APPENDIX C

Updated Preliminary Review of Geological Constraints and Geologic Hazards, Huntington Beach Desalination Report

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Subject: Updated Preliminary Review of Geotechnical Constraints and Geologic Hazards
Huntington Beach Desalination Project
Huntington Beach, California

Dear Mr. Ashimine,

As requested, the following presents the results of a preliminary review of readily available geotechnical and geologic data in the vicinity of the proposed Huntington Beach Desalination Project (HBDP) at the AES Huntington Beach (Power) Generation Plant (AES Plant) in Huntington Beach. This report represents an updated, preliminary evaluation of existing geotechnical reports and geologic data presented in two earlier reports prepared by this office for the previously proposed desalination plant site (report dated September 7, 2002), and what was referred to as the "North and West Tank Options" (report dated July 12, 2002). The currently proposed HBDP site encompasses all of the area of the AES Plant evaluated in the two earlier reports. As with the previous data review study, the information reviewed for this evaluation had been obtained from city, county, and state agencies, as well as from geotechnical consulting firms and the U.S. Geological Survey. A listing of the reports reviewed is presented in the References section at the end of this report.

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1.0 SITE CONDITIONS

The proposed HBDP is occupied by the South, North and West fuel storage tanks that are enclosed on all sides by 10- to 15-foot-high soil berms/impoundments (see Figure 1). Topographically, the floors of the impoundments vary between elevation 5 to 10 feet (+/-) above mean sea level (msl), and the fuel storage tanks are elevated about two to three feet above the impoundment floors. The surface of these impoundments appears to slope gently to the east.

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. The 60-foot-wide Channel is bounded on each side by a 5- to 7-foot-high levee that separates a narrow, low-lying marsh-like region from the easterly-facing soil berm slope for the North and South tank impoundments. 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 mean sea level. According to Mr. Jones, and review of a geotechnical investigation report by GeoSoils, Inc. (1991), the interior sides of the levee are 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 is driven to the point where 10 to 12 feet of each pile is exposed above channel invert. The southern limit of the new sheet-pile walls terminates about 100 feet south of the northeast corner of the impoundment berm for the North fuel storage tank.

2.0 PROJECT DESCRIPTION

According to an October 2009 site plan (Plan) prepared by Tetra Tech, the proposed project site will occupy about 13 acres within the northern portion of the 22-acre AES Plant site. As currently planned, the various structures associated with the HBDP will occupy the area of the existing South and North fuel storage tanks, which have been out of service for some time. The existing West fuel storage will be replaced by an above ground, 251-foot-diameter product water storage tank. Separated from the main HBDP is a proposed influent pump station located on the north side of the existing AES Plant. There are two parallel, 72-inch buried pipelines ("feed line" and "brine line") proposed that will connect the influent pump station to the main plant site. It is reported that the pipelines will have between four to 20 feet of soil cover.

Rough grading for the project will reportedly involve 138,000 cubic yards of cut, 65,000 cubic yards of fill, and the remaining 73,000 cubic yards of soil is to be exported off site. The deepest planned excavation is reported to be on the order of 30 feet, with most of the proposed structures constructed at current grades (i.e. 5.0 to 10.5 feet above mean sea level). The exterior soil berms that surround the existing North, South, and West fuel storage tanks will remain in place, and the interior soil berms will be removed.

Based on the Plan, the site of the existing South fuel storage tank will be replaced with above-ground structures including a pre-treatment filter structure, electrical substation, solids handling facility, and an administration building. It is our understanding that a 22-foot-deep excavation is planned for the spent backwash tank, which is to be located along the southern side of the pretreatment filter structure. If the existing grade of approximately 5 feet above mean sea level is maintained, the bottom of this tank will be about 17 feet below mean sea level.

The site of the existing North fuel storage tank will be occupied by a reverse osmosis (RO) building, a post-treatment structure, chemical storage building, a flush tank, and a portion of the electrical substation, all of which are above ground. There will also be a buried transfer pump station, and an adjacent, 20-foot-deep filtered seawater tank along the northern side, and a back-flush water tank on the south side of pre-treatment filter structure. Assuming little to no change in the current surface elevation (i.e. about 7.5 feet above mean sea level), the bottom of the tank will be about 12.5 feet below mean sea level.

The proposed 251-foot-diameter product water storage tank along with a product water pump station, a 12-foot-high cylindrical ammonia storage tank, and a 12-foot-diameter surge tank will occupy the soil-berm enclosure for the existing West fuel storage tank. A 48-to 54-inch-diameter pipeline will extend between the product water storage tank and the RO processing plant.

