LIMITED GEOTECHNICAL EVALUATION
ALAMEDA CRANE RELOCATION
OFFSHORE OF 2900 MAIN STREET
ALAMEDA, CALIFORNIA

PREPARED FOR:
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November 9, 2010
Project No. 401680001

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Mr. Vincent Wu
Baseline Engineering
1504 Park Street, Suite 8
Oakland, California 94501

Subject: Limited Geotechnical Evaluation
Alameda Crane Relocation
Offshore of 2900 Main Street
Alameda, California

Dear Mr. Wu:

In accordance with your authorization, we have performed a limited geotechnical evaluation for the proposed Alameda Crane Relocation project near 2900 Main Street in Alameda, California. This report presents our preliminary geotechnical findings and conclusions regarding the proposed project.

We appreciate the opportunity to be of service on this project.

Sincerely,
NINYO & MOORE

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1. INTRODUCTION

In accordance with your authorization, we have performed a limited geotechnical evaluation for the proposed Alameda Crane Relocation project near 2900 Main Street in Alameda, California (Figure 1). The purpose of this limited geotechnical evaluation is to provide an assessment of the site conditions for the potential crane relocation sites with preliminary recommendations for seismic design parameters for use in initial planning studies. This report presents our preliminary geotechnical findings and conclusions for the proposed project.

Prior to preparation of design documents, Ninyo & Moore should perform a geotechnical evaluation with subsurface exploration to prepare recommendations for the design and construction of the project.

2. SCOPE OF SERVICES

Ninyo & Moore's scope of services for this phase of the project included the review of pertinent background data, performance of a geotechnical reconnaissance, and the preliminary evaluation of seismic design parameters for the proposed construction. Specifically, we performed the following tasks:

- Review of readily available background materials, including information provided by Baseline Engineering, topographic maps, available geologic and seismic hazard maps, and aerial photographs to perform a qualitative evaluation of the geologic and seismic hazards.
- Conduct a geotechnical site reconnaissance to evaluate the general site conditions and the condition of the historic crane and adjacent improvements.
- Provide a preliminary recommendations for seismic design parameters per the 2007 California Building Code (CBC)
- Preparation of this limited geotechnical evaluation report presenting our preliminary geotechnical findings and conclusions for the proposed project.

3. SITE DESCRIPTION

The existing Alameda crane is located at Pier 5 in the Oakland Inner Harbor Channel, approximately 100 feet offshore and near 2900 Main Street in Alameda, California (Figure 1). The steel

crane structure is mounted on a rail system that is aligned approximately east-west and is supported by concrete piers. The crane is currently located at the east terminus of the rail system. To the east of the rail system is a shop building and dock that are supported on piers. The Alameda Ferry Terminal walkway crosses over the rail structure less than 100 feet west of the crane and connects the ferry dock to the parking lot area located onshore to the south. Drydock facilities operated by "Bay Ship and Yacht" and a warehouse occupied by "Rosenblum Cellars" are situated to the east of the Alameda Ferry Terminal parking lot.

During our site reconnaissance, we did not observe evidence of significant distress to the concrete pier foundations at the existing crane location.

4. AERIAL PHOTOGRAPH REVIEW

Historic aerial photographs available from Google Earth (2010) and dating from 1993 to 2010 were reviewed. The photograph from 1993 showed the crane rail system, and shop building and dock to the east, had been developed, but the location of the crane was unclear. The rail system seemed to extend farther to the west than its current terminus. Onshore, the Ferry Terminal and parking lot to the south had also been developed. The adjacent areas to the east and west were undeveloped. The photograph from 2000 showed little change at the existing crane site; however, the westernmost portion of the rail system was no longer present (matching the current extent). Also, the Ferry Terminal parking lot had been expanded to the west. The photograph from 2002 showed little change other than further development at the westward expansion of the Ferry Terminal parking lot. A photograph from 2004 showed that a parking lot had been constructed on the property to the east of the Ferry Terminal property; while a photograph from 2007 showed that a building had been constructed on this property. Photographs from 2008, 2009, and 2010 showed little observable change. Evidence of geologic hazards was not observed during our review of these aerial photographs.

5. PROJECT DESCRIPTION

The proposed project consists of relocating the existing crane to one of two potential relocation sites nearby. We understand the relocation will be undertaken to preserve the crane structure for historical purposes.

