MILLER PACIFIC
ENGINEERING GROUP

September 11, 2015
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Alameda Unified School District
2060 Challenger Drive
Alameda, California 94501

Attention: Mr. Robbie Lyng, Director of Operations and Facilities

Re: Geotechnical Engineering Investigation
Reconstruction of Exterior Concrete Walkways for ADA Compliance
Bay Farm Elementary School Campus Modernization Project
200 Aughinbaugh Way
Alameda, California

Introduction

As authorized, Miller Pacific Engineering Group is providing geotechnical engineering services for the proposed campus modernization project at Bay Farm Elementary School, located at 200 Aughinbaugh Way in Alameda, California. The purpose of our services is to investigate the site geotechnical conditions in order to evaluate the liquefaction potential and settlement potential of the subject site, and provide recommendations for design measures to mitigate liquefaction and settlement risks, if determined to exist.

The site is located on the westerly side of Aughinbaugh Way, just north of Robert Davey Jr. Drive in Alameda, as shown on the Site Location Map, Figure 1. The project site is located in an area of nearly level to slightly sloping terrain. The proposed project (Phase 1) involves the reconstruction of various exterior walkways that have settled relative to adjacent buildings and are no longer ADA compliant.

As a part of our study, we reviewed a geotechnical report prepared by Kaldveer Associates, Inc. dated August 16, 1990 for the original Bay Farm School development. We also conducted five Cone Penetration Test probes and drilled two exploratory borings to further define the subsurface profile at the project site.

Site Development History

General: The Bay Farm Elementary School campus is situated on a large area of artificial landfill. This man-made fill consists of hydraulic fill composed of loose to dense, fine to medium grained sands and silty sands which extend to a depth of about 15 to 25 feet or more below the ground surface. The hydraulic sand fill was placed over a period of time, beginning in about 1966 and mostly completed by 1970. The hydraulic sand fill was placed over native very soft to soft, highly compressible silty clay marsh deposits (Bay Mud). The Bay Mud thickness beneath the project site varies between roughly 20 feet and 40 feet, and generally increases in thickness toward the northwest. Underlying the Bay Mud, alluvial soils consisting of medium dense to very dense silty sands were encountered, grading to very stiff silty clays. The groundwater level is approximately five feet beneath the ground surface, and would be expected to be influenced by tidal activity and rainfall.

Buried ships are located beneath portions of the site at a depth of about 24 to 34 feet. The ships were sunk at the site sometime prior to the placement of the hydraulic sand fill.

Bay Mud will consolidate when loaded by the placement of new fill and new buildings. This consolidation results in settlement of the ground surface above the new fills and is a slow process which takes several decades to complete, with the rate of surface settlement gradually decreasing over time. Greater surcharge loads (i.e., thicker fills) and thicker Bay Mud layers both increase the total magnitude of surface settlement and the time it takes for consolidation to be complete.

School Site Development: We reviewed original foundation and grading plans for the Bay Farm School site development in the early 1990's. These plans indicate approximately two to three feet of new fill was placed in 1991/1992 for the school site development. Foundation plans and details indicate that structures and structural pods are all supported on structural slabs in turn supported on deep driven pile foundations. The pile foundations extend through the fill and compressible Bay Mud to gain support in the stiff alluvial soil below. The result of this foundation system is that these structures and pods (pods include the small exterior walkways and courtyards within the pods) are not affected by surface settlement caused by consolidation of the Bay Mud and therefore have experienced essentially no settlement. At the same time, concrete flatwork and asphalt pavements that are supported directly on the ground surface or on shallow foundations in the sand fill are prone to settlement caused by ongoing consolidation of the Bay Mud, due to either the "Old" or "New" fill loads.

Settlement Analyses: Using the fill and Bay Mud thicknesses determined by our deep probes and based on information in the referenced Kaldveer report and using time frame estimates of old and new fill placement based on our research and review, we developed consolidation models for the site. Based on these models, we estimate that the placement of the "Old" and "New" fills would have generated approximately five and a half feet of total consolidation settlement where the Bay Mud thickness is 25 feet, and would have caused about seven and a half feet of settlement where the Bay Mud thickness is 40 feet. Where the Bay Mud thickness is 25 feet or less, the primary consolidation settlement from both the "Old" and "New" fill loads should be essentially complete at this time. Where the Bay Mud thickness is greater than 25 feet, some primary consolidation settlement may still be underway due to both "Old" and "New" fill loading. Where the Bay Mud thickness is 40 feet, up to approximately 2 to 4 inches of future primary consolidation settlement is expected over the next twenty to twenty five years.

