APPENDIX I

D. SCOTT MAGORIEN, C.E.G.1290
ENGINEERING GEOLOGIST

July 12, 2002
Revised September 7, 2002

Mr. Alan Ashimine
RBF Consulting
14725 Alton Parkway
Irvine, CA 92619-2027

Subject: Preliminary Review of Geotechnical Constraints and Geologic Hazards
Poseidon Resources Orange County Desalination Project
North and West Tank Options
Huntington Beach, California

Reference: Preliminary Review of Geotechnical Constraints and Geologic Hazards
Poseidon Resources Orange County Desalination Project
Huntington Beach, California: *July 11, 2002(Revised September 7, 2002)*
report prepared by D. Scott Magorien, C.E.G, for RBF Consulting, pp. 13

Dear Mr. Ashimine,

In general accordance with the ***revised*** (June 2002) scope of work, the following presents the results of a preliminary review of readily available geotechnical and geologic data in the vicinity of the proposed "North" and "West" tank options for the Poseidon Resources Orange County Desalination Project (PROCDP) in Huntington Beach. A list of the information and reports reviewed as part of this evaluation are presented in the ***References*** section at the end of the referenced report. Except as noted herein, background information as it relates to the regional geologic and hydrogeologic setting for the project area is presented in the referenced report. The major difference between the project described in the referenced report and this subsequent report is the that proposed product water storage tank would be buried below ground in the referenced report, whereas the new storage tank would be an above ground structure and occupy the site of the existing West or North fuel storage tank at the AES Huntington Beach (Power) Generating Plant (AES) site in Huntington Beach, California.

To date, the only site-specific preliminary geotechnical/ geologic hazards study that has been performed (by Geologic Associates, 2002) focuses on the area immediately surrounding AES's West and North fuel storage tanks. This preliminary geotechnical assessment was performed for the City of Huntington Beach Public Works Department in conjunction with site acquisition for the City's proposed Southeast Reservoir.

330 W Bay Street/Suite 140, Costa Mesa, CA 92627 • telephone (949) 642-4438 ext. 3009 • fax (949) 642-4474

1.0 PROJECT DESCRIPTION

The majority of the proposed project site occupies about 10 acres along the eastern margin and northwest corner of the 22-acre, AES Huntington Beach Power Generation Plant site in Huntington Beach, California. As currently planned, there are two (2) configurations for the various structures associated with the PROCDP. One of the configurations, referred to as the *"North" tank (site) option,* would replace AES's existing North, South and East fuel oil storage tanks, with an aboveground product water storage tank situated at the site of AES's existing North fuel storage tank. A number of other aboveground structures, such as an administration, and reverse osmosis (RO) building, pretreatment filter array, sub-influent pump station product water pump station, lime silos solids handling facility, chemical storage, and flush and scavenger tanks would be constructed in the area now occupied by the existing impoundment for AES's South and East fuel storage tanks.

The other configuration, referred to as the *"West" tank (site) option,* would replace AES's existing West fuel storage tank with an aboveground product water storage tank; and the remaining proposed structures (as discussed above) would be constructed in the area now occupied by AES's South and East fuel storage tanks.

2.0 REGIONAL SETTING (refer to referenced report)

3.0 SITE CONDITIONS

Topographically, the floor of the enclosure for the fuel storage and distillate tanks lies at an elevation of about 5 to 7 feet (+/-) above mean sea level, and are surrounded on all sides by a 10- to 15-foot high soil berm/ impoundment. The impoundment for AES's West and North fuel storage tanks has been breeched by narrow access roads on their east and west sides, respectively. The existing fuel storage tanks are elevated about two to three feet above the floor of the impoundments, which appears to slope gently to the east and west, respectively. Aside from the impoundment berms, the most significant topographic feature near the project area is the Huntington Beach Orange County Flood Control Channel (Channel) that borders the eastern margin of the project site, and lies about 250 feet northerly of the West and North tank sites. The Channel is separated from the northern edge of the existing West and North tank impoundment by Edison Avenue and a relatively level, 200-foot wide (+/-) strip occupied by light industrial buildings that lie astride the Channel.

