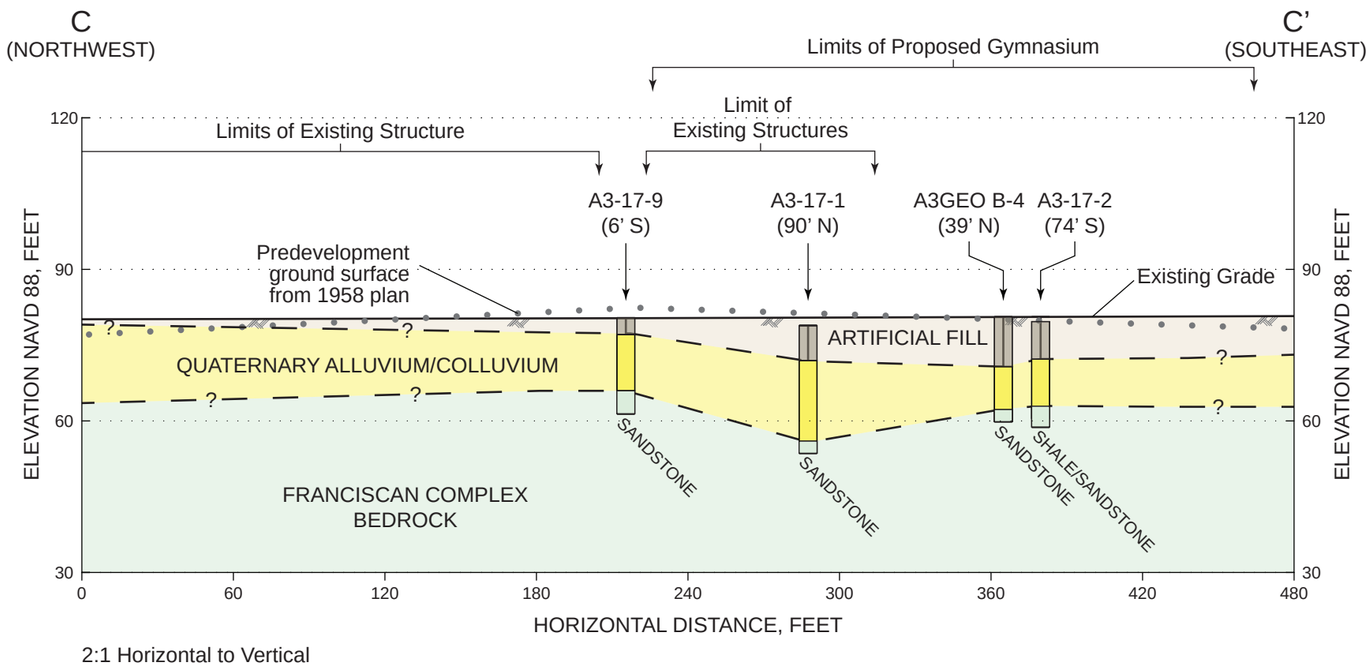
Project No. 1150-1E

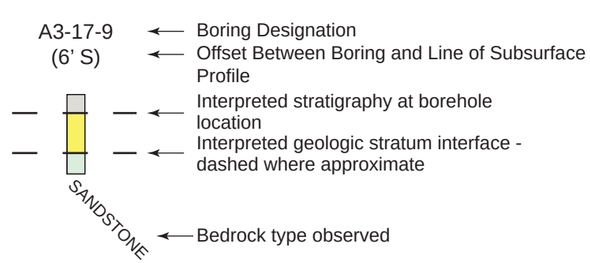
SITE GEOLOGIC MAP

A3GEO

FIGURE 3

Date: 3/8/2020





NOTES:

1. Refer to Figure 2 for plan location, designation and orientation of subsurface section and as-drilled exploration locations.

2. Subsurface profile depict the general geologic conditions at the site and are based on interpretation of data encountered in explorations. Lines representing the interfaces between strata on the profile are based on interpolation between adjacent borings. Test boring sticks show the interpreted sequence of strata at each location. Actual soil conditions and interfaces between explorations may vary significantly from those indicated on profiles.

3 . Refer to test boring logs for more detailed soil and rock conditions.

TERRA LINDA HIGH SCHOOL
NEW GYMNASIUM
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Project No. 1150-1E

CROSS SECTION C - C'

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FIGURE 4

Date: 3/9/2020