Based on the information provided, the first relocation site, which we refer to as "Site A", is located offshore at the west end of the Pier 5 rail system at approximately 37.7907° latitude and -122.2963° longitude. This potential site is approximately 750 feet west of the current crane location (along the same rail system; Figure 1). During our site reconnaissance, we did not observe significant distress to the visible portions of the concrete pier foundations at this location.

The second relocation site, referred to as "Site B", is located onshore near the northeast corner of the Alameda Ferry Terminal parking lot. This potential relocation site is relatively flat with an elevation of about 12 feet above Mean Sea Level (Google Earth, 2010) and is bounded to the north by the Oakland Inner Harbor Channel, to the west by the ferry terminal parking lot, and to the south and east by "Bay Ship and Yacht" facilities (Figure 1). The western portion of this area is paved with concrete. The eastern portion is landscaped with grasses, shrubs and trees. A gravel walkway, aligned east-west, extends through this area. The channel bank to the north of the relocation site is covered with rip-rap and sloped at about 3:1 (horizontal to vertical).

6. GEOLOGY AND SUBSURFACE CONDITIONS

Our findings regarding regional and site geology and groundwater conditions at the subject site are provided in the following sections.

6.1. Regional Geologic Setting

The site is located on the east side of San Francisco Bay in the Coast Ranges geomorphic province of California. The Coast Ranges are comprised of several mountain ranges and structural valleys formed by tectonic processes commonly found around the Circum-Pacific belt. Basement rocks have been sheared, faulted, metamorphosed, and uplifted, and are separated by thick blankets of Cretaceous and Cenozoic sediments that fill structural valleys and

line continental margins. The San Francisco Bay area has several ranges that trend northwest-southeast, parallel to major strike-slip faults such as the San Andreas, Hayward, and Calaveras Faults. Major tectonic activity associated with these and other faults within this regional tectonic framework consists primarily of right-lateral, strike-slip movement. Further discussion of faulting relative to the site is provided in the Section 7.1.1 of this report.

6.2. Site Geology

The subject site is mapped as being underlain by recent artificial fill by California Geological Survey (CGS, 2003a), Graymer (2000), Radbruch and Case (1967), and Radbruch (1959). Graymer (2000) indicates that the artificial fill consists of various materials and ages, and that some are compacted and quite firm; but the fills placed before 1965 are not well compacted and consist simply of dumped materials. Radbruch (1957) indicates that the majority of fill along the east shore of the San Francisco Bay consists of Merritt sand that has been dredged or pumped from offshore underwater borrow areas, but that in some areas it may consist of Bay Mud, material from the Temescal Formation, broken rock, or miscellaneous refuse. CGS (2003a) and Rogers and Figuers (1991) indicate that the artificial fill overlies Bay Mud; and Radbruch (1957) indicates that the artificial fill overlies Bay Mud in most places.

Radbruch (1957) describes Bay Mud as olive-gray clayey or sandy silt with small lenses of sand that contains shells and organic material that in some cases is abundant enough to form layers of peat. The Bay Mud strata is soft and fluid at shallow depths and is increasingly consolidated with depth. California Division of Mines and Geology (CDMG, 1969) and McDonald et al. (1978) indicate that the thickness of the Bay Mud in the project area is between 0 and 20 feet. Rogers and Figuers (1991) indicate that the elevation of the base of the Bay Mud is between about -25 to -50 feet MSL in the project area.

A Regional Geologic Map, taken from Graymer (2000), is provided as Figure 2.

6.3. Groundwater

The CGS Seismic Hazard Zone Report (CGS, 2003a) indicates that the depth to historic high groundwater in the vicinity of relocation site "B" to be less than 5 feet below the ground surface. Relocation site "A" is in an offshore area and, therefore, the soils should be considered saturated.

The depth to groundwater within the limits of the study area is subject to variations from seasonal precipitation, tidal variation, subsurface conditions, topography, and other factors.

7. GEOLOGIC HAZARDS AND GEOTECHNICAL ISSUES

This study considered a number of potential issues relevant to the proposed project, including seismic hazards, slope stability, compressible soils and static settlement, corrosive soils, and expansive soils. These issues are discussed in the following subsections.