North of AES's North fuel storage tank site, the Channel takes a 90-degree bend to the south. The margin of the north-south trending Channel is bounded by a 5- to 7- foot high levee that separates a narrow, low-lying marsh-like region from the contiguous, easterly-facing impoundment/ soil berm slope for AES's North, South and East fuel storage tanks. According to Mr. Phil Jones (Orange County Flood Control Design Engineer, personal communication), the invert (e.g. bottom) of the Channel lies at elevation (-)1 foot below sea level. Based on discussions with Mr. Jones and a review of a 1991 geotechnical investigation report by Geosoils, Inc., the interior sides of the levee are to be supported by driven sheet-piles in order to increase the capacity of the Channel. Each of the 33-to 36-foot long interconnecting sheet-piles will be driven to the point where only 10 to 12 feet of each pile will be exposed above channel invert. The southern limit of the new sheet-pile wall is planned to terminate near the southeast corner of the project site. It is my understanding that installation of the sheet-piles along that portion of the Channel that borders the project site is scheduled for mid 2002.

4.0 SUBSURFACE CONDITIONS and GEOTECHNICAL CONSTRAINTS

To date, the only site-specific preliminary geotechnical/ geologic hazards study that has been performed focuses on the area immediately surrounding AES's West and North fuel storage tanks. This preliminary geotechnical assessment was performed by Geologic Associates (2002) for the City of Huntington Beach Public Works Department in conjunction with site acquisition for the City's proposed Southeast Reservoir.

Although no site-specific geotechnical investigation has been performed for the remaining project area, the information presented in the Geologic Associates (2002) report as well as several subsurface geotechnical/ environmental studies in the vicinity of the project area, serve to provide the basis for the preliminary assessment of geologic hazards and geotechnical constraints presented herein. These include the environmental and geotechnical studies for the adjacent Huntington Beach Maintenance Facility (G.A. Nicoll, Inc., 1999, 2000), a geotechnical investigation by Geosoils, Inc. (1991) for the new sheet-pile walls for the nearby Channel, a Phase II environmental site assessment performed by CH2MHILL (1996); and the 1998 soil and groundwater investigation performed by Woodward-Clyde for the SCE Huntington Beach Generating Station. Other relevant subsurface studies include those prepared for local city and county agencies by various consulting firms, as well as by state and federal agencies (e.g. California Division of Mines and Geology, U.S. Geological Survey, and California Department of Water Resources). A complete list of documents reviewed for this study is presented in the report referenced at the beginning of this report.

4.1 Site Geology

Based on the information presented within various documents (refer to referenced report), the native soils beneath the project site are represented by an upper 60-foot thick layer of interbedded coastal estuarine / littoral sediments (i.e. coastal alluvium) consisting of fine sand, silt and clay, and mixtures thereof. According to GeoLogic Associates (2002), these sediments range in age from about 8,600 years old to the present. These native soil-like deposits are overlain at the surface by a varying thickness (about 5 to 10 feet) of artificial fill soils that were placed during construction for AES's generating station and fuel storage tanks.

Between a depth of about 60 to 90 feet, the native sediments are represented by middle to late Holocene (8,600 to 11,000 years old) fluvial (i.e. stream) deposits. These sediments are composed largely of sand and clayey sand with layers and lenses of silt and highly plastic clay that contains varying amounts of organic detritus. Below a depth of 90 feet below ground surface are Pleistocene (11,000 to 1.8 million years) old marine and nonmarine strata.

4.2 Geotechnical Constraints

According to building foundation studies by G. A. Nicoll, Inc. (2000) for the newly constructed Huntington Beach Maintenance Facility next to AES's North fuel storage tank site, the uppermost 13 feet of the native Holocene deposits are considered unsuitable for foundation support due to their compressible nature when placed under structural (i.e. building) loads. Limited standard penetration test (SPT) and cone penetrometer test (CPT) data (by G. A. Nicoll, Inc., 2000; and GeoLogic Associates, 2002) indicates that the uppermost 10 to 16 feet of the native sediments are saturated and highly susceptible to liquefaction during strong ground motion from nearby seismic sources. According to the study performed by GeoLogic Associates (2002), the soil layers susceptible to liquefaction were not found to be continuous. However, given the liquefiable nature of the near surface sediments, the potential for seismically-induced settlement and lateral spreading are considered a major constraints to development.

Below a depth of about 17 to 25 feet, the native sediments have "N-values" (as derived from SPT and CPT data) that are suggestive of soils that are not prone to liquefaction, nor are they considered compressible or subject to collapse under normal structural loads.

There is no current evidence that would suggest the presence of soils containing collapsible, organic peat deposits within or near the project site.

4.3 Groundwater Conditions (refer to referenced report)

4.4 Corrosive Soils (refer to referenced report)

5.0 GEOLOGIC HAZARDS

5.1 Faulting and Seismicity

The following discussion concerning seismic setting and related hazards, such as surface-fault rupture, liquefaction, seismically-induced soil settlement, and other secondary seismic hazards within the project area are discussed in the referenced report; however, they are reiterated herein for completeness of this report.