3.0 REGIONAL SETTING

The project site is situated within a coastal lowland area referred to as the Santa Ana Gap (Gap), a portion of the Orange County Coastal Plain. The creation of the Gap began in Late Pleistocene time (about 60,000 years before present [ybp] and continued until the end of the last glacial period, approximately 15,000 ybp. The combination of a lowered sea level and accelerated stream erosion produced the ancestral Santa Ana River valley, which is approximately 200 feet deep and several miles wide. At the end of the glacial period, the sea level began to rise, and the ancestral river began backfilling the valley with coastal alluvial deposits. Much of what is known about the subsurface conditions and late Pleistocene erosion and subsequent Holocene-age (0 to 11,000 ybp) sediment deposition in the region has been reported by the U.S. Geological Survey, California Geological Survey, California Department of Water Resources, the Orange County Water District, and a number of site-specific investigations performed by various consulting firms for local agencies.

The Gap is underlain at shallow depths by Holocene sediments consisting of ancient river and flood plain deposits associated with the Santa Ana River, and tidal flat/lagoonal deposits. These sediments consist of unconsolidated sand, gravel, silt, and clay that includes the marine sands and gravel that comprise what is known as the Talbert water-bearing zone/aquifer. The Talbert aquifer, which extends from about 15 to 180 feet below the ground surface, is highly susceptible to saltwater contamination due to its interconnection with the ocean and the Channel. Isolated pockets of peat and organic soil deposits also occur within the uppermost portions of these sediments.

According to State of California Division of Oil, Gas, and Geothermal Resources Map 136 (dated November 25, 2000), the project site and surrounding area are situated within the West Newport (Oil) Field (WNF). The WNF is part of the largest Huntington Beach oil field, which is associated with what is referred to as the Newport-Inglewood Structural Trend. A number of other significant oil fields are located along the Newport-Inglewood Trend, all of which owe their existence largely to the Newport-Inglewood fault zone (NIFZ).

4.0 SUBSURFACE CONDITIONS AND GEOTECHNICAL CONSTRAINTS

In 2002 a preliminary geotechnical assessment report was prepared by GeoLogic Associates (2002) (GLA) for the City of Huntington Beach associated with acquisition of the North and West fuel storage tank sites. There have also been several subsurface geotechnical/environmental studies performed in the vicinity of the proposed project that, along with GLA's report and other documents, provides the basis for the preliminary assessment of geologic hazards and geotechnical constraints presented herein. These include environmental and geotechnical consultants' 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 a 1998 soil and groundwater investigation performed by Woodward-Clyde for SCE, the former owner of the 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).

4.1 Site Geology

Based on the information presented from various sources (refer to the References section of this report), the native soils beneath the project site are represented by an upper 60-foot- thick layer of interbedded coastal estuarine/littoral sediments consisting of fine sand, silt and clay, and mixtures thereof. According to GLA (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 the 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 non-marine strata.

The closest major fault to the proposed project site is the seismically active NIFZ. In the vicinity of the project area, the fault zone is characterized by two main fault segments, the North Branch and South Branch, as well as other branching, lesser defined second-and third-order faults. An expanded discussion of the NIFZ and its relation to the project site is presented below in Section 5.0- Geologic Hazards.

4.2 Groundwater Conditions

The lower part of the Holocene age sediments beneath the site consists of inter-fingering lenses of coarse sand and gravel known as the Talbert aquifer. A relatively impermeable cap of interbedded silts and clay up to about 15-feet-thick overlies the Talbert aquifer. Given the proximity of the site to the Pacific Ocean, and its interconnection with the nearby Channel, depth to groundwater beneath the project site is about five to seven feet. The actual elevation of the groundwater table will fluctuate with the ocean tides and water level in the neighboring flood control channel. Due to this interconnection, groundwater quality is considered brackish. Based on past pump testing, the average permeability of the Talbert aquifer is approximately 1000 gallons per day per square foot (Woodward-Clyde, 1998).

According to the information presented in the environmental assessment reports by CH2MHILL (1996), Woodward-Clyde (1998), G.A. Nicoll, Inc. (1999), and Bryan Stirrat & Associates, Inc. (2002), there is no indication of any significant groundwater contamination (aside from seawater intrusion) of the Talbert aquifer in the immediate vicinity of the project site.

Depending upon construction methods, dewatering of the upper portion of the Talbert aquifer may be required in order to safely excavate the site of the proposed below groundwater facilities.