7.1. Seismic Hazards

The site is located in a seismically active region. The seismic hazards considered in this study include the potential for surface ground rupture, ground shaking due to seismic activity, liquefaction and dynamic settlement, lateral spreading, and seismic slope stability. These potential hazards are discussed in the following subsections.

7.1.1. Faulting and Ground Surface Rupture

The numerous faults in northern California include active, potentially active, and inactive faults. As defined by the CGS, active faults are faults that have ruptured within Holocene time, or within approximately the last 11,000 years. Potentially active faults are those that show evidence of movement during Quaternary time (approximately the last 1,600,000 years) but for which evidence of Holocene movement has not been established. Inactive faults do not show evidence of movement within Quaternary time.

The site is not located within an Alquist-Priolo Fault Rupture Hazard Zone established by the state geologist (California Division of Mines and Geology [CDMG], 1982) to

delineate regions of potential ground surface rupture adjacent to active faults. The closest known active fault is the Hayward fault located approximately 5.1 miles east of site "A" and approximately 5.2 miles east of site "B". Major known active faults in the region consist generally of en-echelon, northwest-striking, right-lateral, strike-slip faults. These include the San Andreas Fault, located west of the site, and the Hayward and Calaveras faults, located east of the site.

Based on our review of the referenced geologic maps, it is our opinion that the project site is not underlain by known active or potentially active faults (i.e., faults that exhibit evidence of ground displacement in the last 11,000 years and 1,600,000 years, respectively). Therefore, the potential for ground surface rupture due to faulting at the site is considered low. However, lurching or cracking of the ground surface as a result of nearby seismic events is possible.

7.1.2. Ground Shaking

The 2007 California Building Code (CBC) recommends that the design of structures be based on the horizontal peak ground acceleration (PGA) having a 2 percent probability of exceedance in 50 years which is defined as the Maximum Considered Earthquake (MCE). The statistical return period for PGA_{MCE} is approximately 2,475 years. The probabilistic PGA_{MCE} for both potential relocation sites was calculated as 0.54 g using the United States Geological Survey (USGS, 2010) ground motion calculator (web-based). The design PGA was estimated to be 0.36 g using the USGS ground motion calculator.

Structures can be designed in accordance with relevant codes to mitigate the impact of ground shaking.

7.1.3. Liquefaction and Dynamic Settlement

The strong vibratory motions generated by earthquakes can trigger a rapid loss of shear strength in saturated, loose, granular, or fine-grained soils of low plasticity (liquefaction) or in wet, sensitive, cohesive soils (strain softening). Liquefaction and strain

softening can result in a loss of foundation bearing capacity or lateral spreading of sloping or unconfined ground. Liquefaction can also generate sand boils leading to subsidence at the ground surface. Liquefaction (or strain softening) is generally not a concern at depths more than 50 feet below ground surface. The strong vibratory motion associated with earthquakes can also dynamically compact loose granular soil leading to surficial settlements. Dynamic settlement is not limited to the near-surface environment and may occur in both dry and saturated sand and silt. Cohesive soils are not typically susceptible to dynamic settlement.

The potential crane relocation sites are located within, or offshore of, a liquefaction hazard zone on the Map of Seismic Hazard Zones (Figure 3) prepared by the CGS (CGS, 2003b). Knudsen et al. (2000) conducted a study to map the potential for liquefaction in the San Francisco Bay Area based on geologic unit (type and age of deposit) and ground water level. The map produced by this study indicates that the project site is within or near an area mapped as having a very high susceptibility to liquefaction. As such, there is a potential for liquefaction and dynamic settlement within the study area following a significant seismic event.

Mitigation measures for liquefaction include designing structures to accommodate liquefaction-induced strength loss; supporting structures on deep foundations, such as driven piles or drilled piers; and/or ground improvement by compaction grouting, deep soil mixing, stone columns, or vibroflotation. Mitigation measures for dynamic settlement include supporting structures on deep foundations, such as driven piles or drilled piers, or ground improvement by compaction grouting, deep soil mixing, stone columns, vibroflotation, or remedial grading.

7.1.4. Lateral Spread

In addition to vertical displacements, seismic ground shaking can induce horizontal displacements as surficial soil deposits spread laterally by floating atop liquefied subsurface layers. Lateral spread can occur on sloping ground or on flat ground adjacent

to an exposed face. Lateral spreading has generally been observed to take place in the direction of a free-face (e.g., a retaining wall or slope).