The project site lies within the seismically active southern California region that is subject to the effects of moderate to large earthquake events along major faults. The site is *not* located within an Alquist-Priolo Earthquake Fault Zone. However, regional faults that could effect the project are the Newport-Inglewood Fault Zone (NIFZ), Compton-Los Alamitos Blind Thrust Fault, Elysian Park Blind Thrust Fault, and Palos Verdes, Whittier-Elsinore, Sierra Madre-Cucamonga, and San Andreas fault systems. The closest regional fault (zone) to the site is the NIFZ, specifically the segment known as the South Branch Fault (SBF), which projects directly beneath the existing South fuel oil tank and the northern portion of the proposed desalination plant. Extensive faulting-related studies on the SBF by Leighton & Associates for the Bolsa Chica Project (as referenced on page V-EH-9 of the 1995 City of Huntington Beach General Plan EIR) suggests that the SBF is neither active nor potentially active. However, the City's General Plan EIR indicates that this "Category C" fault (as defined by Leighton & Associates, 1986) requires special studies, including a subsurface investigation for critical and important land uses. The main trace of the NIFZ (i.e. the North Branch Fault) is located approximately 0.3 mile north of the project site.

As part of GeoLogic Associates' (2002) preliminary geotechnical assessment for the City's Southeast Reservoir site acquisition, a subsurface stratigraphic correlation/ fault investigation was performed to assess the presence and/or potential for surface fault rupture within the Holocene-age deposits. According to the criteria established by the California Division of Mines and Geology, a fault is considered "active" if it can be demonstrated that the fault has produced surface displacement within Holocene time (about the last 11,000 years).

Due to the presence of a relatively thick layer of fill soils and shallow groundwater, conventional fault trenching and soil-stratigraphic techniques could not be employed by GeoLogic Associates to assess the presence and/or potential for surface fault rupture. Instead, their investigation involved the use of CPT and exploratory borings for stratigraphic correlation purposes, as well as the use of radiocarbon dating of organic sediments and shells obtained from the exploratory borings. According to Geologic Associates' stratigraphic correlation study, no evidence of faulting within Holocene sediments was found beneath either site (i.e. North and West fuel storage tanks). The report concludes that the risk of surface fault rupture is minimal over the lifetime of the proposed (Southeast Reservoir) project, yet the stratigraphic correlation on which the assessment was based favors the North tank site. Based on my review of GeoLogic Associates' (2002) soil correlation data, there still remains a possibility the surface fault rupture potential could exist in the southern half of the proposed desalination plant, and the southern corner of the existing impoundment and possible site for the proposed West product water storage tank site.

The next closest regional fault to the project area is the Compton-Los Alamitos Blind Thrust Fault, situated approximately 4 miles directly below the project area (Shaw, 1993). The Elysian Park Blind Thrust, Palos Verdes, Whittier-Elsinore, Sierra Madre-Cucamonga, and San Andreas fault systems are situated between approximately 6 to 50 miles from the site.

Based on a deterministic seismic hazard evaluation, which takes into account a maximum magnitude earthquake M6.9 on the NIFZ, the expected maximum horizontal ground motion (measured in percent of gravity "g") from this seismic source would be approximately 0.9g. In the event of a major earthquake (M6.8) on the Compton-Los Alamitos Blind Thrust Fault (which could be similar to the blind thrust that produced the 1994 Northridge earthquake), which is approximately 5 miles directly below the project site, the maximum ground acceleration could exceed 1g.

According to the 1999 Seismic Shaking Hazard Maps of California, probabilistic seismic hazard analysis (PSHA) indicates the level of ground motion at the site that has 10% chance of being exceeded in 50 years (475 year return period) is approximately 0.4g. These analyses consider all seismic sources within the southern California area. This value of 0.4g is in agreement with a March 2000 PSHA performed by G.A. Nicoll, Inc. for the new Huntington Beach Maintenance Facility, located immediately north of the project area at the end of Edison Street; and the PSHA performed by GeoLogic Associates (2002) for the City's Southeast Reservoir site acquisition project.

Although the conclusions reached by Geologic Associates (2002) that the potential risk of primary surface rupture below the site now occupied by AES's West and North fuel storage tanks is minimal, there still remains a "window" of possible faulting within the southern half of the proposed desalination plant site. A similar, yet more detailed, form of the subsurface stratigraphic correlation investigation as performed by GeoLogic Associates (2002) for the City's Southeast reservoir site acquisition study should be undertaken as part of the site-specific geotechnical investigation for this project.