4.3 Geotechnical Constraints

According to building foundation studies by G.A. Nicoll, Inc. (2000) for the newly constructed Huntington Beach Maintenance Facility, 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 GLA (2002), indicate that the uppermost 10 to 16 feet of the native sediments in the area are highly susceptible to liquefaction during strong ground motion from nearby seismic sources. According to the analyses performed by GLA in 2002, the soil layers susceptible to liquefaction were not continuous beneath the North and West fuel storage tank sites. Below a depth of about 17, the native sediments have "N-values" (as derived from SPT and CPT data) that are suggestive of soils that are not prone to liquefaction. Soils below 17 feet are not considered compressible or subject to collapse under normal structural loads.

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

4.4 Corrosive Soils

According to limited laboratory resting by GLA (2002), near surface soils have a relatively high pH value (8.4), low resistivity (170 ohm-cm) and high soluble sulfate content (4000 ppm), indicating these soils are considered highly corrosive to concrete and metals in contact with these soils.

5.0 GEOLOGIC HAZARDS

5.1 Faulting and Seismicity

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. Regional faults that could affect the project are the NIFZ, Compton Blind Thrust Fault, (lower) 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 southern portion of the proposed plant site. 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 miles north of the project site.

As part of the GLA's (2002) preliminary geotechnical investigation, a subsurface stratigraphic correlation/fault investigation was performed to assess the presence of the SBF and the potential for surface fault rupture within the Holocene-age deposits. According to the criteria established by the California Geological Survey, 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 GLA to assess the presence and/or potential for surface fault rupture beneath the North and West tank sites. 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 GLA's stratigraphic correlation study, no evidence of faulting within Holocene sediments was found beneath either the North or West tank sites. Their report concludes that the risk of surface fault rupture is minimal over the lifetime of the City's proposed "Southeast Reservoir" project, yet the stratigraphic correlation on which the assessment was based favors the North tank site.

However, based on my review of GLA's (2002) soil correlation data, specifically subsurface data from CPT-4 and CPT-5, there still remains a possibility that surface fault- rupture potential exists in the southwest corner of the West fuel storage tank site and the southwestern portion of the South fuel storage tank site.

The next closest regional fault to the project area is the Compton Blind Thrust Fault, situated approximately 4 miles north of the project area (Shaw, 1993). The (lower) 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 Blind Thrust Fault, which could be similar to the blind thrust that produced the 1994 Northridge earthquake, the maximum ground acceleration could exceed 1g.

According to the latest United States Geological Survey [USGS (2008)] Seismic 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 GLA (2002). However, given the changes to the latest Unified Building Codes (UBC), as well as the nature of the proposed project, the use of more stringent earthquake ground motions (i.e. 2% chance of exceedance in 50 years) should be evaluated as part of the future site-specific geotechnical investigation for the project.

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 run-up and seiche.

5.2.1 Liquefaction

As shown on the State of California's Seismic Hazard Zone Map for the Newport Beach Quadrangle, and the City's General Plan "Liquefaction Potential" Map, the project site lies within an area of high liquefaction potential. This assessment is further validated by the results of the subsurface geotechnical studies performed for the nearby Huntington Beach Maintenance Facility, the sheet-pile wall improvements for the Channel, and GLA's preliminary geotechnical assessment for the City's Southeast Reservoir site acquisition project in 2002.

As part of this updated review, we have revisited the topic of liquefaction potential at the site by reviewing the most current ground motion information provided by the USGS (2008), and the current design guidelines provided in ASCE 7-05 (ASCE, 2006). The earthquake parameters used in GLA's 2002 study was based on the Maximum Credible Earthquake on the NIFZ with a magnitude (M) of M6.9, and a peak ground acceleration (PGA) of 0.54g. The current seismic design guidelines as presented in ASCE 7-05 (ASCE, 2006) requires the use of PGA from the Maximum Considered Earthquake with a 2% probability of exceedance in 50 years as the design ground motion for the evaluation of liquefaction triggering. We have used the ground motion maps presented in ASCE 7-05 as well as the information provided by USGS (2008) to estimate the PGA at the site. The PGA was estimated to be 0.74g assuming an average shear wave velocity of 350 m/s within the upper 100 ft below ground surface. Therefore, the ground motion level is significantly higher than what was used in GLA's 2002 study for evaluating the liquefaction triggering potential beneath the North and West fuel storage tank sites.

In GLA's 2002 study, the liquefaction susceptible layers were identified to be limited to a depth of 17 feet at which depth the density of the soils increases significantly, based on the observation made in the borings and the resistance measured in CPTs. Based on our review, we agree with GLA that the density of soils below 17 feet is significantly higher and anticipate the results would be similar to GLA's 2002 study if the liquefaction study was revised based on the current ground motion levels. However, we recommend the liquefaction potential to be reevaluated and documented as part of the future site-specific geotechnical investigation for the proposed project.