In the study area, free-facing slopes and exposed faces that are underlain by potentially liquefiable soils are present along the channel bank. Therefore, there is a potential for lateral spreading in the study area.

Mitigation measures for lateral spreading include ground improvement by compaction grouting, deep soil mixing, stone columns, or vibroflotation.

7.1.5. Seismic Slope Stability

As discussed previously, slopes are present in the study area along the channel bank. The study area is not located within a landslide hazard zone on the map of Seismic Hazard Zones (Figure 3) prepared by the California Geological Survey (CGS, 2003b). As such, it is our opinion that seismic slope stability in the study area is not a design consideration.

7.2. Slope Stability

As discussed previously, slopes are present in the study area along the channel bank. Roberts et al. (1999) do not indicate landslides within the study area. Wentworth et al. (1997) indicate that the study area is an area with little or no potential for slope instability except along stream banks or terrace margins.

The slopes along the channel bank in the study area are relatively gentle and are covered with rip-rap. We did not observe indications of instability on these slopes during our site reconnaissance. In addition, we understand that the proposed project does not include the grading of new slopes. As such, it is our opinion that slope instability is not a design consideration for the proposed project.

7.3. Compressible Soils and Static Settlement

Geologic maps (CDMG, 1969; Radbruch, 1959) indicate that the study area may be underlain by loose fill and/or Bay Mud. These soils can be considered compressible and may result in ground settlement when subjected to new loads from structures or fill embankments.

Means to mitigate compressible soils include removal and recompaction (to improve their density), surcharging, compaction grouting, deep soil compaction, deep foundations, or foundations specially designed to tolerate the anticipated settlement.

7.4. Corrosive Soils

There is a potential for corrosive soils to be encountered in the study area. Natural Resources Conservation Service (NRCS) soil maps of the study area (NRCS, 2009) did not evaluate the corrosivity of the soils at the study area. However, Caltrans defines a corrosive environment as an area within 1,000 feet of brackish water (Caltrans, 2003). The study area is within 1,000 feet of brackish water. This should be taken into consideration for ferrous metals and concrete materials used on site.

Measures to mitigate the impact of corrosive soil can include removal and replacement with non-corrosive soil, use of cement resistant to sulfate attack, providing appropriate concrete cover over reinforcing steel, or use of epoxy coatings or cathodic protection for ferrous metals.

7.5. Expansive Soils

Some clay minerals undergo volume changes on wetting or drying. Unsaturated soils containing those minerals will shrink/swell with the removal/addition of water. The heaving pressures associated with this expansion can damage structures and flatwork. Soils in the study area that have relatively high clay contents may be expansive. As such, it is our opinion that mitigation of expansive soils could potentially be a design consideration.

Mitigation of expansive soils, if present at or near grade of new surface improvements sensitive to the action of expansive soils, could include removal and replacement with non-expansive soils, lime treatment, moisture conditioning, or utilization of special foundations.

8. CONCLUSIONS

Based on the results of our limited geotechnical evaluation, it is our opinion that several geologic hazards may potentially impact the proposed crane relocation project. In general, the geologic hazards found to be potential design considerations can be mitigated. Further study is needed to evaluate the impact of these potential design considerations and to provide appropriate recommendations for mitigation, if needed. The following geologic hazards were found to be potential design considerations:

- The study area could experience a relatively large degree of ground shaking during a significant earthquake on a nearby fault.
- Liquefiable soils may be present within the study area.
- Seismically induced dynamic settlement may occur within the study area following a significant seismic event.
- There is a potential for lateral spreading in the study area, particularly at the slopes along the channel bank.
- Expansive soils may be present in the study area.
- Geologic maps indicate that compressible soils (Bay Mud and loose, uncompacted fill) may be present in the study area. Loads imposed by surface improvements or new embankments may result in ground settlement.
- The study area is located within 1,000 feet of brackish water, which is considered to be a corrosive environment. In addition, there is a potential for corrosive soils to be encountered in the study area.

9. PRELIMINARY RECOMMENDATIONS FOR SEISMIC DESIGN CRITERIA

Table 1 presents the seismic design parameters for the site in accordance with CBC (2007) guidelines and mapped spectral acceleration parameters (USGS, 2010) based upon our prelimi-

nary evaluation of site classification. These parameters may be used for the purposes of a preliminary study presuming that the fundamental period of the crane structure does not exceed 0.5 seconds. The site classification and corresponding seismic design parameters should be re-evaluated after subsurface exploration is performed.