In addition, further subsurface investigative work is, in my opinion, necessary to evaluate the nature of the apparent variation in elevation of stratigraphic units below a depth of about 30 feet (between GeoLogic Associates CPT-4 and CPT-5) in the southern corner of the impoundment area of AES's West fuel storage tank.

5.2 Secondary Seismic Hazards

Secondary seismic hazards are generated by strong ground motion/ shaking from a nearby or distant earthquake and can result in permanent ground deformation. The types of hazards resulting from strong ground motion include liquefaction, lateral soil spread, subsidence or ground settlement, landslides or slumps, tsunami runup and seiche.

Liquefaction

As shown on the State of California's Seismic Hazard Zone Map for the Newport Beach Quadrangle, the City's General Plan "Liquefaction Potential" Map, the project site lies within an area of high liquefaction potential. These assessments are further validated by the subsurface geotechnical studies performed for the new Huntington Beach Maintenance Facility, the sheet-pile wall improvements for the Channel, and the preliminary geotechnical assessment for the City's Southeast Reservoir site acquisition. Typical methods to mitigate the potential impacts resulting from liquefaction include the following:

- Overexcavation and recompaction of the liquefaction-prone soils;
- In-situ soil densification, such as vibro-floation, vibroreplacement (i.e. stone columns);
- Injection grouting; or
- Deep soil mixing

The geotechnical assessment performed by GeoLogic Associates (2002) in the area surrounding AES's West and North fuel storage tanks concludes that the proposed Southeast Reservoir could be supported by a conventional concrete mat type foundation, provided provision is made to accommodate the anticipated settlements due to consolidation of the uppermost saturated, soft clay layers and the potential post-liquefaction settlements. GeoLogic Associates (2002) also indicates that soil conditions would not preclude use of other foundation systems, which can be evaluated when design concepts are available.

Lateral Spread

Lateral spreading involves the dislocation of the near surface soils generally along a near-surface liquefiable layer. In many cases, this phenomenon of shallow landsliding occurs on relatively flat or gently sloping ground adjacent to a "free face," such as an unsupported channel wall along a stream or flood control channel. Given the "weak" nature of the near surface, fine-grained sediments, shallow groundwater, liquefaction-prone soils, and the nearby flood control channel, there is a high potential for lateral spread beneath the site during a major earthquake in the area. According to discussions with Mr. Phil Jones at Orange County Flood Design, the sheet-piles that are to be installed along the sides of the Channel are not designed to resist liquefaction or lateral loads that could occur as the result of a lateral spread.

None of the geotechnical reports reviewed for this study address the potential for lateral spread. An analysis concerning this potentially significant risk should be required as part of the geotechnical investigation for the project.

Earthquake-Induced Ground Settlement and Subsidence

Due to the relatively loose, unconsolidated nature of the near-surface soils, there is a high potential for earthquake-induced ground settlement within the project area. According to the liquefaction evaluation performed by GeoLogic Associates (2002), it is anticipated that liquefied soils may experience post-liquefaction settlements of 4 to 5 inches. However, given the nature and lateral extent of the liquefiable soils, post-liquefaction settlement will likely be uniform throughout the site (GeoLogic Associates, 2002).

If some form of mitigation were ultimately required, measures would include removal and recompaction of the settlement-prone soils, or the use of structural mat or deep foundations.

Landslides and Slumps

The potential for seismically induced landsliding along the levee of the neighboring Channel is considered moderate to high. The new sheet-pile walls that are to be constructed along the interior walls of the levee are not designed to withstand potentially large lateral forces associated with strong ground motion from a nearby earthquake. As such, earthquake-induced slope instability should be considered as part of the geotechnical evaluation for the project. It is my understanding that the soil berms that surround the existing fuel storage tanks will not be removed, and will remain as part of the project.

Tsunamis and Seiches

According to D.S. Mc Culloch (*in* U.S. Geological Survey Professional Paper 1360, p 400), the heights of the 100- and 500-year tsunamis along the coastal area of Huntington Beach are 5 feet and 7.5 feet, respectively. The resulting seiches within the nearby Channel would likely be somewhat less, given the frictional energy dissipation along the bottom and walls of the channel. It is unknown as to the potential impact to the project from resulting seiches because ultimate surface grades are not known at the present time. According to the preliminary geotechnical assessment for the City's Southeast Reservoir site acquisition, there is an unquantifiable potential for the site being impacted by a tsunami associated with an offshore earthquake (GeoLogic Associates, 2002).