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

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

It is our understanding that all proposed structures for the currently proposed desalination plant are to be supported on 25-foot-deep stone columns. However, site-specific geotechnical studies will be necessary in order to determine the applicability and actual nature and extent of stone columns, as well as other geotechnical- and geologic-related studies for the project.

5.2.2 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 walls. 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 past discussions with Mr. Phil Jones at Orange County Flood Design, the sheet-piles 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 addressed the potential for lateral spread. An in-depth analysis concerning this potentially significant risk should be required as part of the site-specific geotechnical investigation for the project.

5.2.3 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 GLA (2002), it is anticipated that liquefied soils may experience post-liquefaction settlements of 4 to 5 inches.

Mitigation measures would include removal and recompaction of the settlement-prone soils, or the use of deep foundations.

5.2.4 Landslides and Slumps

The potential for seismically-induced landsliding along the levee of the neighboring Channel is considered moderate to high. As stated above, the sheet-pile walls constructed along the Channel walls 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 exterior soil berms that surround the existing North, South, and West fuel storage tanks will remain in place, and the interior soil berms will be removed. Hence, the remaining exterior berms will require slope stability analyses.

5.2.5 Tsunamis and Seiche

According to D.S. McCulloch [(1985), 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 seiche within the Channel would likely be somewhat less, given the frictional energy dissipation along the bottom and walls of the channel. Given that the existing exterior containment berms along the northern, eastern and southern margins of the project area will remain, the likelihood of seiche or the 100- and 500-year tsunamis impacting the site is considered low.

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 OF IMPACTS AND MITIGATING MEASURES

Based on the information presented above, the following summary of project-related impacts related to geotechnical constraints and geologic hazards has been preliminarily identified in the vicinity of the project area. Mitigating measures 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 to seven feet. Groundwater quality is considered brackish. Saturated soils and caving conditions would be encountered during excavation for the tank, or 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: Depending upon the construction methods dewatering may be required in order to safely excavate the sites of the proposed below groundwater facilities, and may require some form of lateral support. Groundwater pumped from the dewatering wells will need to meet NPDES permit requirements before it is discharged.

  In order to prevent the buried tanks (and certain pipelines) from "floating" when water levels in the tanks/pipelines are drawn down, it will be necessary to either "anchor" them down with piles, add additional weight to the tanks/pipelines themselves, and/or add sufficient a soil surcharge across the top of the tank/pipelines.

- **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. above ground storage tanks, single and multi-story structures, 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 will require dewatering and support of the walls of the excavation), or use deep foundations such as stone columns or piles and grade beams to support the structure(s).

- **Impact #7.1.3:** The uppermost 17 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, with the exception of the buried product water storage tank, could experience significant post-liquefaction distress.

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

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

  It is our understanding that 25-foot-deep stone columns are being considered for all structures to mitigate the potential effects of liquefaction.

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

  Mitigation #7.1.4: A subsurface fault investigation, similar to the one performed by GLA (2002) for the Southeast Reservoir site acquisition project, should be performed in accordance with CGS Note 49 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. Significant distress to both above- and below-ground structures would occur in the event of this form of seismically-induced landsliding.

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 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 Uniform Building Code. However, given the proximity to the NIFZ, Compton Blind Thrust fault, more stringent design measures may be warranted or required.

- **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 engineering parameters, will be required.

CLOSURE

The information presented herein is intended to serve as a preliminary evaluation of the geotechnical and geologic constraints for the proposed HBDP. Each of the geotechnical issues discussed herein, as well as other relevant geotechnical aspects, will require a thorough evaluation as part of the geotechnical investigation that would be required for development of the project.

The findings and recommendations presented in this report were obtained from a review of previously published and unpublished literature in agreement with the general principles and practices in engineering geology and geotechnical engineering. We make no other warranty, either express or implied.

Please call the undersigned if you have any questions, or require clarification of the information presented in this report.

Respectfully submitted,

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Attachment: Figure 1- Site Plan

REFERENCES

American Society of Civil Engineers, 2006, Minimum Design Loads for Buildings and Other Structures, ASCE, January.

Barrows, A.G., 1974, A Review of the Geology and Earthquake History of the Newport-Inglewood Structural Zone, Southern California: California Division of Mines and Geology Special Report 114.

Bryan Stirrat & Associates, Inc., 2002, Focused Site Investigation Report (for) Southeast Reservoir Site Acquisition, Huntington Beach, California; prepared for City of Huntington Beach Department of Public Works, dated May 23, 2002.