Table 1 – 2007 California Building Code Seismic Design Criteria

Seismic Design Factors	Value
Site Class	E
Site Coefficient, F_a	0.9
Site Coefficient, F_v	2.4
Mapped Spectral Acceleration at 0.2-second Period, S_s	1.500 g
Mapped Spectral Acceleration at 1.0-second Period, S_1	0.600 g
Spectral Acceleration at 0.2-second Period Adjusted for Site Class, S_{MS}	1.350 g
Spectral Acceleration at 1.0-second Period Adjusted for Site Class, S_{M1}	1.440 g
Design Spectral Response Acceleration at 0.2-second Period, S_{DS}	0.900 g
Design Spectral Response Acceleration at 1.0-second Period, S_{D1}	0.960 g

10. LIMITATIONS

The field evaluation and geotechnical analyses presented in this report have been conducted in accordance with current engineering practice and the standard of care exercised by reputable geotechnical consultants performing similar tasks in this area. No warranty, implied or expressed, is made regarding the conclusions, recommendations, and professional opinions expressed in this report. Variations may exist and conditions not observed or described in this report may be encountered. Our preliminary conclusions are based on an analysis of the observed conditions and the referenced background information.

The purpose of this study was to evaluate geologic hazards and geotechnical conditions within the project site and to provide preliminary seismic design criteria for use in initial planning studies. The report is not intended for design or construction purposes. A more detailed geotechnical and geologic evaluation, including site reconnaissance, subsurface exploration, and laboratory testing, should be performed for the selected site prior to design and construction of the proposed project.

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REFERENCE: GOOGLE EARTH, 2010.

N

SCALE IN FEET

0 300 600

NOTE: ALL DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

Ninyo & Moore		SITE LOCATION	FIGURE
PROJECT NO.	DATE	ALAMEDA CRANE RELOCATION OFFSHORE OF 2900 MAIN STREET ALAMEDA, CALIFORNIA	1
401680001	11/10		

REFERENCE: GRAYMER, R.W. ET. AL, 2000, GEOLOGIC MAP AND MAP DATABASE OF THE OAKLAND METROPOLITAN AREA, ALAMEDA, CONTRA COSTA AND SAN FRANCISCO COUNTIES, CALIFORNIA, UNITED STATES GEOLOGICAL SURVEY, MF-2342, SCALE 1:50,000.

N

SCALE IN FEET

0 2500 5000

NOTE: ALL DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

LEGEND

af	Artificial fill (Historic)
Qds	Dune sand (Holocene and Pleistocene)
Qmt	Marine terrace deposits (Pleistocene)
Qms	Merrit sand (Holocene and Pleistocene)
- - - - -	Geologic Contact

