APPENDIX 2G

Geologic and Foundation Design Criteria

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2G.1 Introduction

This appendix includes a summary of geotechnical aspects for the project to support the Application for Certification (AFC). This summary is based on information from previous site investigations. Pertinent site-specific geotechnical information and data is presented in Appendix 5.4A.

Section 5.4 Geologic Hazards and Resources and Appendix 5.4A contain a description of the site conditions and preliminary foundation-related subsurface conditions. Soil-related hazards addressed include soil liquefaction, seismic and geological data, and construction considerations. Preliminary foundation and earthwork considerations are addressed based on existing information and established geotechnical engineering practices.

Information contained in this appendix reflects the codes, standards, criteria, and practices that will be used in the design and construction of site and foundation engineering systems for the facility. More specific project information will be developed during execution of the project to support detailed design, engineering, material procurement specification and construction specifications. This information will be included in a final geotechnical engineering report later in the final design phase.

2G.2 Scope of Work

The scope of geotechnical services for the preparation of this appendix included an assessment of soils-related hazards, a summary of preliminary foundation and earthwork considerations, and preliminary guidelines for inspection and monitoring of geotechnical aspects of construction based on available published data as analyzed in Subsection 5.4 of this AFC.

2G.3 Site Conditions

The project site is approximately 10 acres. The site is where previous fuel oil storage tanks Nos. 5, 6 and 7 were located. It is a relatively flat and cleared site (approximate elevation 29 feet) within the bermed area of the previous tank area (top of existing berm is approximately EL 55). The site will drain to three existing pumped sumps which discharge stormwater via the existing plant system into Agua Hedionda Lagoon. The historic high groundwater level at approximately 25 feet below existing grade will not be a concern for the construction of these foundations.

2G.4 Site Subsurface Conditions

2G.4.1 Stratigraphy

The stratigraphy is shown in Appendix 5.4A (Geotechnical Boring Logs). Additional borings will be performed at the project site to verify the soil consistency and characteristics during the Final Report phase.

2G.4.2 Seismicity / Ground-Shaking

The project site is subject to the probability of seismic activities. The nearest fault system is located approximately 4.3 miles from the project site. Maximum credible earthquake is 6.9 Per the California Building Code (CBC), the site is located in Seismic Zone 4.

The project site is susceptible to ground-shaking during major earthquakes from the Rose Canyon Fault, Newport-Inglewood Fault, Coronado Bank Fault, Elsinore Fault, and San Jacinto Fault. The seismic risk to structures depends upon the distance to the epicenter; the characteristics of the earthquake, the geologic, groundwater, and soil conditions underlying the structures and their vicinity. Due to the site distance from the above faults and the subsurface conditions, maximum horizontal ground acceleration is expected to be on the order of about 0.32g. The design ground motion earthquake is estimated to have a peak horizontal ground acceleration of 0.28g.

2G.4.3 Ground Rupture

Ruptures along the surface trace of a fault tend to occur along lines of previous faulting. There is no evidence of potentially active fault trace at the nearby site; and thus the primary hazard of surface rupture at the project site is expected to be negligible. However, a ground rupture study at the project site will be performed as part of the final geotechnical investigation in order to verify this assumption.

2G.4.4 Liquefaction Potential

Soil liquefaction is a phenomenon in which saturated cohesionless soils are subject to a temporary but essentially total loss of shear strength under the reversing cyclic shear stresses associated with earthquakes. Based on the anticipated relative density of the cohesionless sediments near the project site, it is expected that the potential for liquefaction is low. Liquefaction-induced settlements are expected to be limited and will be defined in the final design phase.

2G.4.5 Groundwater

The historical high groundwater level is about 25 feet below the ground surface based on drilling of previous borings. The groundwater elevation will be confirmed during the final geotechnical investigation.