6.0 Active or Abandoned Oil/ Gas Wells

Based on a review of the November 25, 2000, Division of Oil, Gas, and Geothermal Resources Map No.136, there are no producing or abandoned oil or gas wells within the limits of the project area. The closest producing oil wells are located north of the project site at the end of Edison Street, near the Huntington Beach Maintenance Facility. The closest abandoned (dry hole) wells are located approximately 300 feet north, and another approximately 600 feet southwest of the project area.

There are no indications that the site or surrounding area has experienced any significant subsidence due to oil and gas extraction.

7.0 SUMMARY IMPACTS AND MITIGATING MEASURES

Based on the information presented above, the following summary of project-related impacts related to geotechnical constraints and geologic hazards have been preliminarily identified in the vicinity of the project area. Mitigating measures for each impact follow each of the identified impacts.

7.1 Impacts and Mitigating Measures

- ***Impact #7.1.*1:** Depth to groundwater beneath the project area is approximately five feet. Groundwater quality is considered brackish. Saturated soils and possibly caving conditions would be encountered if remedial grading associated with removal and recompaction of soils within several feet above, or at any depth below the groundwater table.

  Mitigation #7.1.1: In order to excavate and recompact the soils within several feet above, or below the elevation of the water table, dewatering will be necessary. Depending upon the depth of the excavation, some form of lateral support for the sides of the excavation may also be required. Groundwater pumped from either the excavation or from dewatering wells will require some form of treatment, in order to reduce total dissolved solids (TDS) content, and/or other excessive contaminants, before it can be discharged into any surface water body, such as the Santa Ana River or Pacific Ocean.

- ***Impact #7.1.2:*** The uppermost 17 feet of the native soils within the project area are considered compressible upon placement of structural loads (e.g. aboveground storage tanks, single and multi-story buildings, etc.). Unless some form of mitigation is performed, the proposed structures could experience significant structural distress.

  Mitigation #7.1.2: Complete removal and recompaction of compressible soils (although this would require dewatering and support of the walls of the excavation), use of piles and grade beams to support the structure(s).

- ***Impact #7.1.3:*** The uppermost 16 to 25 feet of native soils in the project area are highly susceptible to liquefaction and up to approximately 4 to 6 inches of seismically-induced settlement. Unless some form of mitigation is performed, the proposed structures could experience significant post-liquefaction distress.

  Mitigation #7.1.3: Typical methods to mitigate the potential impacts resulting from liquefaction include the following:

  1. Overexcavation and recompaction of the liquefaction-prone soils;
  2. In-situ soil densification, such as vibro-floation, vibroreplacement (i.e. stone columns);
  3. Injection grouting; or
  4. Deep soil mixing.

- ***Impact #7.1.4:*** The subsurface trace of the SBF of the seismically active Newport-Inglewood Fault Zone may project beneath the southern portion of the project site.

  Mitigation #7.1.4: A subsurface fault investigation, similar to the one performed by Geologic Associates (2002) for the nearby Southeast Reservoir site acquisition project should be performed to assess the nature and extent of possible surface-fault rupture across the southern portion of the site. If evidence for potential fault-surface rupture is found, an appropriate "setback" for structures from the zone of surface faulting will be required.

- ***Impact #7.1.5:*** The presence of underlying liquefaction-prone soils and the site location relative to the Channel poses a risk of seismically induced lateral spread.

  Mitigation #7.1.5: The potential of lateral spread should be performed as part of the site-specific geotechnical investigation for the project. If found to be possible, subsurface reinforcement of the potential zone of lateral spread will be necessary. The methods to mitigate lateral spread are similar to those presented above to mitigate soils prone to liquefaction.

- ***Impact #7.1.6:*** Given the proximity to major active faults, severe ground motion, perhaps exceeding 1g should be expected at the site.

  Mitigation #7.1.6: All structures associated with the proposed desalination plant should be designed to withstand the "design-level" earthquake as set forth in the latest edition of the Unified Building Code.

- ***Impact #7.1.7:*** Near surface soils are highly corrosive to cement and metals in contact with these soils.

  Mitigation #7.1.7: The use of Type V cement should be used for concrete and special coatings or other measures should be used to protect metal pipes against the effects of corrosion.

Once a site layout and grading plan has been approved, a site-specific geotechnical evaluation of each of the constraints and geologic hazards indicated above as well as other geotechnical engineering parameters will be required.

CLOSURE

In the absence of a site-/ project-specific geotechnical report, the information presented herein is intended to serve as a very preliminary evaluation of the geotechnical and geologic constraints for the proposed PROCDP. Each of the geotechnical issues discussed herein, as well as other