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TECHNICAL MEMORANDUM

Draft Report of Observations of 24-in Pile Installation, Project Location No. 31
Millennium Tower Perimeter Pile Upgrade
San Francisco, California
DBA Project No. 21-152

To: Neville Pereira
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Date: 23 November 2021

1.0 Introduction

This Draft Technical Memorandum (TM) reports observations and opinions of Dan Brown and Associates, PC (DBA) regarding drilling of the 24-in diameter pile at project location No. 31 by Shimmick/Legacy Foundations (Shimmick) on 15-17 Nov. 2021. The 24-in pile, referred to as Perimeter Pile 31 (PP31), was installed following the revised document "Casing/Pile Installation Procedure Pilot Program" dated 10 Nov. 2021, referred to herein as the "Supplemental Procedures".

Observations described in this TM were made by Dr. Benjamin Turner of DBA. All drilling activities described herein were performed by Shimmick personnel, with assistance from representatives of Center Rock, Inc., the reverse circulation drill manufacturer. Surveying and vibration monitoring were performed by others and are not described herein.

As specified by the Supplemental Procedures, a log of the drilling progress was maintained by personnel from Shimmick and Slate Geotechnical. The observations recorded by Slate Geotechnical included drilling penetration rates for each foot of advancement.

2.0 Drilling Summary

The 24-in piles are being installed by Shimmick using a reverse circulation drill (RCD) mounted to a Liebherr HS 8130 crane with a Berminghammer lead system. An approximately 2-ft tall piece of 36-in casing had been welded to the top of the previously installed 36-in casing at location No. 31, and a casing clamp used to hold the 24-in casing straddled this protruding section of 36-in casing. Prior to the start of drilling on Nov. 15, Shimmick had spliced three 24-in diameter casing segments and assembled them with the RCD and drill string and lowered the assembly approximately 82 ft into the 36-in casing. Based on measurements taken by Shimmick prior to lowering the drill into the hole, approximately 16 ft of sediment had accumulated on top of the 6-ft soil plug that remained inside the 36-in casing.

At the start of drilling, the drill advanced through the upper 16 ft of sediment in approximately 2 minutes. Drilling then proceeded in approximately 40 ft increments corresponding to the length of the casing segments. The drilling penetration rates ranged from approximately 0.1 ft/min to 9 ft/min, with an average of 1 ft/min; these rates only include drilling time and do not include stops for procedures related to casing splices or time between shifts. The cumulative drilling time was approximately 3.7 hours.

As has been observed on the previous 24-in pile installations documented by Slate Geotechnical, drilling rates correlated to material type. Drilling progressed at a relatively consistent rate of about 1 ft/min through the Old Bay Clay (OBC), then began to vary through the transition zone between OBC and the predominantly-granular Alameda Formation that was encountered between depths of 175 ft to 190 ft. Below a depth of 190 ft, drilling rates in the Alameda Formation were highest through zones of "clean" sand and gravel that had the lowest fine-grained soil content, and slower in the zones of sandy clay. Franciscan Formation bedrock was encountered at a depth of approximately 255 ft, after which drilling progressed at a relatively consistent rate of about 0.5 ft/min to the final drilled casing depth of 282.3 ft. After lifting the drill off the base of the excavation, the casing was pushed down by approximately 11 inches using crowd from the rig; this reflects the distance that the drill head protrudes in front of the casing when operating. The drill was then lowered close to the base of the excavation and reverse circulation of pressurized air was used to clean spoils from the base of the hole.

Air pressure and water pressure/flow were controlled from an air manifold system which was monitored during drilling by representatives of Center Rock, Inc. During drilling, air pressure varied from approximately 190 psi to 220 psi, water pressure varied from approximately 200 psi to 240 psi, and the water flow rate was approximately 20 gpm. These values represent observations by DBA; a detailed log was maintained by Shimmick personnel.