2G.5 Assessment of Soil-Related Hazards

2G.5.1 Liquefaction

Soil liquefaction is a process by which loose, saturated, granular deposits lose a significant portion of their shear strength due to pore water pressure buildup resulting from cyclic loading, such as that caused by an earthquake. Soil liquefaction can lead to foundation bearing failures and excessive settlements when:

- The design ground acceleration is estimated at 0.28g
- The groundwater level is within the underlying very dense to hard sediment

The results of the subsurface investigation at the adjacent site indicate low potential for liquefaction.

2G.5.2 Expansive Soils

Soil expansion is a phenomenon by which clayey soils expand in volume as a result of an increase in moisture content, and shrink in volume upon drying. Expansive soils are usually identified with index tests, such as percentage of clay particles and liquid limit. It is generally accepted that soils with liquid limits larger than about 50 percent, i.e., soils that classify as high plasticity clays (CH) or high plasticity silts (MH), may be susceptible to volume change when subjected to moisture variations.

The soils encountered in the borings, based on laboratory expansion index testing, the expansion potential of the soil encountered is low. No special design and specific recommendations are required to mitigate the expansive characterized of the onsite soils.

2G.5.3 Collapsible Soils

Soil collapse (hydrocompaction) is a phenomenon that results in relatively rapid settlement of soil deposits due to addition of water. This generally occurs in soils having a loose particle structure cemented together with soluble minerals or with small quantities of clay. Water infiltration into such soils can break down the interparticle cementation, resulting in collapse of the soil structure. Collapsible soils are usually identified with index tests, such as dry density and liquid limit, and consolidation tests where soil collapse potential is measured after inundation under load.

Based on the available data, the potential for soil collapse at the site is expected to be low.

2G.6 Preliminary Foundation Considerations

2G.6.1 General Foundation Design Criteria

For satisfactory performance, the foundation of any structure must satisfy two independent design criteria. First, it must have an acceptable factor of safety against bearing failure in the foundation soils under maximum design load. Second, settlements during the life of the structure must not be of a magnitude that will cause structural damage, endanger piping connections or impair the operational efficiency of the facility. Selection of the foundation type to satisfy these criteria depends on the nature and magnitude of dead and live loads, the base area of the structure and the settlement tolerances. Where more than one foundation type satisfies these criteria, then cost, scheduling, material availability and local practice will probably influence or determine the final selection of the type of foundation.

An evaluation of the information collected for the AFC indicates that no adverse foundation-related subsurface and groundwater conditions would be encountered that would preclude the construction and operation of the proposed structures. The site can be considered suitable for development of the proposed structures, pursuant to completion of a final geotechnical investigation.

2G.6.2 Shallow Foundations

Completion of the geotechnical investigation will determine if the proposed structures can be supported directly on the native soils. Shallow foundation construction will require the earthwork measures discussed in Subsection 2G.7.

Allowable bearing pressures will include a safety factor of at least 3 against bearing failures. Settlements of footings are expected to be limited to 1 inch, and differential settlement between neighboring foundations to less than 0.5 inch. Tanks can usually undergo much larger settlements.

Pursuant to a geotechnical investigation, exterior foundations and foundations should be placed at a depth of at least 2 feet below the ground surface for protection. Interior footings can be placed at nominal depths.

2G.6.3 Deep Foundations

Deep foundations are not anticipated based on available information analyzed for the project.

2G.6.4 Corrosion Potential and Ground Aggressiveness

Corrosivity tests will be conducted to determine whether the site soils to be noncorrosive or corrosive for buried steel based on the chloride content and pH values.

2G.7 Preliminary Earthwork Considerations

2G.7.1 Site Preparation and Grading

A program to remove necessary fuel storage tanks and associated piping and rough grading the site has been conducted. Two intermediate berms within the tank farm area will be removed from the tank pit project site as part of the project. A detailed final geotechnical investigation and report will be performed to support power plant final design. This geotechnical report will provide recommendations for over excavation and backfill for spread footings and mats.

