APPENDIX C

Geology of the San Francisquito Cone Area

Most studies in the San Mateo Plain have focused on the San Francisquito Cone. The first study was done in 1932 by Killingsworth and Hyde in response to drastically dropping water levels in wells in the area from Atherton to Palo Alto. Their goal was to identify the characteristics of the groundwater basin under San Francisquito Creek and to address the feasibility of water supply in the following years. Other than for the San Francisquito Cone, few studies have examined the northern part of the San Mateo Plain Basin.

Based on available well logs and field investigation, Killingsworth and Hyde identified two separate aquifers, one lower, and one upper, both composed of gravels, sands, and clays derived from the Santa Cruz Mountains. The lower aquifer (composed of "Santa Clara sands and gravels") used to be part of a larger alluvial fan that was connected to the alluvial deposits found in Portola Valley. This "old" alluvial fan was truncated by The San Andreas and Pulgas faults in the Pleistocene age.

The central block, between the San Andreas Fault and the Pulgas Fault, was uplifted in relation to the adjacent two blocks and consequently attacked by erosion. The old alluvial deposits on the central block were transported downhill toward the San Francisco Bay and were deposited unconformably on top of the old alluvial deposits east of the Pulgas Fault. These relatively younger alluvial deposits built the upper aquifer zone. The old alluvial deposits of Killingsworth and Hyde are differentiated in Pampeyan's (1993) geologic map of the Palo Alto and part of the Redwood Point quadrangles into the Santa Clara Formation of Pliocene and lower Pleistocene age and older alluvium of Pleistocene age.

The Holocene, upper Pleistocene, and Pleistocene alluvium are separated by a thick continuous clay layer that pinches out to the west. Helley and others (1979) referred to this clay layer as the Pleistocene Bay Mud, with an age ranging from 70,000 to 120,000 years (Figure 3). Along the Pulgas Fault, the sediments of the Santa Clara Formation are exposed at the surface due to upward dragging along the fault plain (Killingsworth and Hyde, 1932). There, gravels from the Santa Clara Formation are connected with the gravels and sands of the Quaternary alluvium and cannot be differentiated (Killingsworth and Hyde [1932]; Helley, et. al., [1979]).

Based on cross sections, Killingsworth and Hyde (1932) noticed that the gravels are thickest near the base of the foothills and extend in small streamers out under San Francisco Bay. These streamers range from 1 foot to greater than 20 feet in thickness (Erler and Kalinowski, 1993). Some of these streamers may extend as far north as the mouth on Redwood Creek (Poland and Garrett, 1943). Within the Holocene and late Pleistocene alluvium, Erler and Kalinowski (1993) identified two clearly distinguishable aquifer zones, a shallow "A" aquifer ranging between 5 and 36 feet below ground surface and a deeper "B" aquifer ranging from 34 to more than 60 feet below ground surface.

Killingsworth and Hyde (1932) identified Waverly Street in Palo Alto as an approximate northern limit of the area in which gravels predominate. Overall, the gravel strata have a definite dip to the north and if projected to the surface in their present attitude they would outcrop in the vicinity of Lagunita, at the Stanford Campus. Locally, the dipping may vary. Erler and Kalinowski (1993) noted that in the area of the Lincoln Willow property, the A aquifer zone appears to dip to the east.

Killingsworth and Hyde (1932) differentiated the clays described in the well logs and divided the field into two groups, the yellow clays and the blue clays. They described the yellow clays as merely the fine-grained material of the alluvial cone interbedded with the gravels and sands. This agrees with Helley and other's (1979) depositional model of alluvial deposits. The thickness of these clays is up to 50 feet

The blue clays, also known as bay muds, vary in lithology from a pebbly clay to a silty clay. In some places the blue clay has small subangular to sub-rounded pebbles of chert 0.25 to 1 inch in diameter (Killingsworth and Hyde, 1932; Erler Kalinowski, 1993) that are scattered throughout the formation, and there is occasional gradation of the clays into sandy clay. Root casts are common. With greater depth, root casts are less common and the clays become mottled with light-brown, rusted colored, or light gray material. These color changes reflect the development of a soil profile. The bay muds thin out to the west and interfinger with the yellow clays. Close to the San Francisco Bay, they build the aquitard between the lower and the upper aquifer zones. They are also found under the lower aquifer, starting at depths of 320 feet and continuing to 500 feet.

The interfingering of the bay muds with the yellow clays has only been observed to a depth of 450 feet. No one has penetrated this blue clay deep enough to determine whether gravels underlie it, but as reported by various drillers, it is encountered much closer to the surface in the greater part of the Atherton district.

As in many alluvial fans, the San Francisquito Cone contains both unconfined and confined aquifers. Before pumping in the region began, three water-level phenomena were observed: an unconfined surficial water-bearing zone, an upper confined aquifer, and a lower confined aquifer. All three water-bearing zones were saturated, and the water level in the upper and lower aquifers most likely coincided.

The water surface in both the upper and lower water aquifers gently sloped toward the Bay. By 1932 the groundwater flow direction had been reversed from the San Francisco Bay inland, and different water levels could be noticed for the upper and the lower aquifers. The water level in the upper aquifer was above mean sea level, while in the lower aquifer it ranged between –45 and –60 feet mean sea level. Killingsworth and Hyde estimated that 7,218 acre-feet of water had been extracted in the area during the water year 1930 to 1931.

Erler and Kalinowski (1993) determined the general groundwater gradient for the area close to Willow Road and Bayfront Expressway to be to the northwest and to range from 0.0015 feet per foot to 0.028 feet per foot. They estimated the transmissivity and the hydraulic conductivity for the channel deposits to be 28,000 to 70,000 gallons per day/ft. and 1.65×10^{-1} to 4.27×10^{-1} centimeters per second, respectively. For the fine-grained material, the transmissivity was estimated to be 300 gallons per day per foot. and the hydraulic conductivity to be 1.48×10^{-2} centimeters per second. The groundwater flow in the A zone ranges from 2 to 10 feet per day.