Measurements of the depth to top of soil plug/sediment were attempted between installation of each casing segment, however, the weighted tape measure was generally obstructed by the plastic centralizers used to keep the 24-in pipe centered in the 36-in casing. The casing clamp only had one small opening through which the weighted tape could be lowered. Likewise, it was not feasible to observe through this small opening if air bubbles were rising between the 24-in and 36-in casings during drilling, primarily due to safety concerns.

Apart from brief pauses (typically 30 seconds or less) to facilitate communication between Shimmick/Center Rock personnel, drilling for each 40-ft casing segment generally occurred in one continuous interval of drilling except for stops at two points: (1) when the casing lifting lugs ("ears") used to hoist the casing were about 10 ft above the casing clamp, drilling paused so the lugs could be cut off, and (2) when the top of a casing segment was within a few feet of the casing clamp, drilling stopped so the next casing segment could be spliced. During each of these stops, the operator lifted the drill approximately 1 ft off the base of the excavation (*i.e.*, by withdrawing the drill string up into the 24-in casing) and air continued to be circulated through the face of the tool and up the return line at approximately 200 psi. It is necessary to keep circulating air through the drill in order to continue flushing remaining spoils up and out of the return line; if the air pressure were to be abruptly stopped, the spoils would fall out of suspension and could cause clogging of the drill upon restarting. This is notable because of the potential for the drill to unintentionally "mine" soil during these intervals when air is circulating but downward drilling progress is not occurring. The greatest potential for unintentional mining would be in clean sand layers such as were encountered near the base of the Alameda Formation.

3.0 Grout Pour

DBA did not observe the grout pour of PP31 that took place on Nov. 19. However, we reviewed the preliminary grout pour log recorded by Slate Geotechnical. The pour log indicates that partway through pouring from the fourth grout truck, while the 24-in casing was being lifted such that the casing tip passed through the depth interval of approximately 260 ft to 256 ft below the top of guide wall, the grout level dropped from 19 ft to 37 ft below the top of guide wall. As grout pumping

continued and the casing was withdrawn to the final tip depth of 243 ft, the grout level continued to drop to a low point of 67 ft below the top of guide wall before beginning to rise again. In total, the grout level dropped 48 ft over a period of about 30 minutes, corresponding to about 5 yd^3 of grout loss plus the additional volume that was pumped during this time.

Drilling records indicate that the material encountered over the depth interval from 243 ft to 260 ft below top of guide wall includes sand and gravel layers of the Alameda Formation. The bottom of this interval, between depths of 255 ft and 260 ft, may represent the weathered surface of Franciscan Formation bedrock. Drilling was temporarily stopped at a depth of 259.7 ft below top of guide wall to cut the casing lifting lugs.

4.0 Discussion

Drilling of 24-in PP31 was performed in general accordance with the Supplemental Procedures. Based on DBA observations, Shimmick and Center Rock personnel were attentive to drilling rates and made adjustments as necessary to maintain downward drilling progress.

From discussions with Shimmick personnel, we understand that Shimmick is aware of the potential for unintentional mining during intervals of air circulation without drilling and proactively seeks to avoid it by (a) lifting the drill off the base of the excavation and (b) through monitoring of the return discharge to ensure the volume of spoils gradually decreases, as opposed to discharging at a constant rate which could indicate unintentional mining. For 24-in PP31, during each of the intervals while air continued to be circulated to facilitate cutting off lifting lugs and splicing, spoils discharge did eventually stop. Nonetheless, it is not possible to know if some amount of unintentional mining may have occurred in the clean granular zones of the Alameda Formation.

The observed grout loss during the pour could be the result of grout penetrating permeable zones of weathered/fractured rock or layers of sand and gravel with low fines content in the Alameda Formation. Alternatively, some of the grout loss could represent grout filling a zone where drilling overbreak occurred. We note that the grout pour logs for PP9 and PP16 also indicate grout loss as the casing was withdrawn through similar depth increments. Similarly, results of thermal integrity profiling performed on Indicator Pile No. 2 indicate an enlarged pile section immediately below the 24-in casing final tip depth.