2G.7.2 Temporary Excavations

It is anticipated that confined temporary excavations at the site will be required during construction for the installation of connecting utility pipe lines and HV electrical line structures. All excavations should be sloped in accordance with Occupational Safety and Health Act (OSHA) requirements. Shored excavations can also be used to support any excavation, as necessary. The need for internal supports in the excavation will be determined based on the final depth of the excavation.

2G.7.3 Permanent Slopes

Cut and fill slopes shall be 1.5h:1v (horizontal to vertical) maximum.

2G.7.4 Backfill Requirements

All fill material will be free of organic matter, debris, or clay balls, with a maximum size not exceeding 3 inches. Structural fill will also have a Plastic Index of less than 20, a Liquid Limit of less than 40, and a maximum fine content (passing the 200 sieve) of 40 percent. Granular, uniformly graded material with a maximum aggregate size of 0.5 inch may be used for pipe bedding.

Structural fill will be compacted to at least 95 percent of the maximum dry density as determined by American Society for Testing and Materials (ASTM) D 1557 when used for raising the grade throughout the site, below footings or mats, or for rough grading. Fill placed behind retaining structures may be compacted to 90 percent of the maximum dry density as determined by ASTM D 1557. Initially, structural fill will be placed in lifts not exceeding 6-inches loose thickness. Thicker lifts may be used pursuant to approval based on results of field compaction performance. The moisture content of all compacted fill will fall within 2 percentage points of the optimum moisture content measured by ASTM D 1557, except the top 12 inches of subgrade will be compacted to 95 percent of ASTM D 1557 maximum density.

2G.8 Inspection and Monitoring

A California-registered Geotechnical Engineer or Engineering Geologist will monitor geotechnical aspects of foundation construction and/or installation and fill placement. At a minimum the Geotechnical Engineer/Engineering Geologist will monitor the following activities:

- Surfaces to receive fill will be inspected prior to fill placement to verify that no pockets of loose/soft or otherwise unsuitable material were left in place and that the subgrade is suitable for structural fill placement.
- Fill placement operations will be monitored by an independent testing agency. Field compaction control testing will be performed regularly and in accordance with the applicable specification to be issued by the Geotechnical Engineer.
- Settlement monitoring of significant foundations and equipment is recommended on at least a quarterly basis during construction and the first year of operation, and then semi-annually for the next 2 years.

2G.9 Site Design Criteria

2G.9.1 General

The project will be located in the City of Carlsbad, California. The tank pit floor site is relatively flat, with limited remaining permanent piping facilities. The site would be accessible from both Carlsbad Blvd and Cannon Road. However, the preferred primary access will be from Carlsbad Blvd.

2G.9.2 Datum

The site grade varies between elevation 29 to 60 feet, mean sea level, based on the June 2007 preliminary site survey and the 1929 National Geodetic Vertical Datum (NGVD). Final site grade elevation will be determined during detail design.

2G.10 Foundation Design Criteria

2G.10.1 General

Reinforced concrete structures (spread footings and mat foundations) will be designed consistent with Appendix 2B.

Allowable soil bearing pressures for foundation design will be in accordance with this Appendix and the detailed final geotechnical investigation for the site.

2G.10.2 Groundwater Pressures

Hydrostatic pressures due to groundwater or temporary water loads should not have to be considered.

2G.10.3 Factors of Safety

The factor of safety for structures, tanks and equipment supports with respect to overturning, sliding, and uplift due to wind and buoyancy will be as defined in Appendix 2B, Structural Engineering Design Criteria.

2G.10.4 Load Factors and Load Combinations

For reinforced concrete structures and equipment supports, using the strength method, the load factors and load combinations will be in accordance with Appendix 2B, Structural Engineering Design Criteria.

2G.11 References

California Building Code. 2001.

Department of the Navy.1982. "Identification and Classification of Soil and Rock." Chapter 1 in *Soil Mechanics Design Manual 7.1*. Naval Facilities Engineering Command. Alexandria, VA.

Caltrans. 1996. "California Seismic Hazards Map."

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