In addition to primary consolidation settlement, secondary settlement also occurs as a result of placing fill or building loads on the soft Bay Mud. Secondary consolidation settlement is a much smaller magnitude than the primary consolidation settlement, but occurs over a much longer period of time. We estimate that an additional approximately one to three inches of secondary settlement will occur across the entire area of the school campus over the next twenty five to fifty years.

Liquefaction Analyses: Based on the Cone Penetration Testing we have conducted, the hydraulic sand fill beneath the campus is subject to liquefaction during a future seismic event. Liquefaction refers to the sudden, temporary loss of soil shear strength during strong ground shaking. Liquefaction-related phenomena include liquefaction-induced settlement, flow failure, and lateral spreading. These phenomena can occur where there are saturated, loose, granular deposits. Recent advances in liquefaction studies indicate that liquefaction can occur in granular materials with a high fines content (35 to 50% clayey and silty materials that pass the #200 sieve) provided the fines exhibit a plasticity less than 7. Granular layers with a potential for liquefaction were observed during our subsurface exploration.

To evaluate soil liquefaction, the seismic energy from an earthquake is compared with the ability of the soil to resist pore pressure generation. The earthquake energy is termed the cyclic stress ratio (CSR) and is a function of the maximum credible earthquake peak ground acceleration (PGA) and depth. The soil resistance to liquefaction is based on the relative density, and the amount and plasticity of the fines (silts and clays). The relative density of cohesionless soil is correlated with Cone Penetration Test data measured in the field.

We analyzed the potential for liquefaction utilizing the CPT Liquefaction Assessment software program CLiq (2007, ver 1.7.6.49), and the procedures outlined by Idriss and Boulanger (2014). The design seismic conditions consisted of a magnitude 7.3 earthquake producing a PGA of 0.51 g, which corresponds to the PGA_M per ASCE 7-10 Section 11.8.3. The results of our liquefaction analyses indicate the granular soil layer observed between roughly 10 to 25 feet below the ground surface classifies as liquefiable during the design seismic event. Therefore, we judge the risk of liquefaction at the site is moderate to high.

Based on procedures outlined by Idriss and Boulanger, 2014, the approximate 15-foot layer of potentially liquefiable soil observed 10-feet below the ground surface may experience 3 to 4-inches of post-liquefaction settlement. Due to the relatively shallow depth of the liquefiable layer, ground surface settlement would be expected.

Conclusions and Recommendations

The results of our study, as discussed above, indicate that the cause of observed differential elevations between exterior flatwork and buildings is a differential foundation condition between the two structure types. Site structures have deep foundation systems not prone to surface settlement caused by consolidation of the Bay Mud, while walkways and exterior flatwork are founded directly on the surface or on shallow foundations and therefore have experienced post construction settlement due to long term consolidation of the Bay Mud.

Based on our settlement analyses, in the case of no new loading (i.e., no new fill or structural loads), future surface settlement due to consolidation of the soft Bay Mud (under static conditions) is anticipated to be on the order of between two and seven inches over the next twenty five to fifty years, depending on the thickness of the Bay Mud at any given location. New loads, if applied, will trigger new settlement, the magnitude of which will depend on the magnitude of the new load.

In addition to consolidation settlement of the Bay Mud under static loading conditions, liquefaction induced settlement of approximately three to four inches is predicted in the event of a major earthquake.

Loading imposed by the placement of new fill in the development area will induce settlement in the soft clay layer beneath the site. Where walkways around the existing buildings will need to be raised by the placement of fill to re-establish a flush transition with the existing building floor elevation for ADA purposes, we recommend that a “no new load” design should be utilized. Light weight (lava rock) fill (approximately 65 pounds per cubic foot) can be used beneath fill areas to compensate for the new loads caused by raised elevations.

