CORNERSTONE EARTH GROUP

Date:	December 7, 2017
Project No.:	608-5-2
Prepared For:	Mr. Alberto Vasquez **SAN FRANCISCO UNIFIED SCHOOL DISTRICT** 135 Van Ness Avenue - Room 207a San Francisco, California 94102
Re:	Geotechnical Consultation Geotechnical Recommendations for Retaining Wall Repair McCoppin Elementary School Improvement Project 651 6th Avenue San Francisco, California

Dear Mr. Vasquez:

As requested, this letter presents our supplemental geotechnical recommendations for the existing retaining wall repair for the above referenced project. Our services were performed in accordance with our agreement dated April 2, 2016. As you are aware, we have previously completed a report, titled "Geotechnical Investigation and Geologic Hazards Evaluation, "Frank McCoppin Elementary School Improvements, 651 6th Avenue, San Francisco, California," dated January 23, 2015, as well as a supplemental foundation recommendations letter, dated September 22, 2015. The geotechnical investigation and geologic hazard evaluation report has been previously submitted to CGS for review as part of the DSA approval process for the recently completed construction at the school campus. For our use, we were provided a conceptual structural sketch, titled "McCoppin ES Retaining Wall, San Francisco, CA, Deadman Tie-Back Option" prepared by KPW Structural Engineers, Inc., dated November 1, 2017. The purpose of our consultation services is to provide geotechnical recommendations for the retaining wall mitigation/repair. The information presented in this letter is intended to supplement or existing report; please refer to our existing report for information not presented here.

Project Understanding

Based on our conversations with the District and KPW, we understand that the existing retaining wall has rotated to the point that the wall is touching the adjacent apartment building (630 7th Street) located to the north of the school property. Mitigation will be performed along the wall running along the existing property line. The existing retaining wall ranges up to about 10 feet in height. Mitigation will be performed to re-establish clearance between the wall and the adjacent building. Mitigation will likely consist of removing and replacing the upper few feet of the existing concrete retaining wall and installing footing-type concrete "Deadman" anchors, likely in several isolated footings spaced at 8 to 10 feet on center with tie rods to provide resistance to lateral earth pressures on the existing wall and resist further rotation of the existing retaining wall towards the adjacent property. To further reduce the lateral pressure from the existing soil on the retaining wall, the backfill will be excavated down to about 6½ feet below existing grade

and replaced with Geo Foam. A subdrain will be installed behind the wall. We understand no improvements to the existing retaining wall foundation are planned.

Supplemental Retaining Wall Recommendations

GEOTECHNICAL PARAMETERS FOR DESIGN OF RETAINING WALL MITIGATION

Static Lateral Earth Pressures

The structural design of the retaining wall mitigation should include resistance to lateral earth pressures that develop from the soil behind the wall. As discussed in our geotechnical report, ground water was not encountered in our borings and is anticipated to be greater than 50 feet at the project site. No ground water seepage issues with the existing wall have been reported to our office. Based on this information, designing the mitigation to address build-up of hydrostatic pressures is not considered needed, in our opinion, however, we do recommend that the subdrain be placed below the geo foam to intercept any incidental perched ground water. The lateral pressure from the soils need to be only applied for the part of the wall that does not have geo foam. Since the mitigated wall will be restrained, we recommend that it be evaluated with following at-rest earth pressures:

Table 1: Recommended Lateral Earth Pressures

Wall Condition	Lateral Earth Pressure*	Additional Surcharge Loads
Restrained – Braced Wall	30 pcf + 8H** psf	1/2 of vertical Areal loads at top of wall Isolated equipment pads and other loads should be evaluated on a case by case basis (see note below***)

* Lateral earth pressures are based on level backfill conditions
** H is the distance in feet between the bottom of footing and top of retained soil
*** Note: geotechnical engineer to evaluate surcharge loading on a case by case basis and provide lateral pressures to structural engineer during the final structural design

Seismic Lateral Earth Pressures

The 2016 CBC states that lateral pressures from earthquakes should be considered in the design of basements and retaining walls. We reviewed the seismic earth pressures for the proposed retaining wall mitigation using procedures generally based on the Mononobe-Okabe method. Because the existing wall is greater than 6 feet in height, and peak ground accelerations are greater than 0.40g, we checked the result of the seismic increment when added to the recommended active earth pressure component against the recommended restrained wall earth pressures. Because the wall is of cantilever design, the design pressure should be considered and based on current recommendations for evaluating seismic earth pressures (Lew et al., SEAOC 2010), it appears that active earth pressure plus a seismic increment do exceed the recommended cantilever wall earth pressures for level backfill conditions, but the overall magnitude of the seismic earth pressures would be reduced because of the use of Geo Foam. For a level existing soil backfill condition, we estimate an additional seismic increment equal to $20H^2$ (resultant force), which will be applied as an additional triangular load, with the resultant force occurring at a distance ⅓ the height of the wall above the bottom is recommended in addition to the above at-rest earth pressures. For a level existing soil combined with Geo Foam backfill condition, we estimate an additional seismic increment

equal to $10H^2$ (resultant force), which will be applied as an additional triangular load, with the resultant force occurring at a distance ⅓ the height of the wall above the bottom is recommended in addition to the above at-rest earth pressures.