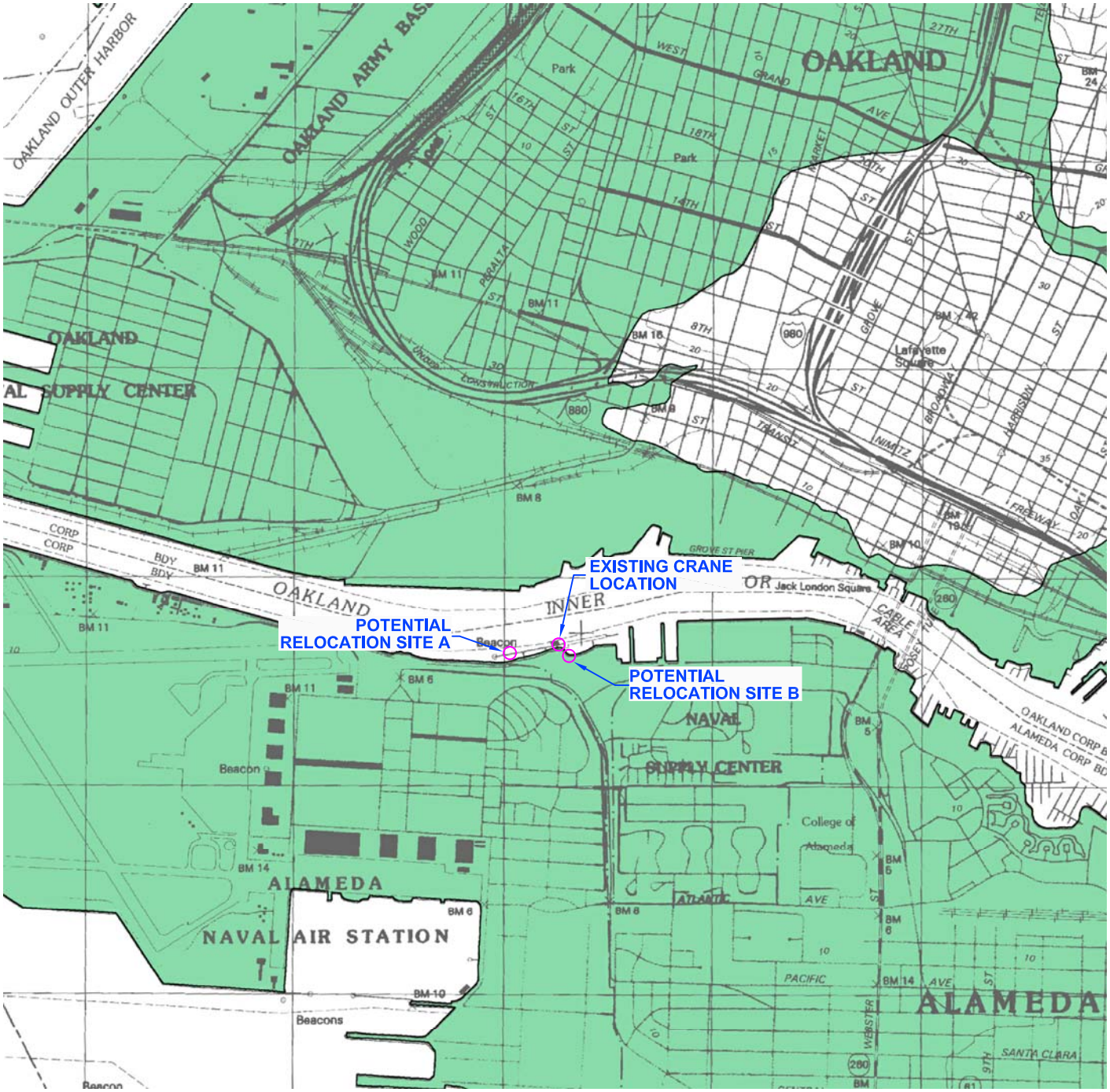
Ninyo & Moore

REGIONAL GEOLOGY

FIGURE 2

PROJECT NO.	DATE
401680001	11/10

ALAMEDA CRANE RELOCATION
OFFSHORE OF 2900 MAIN STREET
ALAMEDA, CALIFORNIA



REFERENCE: CALIFORNIA GEOLOGICAL SURVEY, 2003, SIESMIC HAZARD ZONES,OAKLAND WEST QUADRANGLE, SCALE 1:24000.

N

SCALE IN FEET

0 2500 5000

NOTE: ALL DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

SEISMIC HAZARDS

LIQUEFACTION

AREAS WHERE HISTORICAL OCCURRENCE OF LIQUEFACTION, OR LOCAL GEOLOGICAL, GEOTECHNICAL AND GROUNDWATER CONDITIONS INDICATE A POTENTIAL FOR PERMANENT GROUND DISPLACEMENTS SUCH THAT MITIGATION AS DEFINED IN PUBLIC RESOURCES CODE SECTION 2693(c) WOULD BE REQUIRED.

EARTHQUAKE-INDUCED LANDSLIDES

AREAS WHERE PREVIOUS OCCURRENCE OF LANDSLIDE MOVEMENT, OR LOCAL TOPOGRAPHIC, GEOLOGICAL, GEOTECHNICAL AND SUBSURFACE WATER CONDITIONS INDICATE A POTENTIAL FOR PERMANENT GROUND DISPLACEMENTS SUCH THAT MITIGATION AS DEFINED IN PUBLIC RESOURCES CODE SECTION 2696(c) WOULD BE REQUIRED.

Ninyo & Moore		SEISMIC HAZARD ZONES	FIGURE
PROJECT NUMBER	DATE	ALAMEDA CRANE RELOCATION OFFSHORE OF 2900 MAIN STREET ALAMEDA, CALIFORNIA	3
401680001	11/10		