Site Preparation and Grading

The general grading recommendations presented below are appropriate for construction in the late spring through fall months. From winter through the early spring months, on-site near surface soils will likely be saturated by rainfall and will not be compactable without drying by aeration or the addition of lime (or a similar product) to dry the soils. Site preparation and grading should conform to the recommendations and criteria outlined below.

1. Surface Preparation – Clear all grass, roots, over-sized debris, and organic material from areas that will be within the new project work area. These "organic" soils will not be suitable for use as structural fill and should be removed from the site or stockpiled for use in landscape areas. Clear all structures, old concrete footings, walls, over-size debris, and organic matter from the site.

Any existing concrete foundations should be removed where they conflict with new grades and foundations. Old utility pipes should be removed and the resulting excavations properly backfilled with compacted soils. Any areas of loose soil observed during the site preparation need to be over-excavated down to firm soil and replaced with compacted fill.

Following clearing, stripping and required excavations, the exposed soils within the project area (extending to 5 feet beyond perimeter footings and 3 feet beyond exterior slabs or pavements) should be scarified to a depth of 8-inches; moisture conditioned to near optimum moisture content, and compacted to at least 90 percent relative compaction[1] (R.C.). In areas where new asphalt or concrete pavement will be installed and subject to vehicular loads, the upper 6-inches should be moisture conditioned to within 2 percent of the optimum moisture content and compacted to at least 95 percent R.C. Subgrades should be maintained at a moist condition up until final pavement, flatwork, or structures are constructed to prevent shrinkage cracks due to drying.

2. Compacted Fill – On-site fill, backfill, and scarified subgrades should be conditioned to within 3 percent of the optimum moisture content. Properly moisture conditioned and cured on-site materials should subsequently be placed in loose horizontal lifts of 8 inches thick or less, and uniformly compacted to at least 90 percent R.C. Fills greater than 5-feet in thickness should be further compacted to at least 92 percent R.C. Relative compaction, maximum dry density, and optimum moisture content of fill materials should be determined in accordance with ASTM Test Method D 1557, "Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using a 10-lb. Rammer and 18-in. Drop."

3. Materials – Most onsite soils appear suitable for use as fill (in areas where light weight fill is not required, such as utility trench backfill). If imported fill (normal weight) is required, the material shall consist of soil and rock mixtures that: (1) are free of organic material, (2) have a Liquid Limit less than 40 and a Plasticity Index of less than 15, and (3) have a maximum particle

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[1] Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density, as determined by laboratory test procedure (ASTM 1557).

size of 3 inches. Any imported fill material needs to be tested to determine its suitability for use as fill material.

4. Lightweight Fill – To reduce settlements, lightweight fill should be utilized in areas where site grades are raised. Lava rock, with a maximum unit weight of about 65 pounds per cubic foot or less, is probably the most practical lightweight fill material to utilize at the project site. Lava rock gradation should consist of ¾-inch to 1½-inch lava gravels. The lightweight fill should be placed in lifts no greater than 12 inches thick and statically compacted with a lightweight smooth drum compactor to the planned pad elevation.

Exterior Concrete Slabs-on-Grade

Where exterior concrete slabs or walkways are constructed, we recommend they be at least 6-inches thick and reinforced with steel bars (not wire mesh). Concrete slabs should be underlain by at least 6-inches of Caltrans Class 2 Aggregate Baserock compacted to at least 92 percent relative compaction. Additionally, contraction joints should be incorporated in the concrete slabs in both directions, no greater than 8 feet on center, and the reinforcing bars shall extend through the control joints. We recommend that concrete walkways should be doweled to the perimeter foundation of the building to minimize the risk that differential settlement at this connection will result in a vertical offset (tripping hazard). The Structural Engineer should provide the design details for concrete flatwork.

Consideration could be given to constructing new concrete walkway slabs so that they could be "releveled" periodically, as needed, by grouting beneath the slabs. In this case, slabs should be designed to structurally span and cantilever some distance. Slabs could be constructed with thickened edges that extend to a minimum depth of approximately 12 inches beneath the adjacent ground surface to provide confinement during future grouting/re-leveling operations.

We are pleased to have been of service to you. Please call us at your convenience if you have questions or need further assistance.

Very truly yours,
MILLER PACIFIC ENGINEERING GROUP

DRAFT

Daniel S. Caldwell
Geotechnical Engineer No. 2006
(Expires 9/30/17)