Footing-Type Deadman Anchor Recommendations

General

In our opinion, the proposed Deadman anchor system is feasible provided the recommendations in letter are considered in the design and construction of the retaining wall mitigation.

Isolated Deadman footings should bear on natural, undisturbed soil or engineered fill, be at least 18 inches wide, and extend at least 3 feet below the lowest adjacent grade. The closest edge of the Deadman footing should be at least 15 feet away from the back of the existing retaining wall unless reviewed by our office. The new Deadman footing excavations are not anticipated to extend past the northwest corner of the existing two-story classroom building; therefore, we do not anticipate the new excavations to extend parallel or below the plane of influence for the existing school building foundations. If the extent of the retaining wall will extend beyond the projected footprint of the existing two-story classroom building, we should be retained to provide further recommendations.

Lateral Capacity

Lateral loads exerted on the Deadman anchor footing may be resisted by passive pressures generated against footing sidewalls, and also by friction between the bottom of footing and the supporting subgrade. An ultimate passive pressure based on an equivalent fluid pressure of 350 pcf and an ultimate frictional resistance of 0.45 applied to the footing dead load may be used in design. The structural engineer should apply an appropriate factor of safety to the ultimate values above.

Deadman Footing Construction Considerations

The on-site soils are considered as OSHA Soil Type C soils and may not stand vertical even for shallow excavations. The contractor should be prepared to address this condition before excavation begins. Sloughing and or caving of the sandy soil is considered likely; therefore, we recommend that Stay-Form® or similar be placed within the footing excavations as they are excavated during construction of the Deadman foundation elements. If the footing sidewalls will not stand for even short periods of time, the side walls should be sloped and the footings will need to be formed. The contractor should anticipate side wall over-break or caving and additional concrete may be needed to cast the Deadman footing. Footing excavations should be filled as soon as possible or be kept moist until concrete placement to further reduce the potential for further sloughing. A Cornerstone representative should observe all footing excavations prior to placing reinforcing steel and concrete. If there is a significant schedule delay between our initial observation and concrete placement, we may need to re-observe the excavations.

Wall Drainage and Subdrain

Adequate drainage should be provided by a subdrain system behind the wall. This system should consist of a 4-inch minimum diameter perforated pipe placed near the base of the Geo Foam behind the wall (perforations placed downward). The pipe should be bedded and backfilled with Class 2 Permeable Material per Caltrans Standard Specifications, latest edition. The permeable backfill should extend at least 12 inches out from the wall and be at least 12 to 18 inches thick. Alternatively, ½-inch to ¾-inch crushed rock may be used in place of the Class 2 Permeable Material provided the crushed rock and pipe are enclosed in filter fabric, such as Mirafi 140N or approved equivalent. The upper 6 inches to 12 inches of wall backfill should consist of compacted on-site soil or planting soil. The subdrain outlet should be connected to a free-draining outlet or sump.

Wall Backfill Compaction and Geotechnical Construction Observation and Testing

Backfill placed behind the walls should be compacted to at least 90 percent relative compaction but not greater 93 percent using light compaction equipment. If heavy compaction equipment is used, the walls should be temporarily braced.

As site conditions may vary significantly between the small-diameter borings performed during this investigation, we also recommend that a Cornerstone representative be present to provide geotechnical observation and testing during earthwork and Dead Man construction. This will allow us to form an opinion and prepare a DSA 293 at the end of construction regarding contractor compliance with project plans and specifications, and with the recommendations in our report and supplemental letter. We will also be allowed to evaluate any conditions differing from those encountered during our investigation, and provide supplemental recommendations as necessary. For these reasons, the recommendations in this report are contingent of Cornerstone providing observation and testing during construction. Contractors should provide at least a 48-hour notice when scheduling our field personnel.

Closure

We hope this provides the information you need at this time. Recommendations presented in this letter have been prepared for the sole use of San Francisco Unified School District and their design consultants specifically for the property at 651 6th Avenue in San Francisco, California. Our professional services were performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices at this time and location. No warranties are either expressed or implied.

If you have any questions or need any additional information from us, please call and we will be glad to discuss them with you.

Sincerely,

Cornerstone Earth Group, Inc.

Scott E. Fitinghoff, P.E., G.E.
Senior Principal Engineer

Copies: Addressee (by email)