Bryant, W.A., 1988, Recently Active Traces of the Newport-Inglewood Fault Zone, Los Angeles and Orange Counties, California: California Division of Mines and Geology Open-File Report 88-14.

California Department of Water Resources (Southern District), 1967, Progress Report on Ground Water Geology of the Coastal Plain of Orange County.

California Division of Oil, Gas, and Geothermal Resources Map sheet 136, November 25, 2000; scale 1'=500'.

California Division of Mines and Geology, 1976, Environmental Geology of Orange County, California: Open-File Report 79-8 LA.

________________________________, 1995, The Northridge, California, Earthquake of 17 January 1994: Special Publication 116.

________________________________, 1996, Probabilistic Seismic Hazard Assessment for the State of California: DMG Open-File Report 96-08.

________________________________, 1997, Guidelines for Evaluating and Mitigating Seismic Hazards in California: DMG Special Publication 117.

________________________________, 1997, State of California Seismic Hazards Zones, Newport Beach Quadrangle, scale 1:24,000.

________________________________, 1997, Fault-Rupture Hazard Zones in California, Special Publication 42 (Revised 1997).

California Geological Survey, Note 49, Guidelines for Evaluating the Hazard of Surface Fault Rupture.
________________________, 2010, Interactive Ground Motion Map, Probabilistic Seismic Hazards Assessment; redirect.conservation.ca.gov/cgs/rghm/pshamap/psha1 1834.html.

CH2MHILL, 1996, Huntington Beach Generating Station Phase II Environmental Site Assessment (Volume I): consultants DRAFT report prepared for Southern California Edison Company, dated November 27, 1996, P.O. No. C4096906.

City of Huntington Beach, 1995 Environmental Hazards Element of the City of Huntington Beach General Plan EIR (Section 5.6-Geology and Soils): dated July 5, 1995.

Coastal Frontiers Corp., 1988, Technical Memorandum "Wave Heights at Parking Lot Bridge" Talbert Channel: consultants report prepared for Simons, Li & Associates, dated October 14, 1988, ref. CFC-118-88 Talbert Channel.

Fuller, D.R., 1980, Talbert and Bolsa Aquifer Map; in Sprotte, E.C. et al., Classification and Mapping of Quaternary Sedimentary Deposits for Purposes of Seismic Zonation, south coastal Los Angeles Basin and Orange County California: California Division of Mines and geology Open-File Report 80-19, Map No. 5, scale 1:62,500.

G.A.Nicoll, Inc., 1999, Limited Phase II Environmental Investigation (for) Future Huntington Beach Maintenance Facility east End of Edison Road, East of Newland Street, Huntington Beach, California: consultants report prepared for the City of Huntington Beach, dated July 9, 1999, Project No. 5670-09.

G.A.Nicoll, Inc., 2000, Geotechnical Investigation for Future Huntington Beach Maintenance Facility East End of Edison Road, East of Newland Street, Huntington Beach, California: consultants report prepared for the city of Huntington Beach, dated March 27, 2000, Project No. 5670-04.

GeoLogic Associates, 2002, Preliminary Geotechnical Assessment (for) Southeast Reservoir Site Acquisition, Huntington Beach California: prepared for City of Huntington Beach Public Works Department, dated May 24, 2002.

GeoSoils, Inc., 1991, Geotechnical Investigation Huntington Beach Channel (Flood Control Facility No. D01) City of Huntington Beach, County of Orange, California: consultants report prepared for Orange County Environmental Management Agency, dated February 21, 1991, W.O. 2233-A-OC.

Grant, L.B., et al., 1997, Paleoseismicity of the North Branch of the Newport-Inglewood Fault Zone in Huntington Beach, California from Cone Penetrometer Test Data: Bulletin of the Seismological Society of America, vol. 878, No 2, pp.277-293, April 1997.

Morton, P. K. and Miller, R. V., 1981, Geologic Map of Orange County, California Showing Mines and Mineral Deposits: California Division of Mines and Geology Bull. 204, scale 1:48,000.

Piper, A.M., Garrett, A.A., et al., 1953, Native and Contaminated Ground Waters in the Long Beach – Santa Ana area, California: U.S. Geological Survey Water Supply Paper 1136.

RBF Consulting, 2001, Administrative Draft Preliminary Hazardous Materials Assessment for the Southeast Coastal Area Redevelopment Project Located within the City of
Huntington Beach, County of Orange, State of California: consultants report prepared for the City of Huntington Beach, dated January 11, 2001, Job No. 10- 100848.001.

Shaw, J.H., 1993, Active Blind-Thrust Faulting and Strike-Slip Fault-Bend Folding in California: Ph.D. dissertation, Princeton University, October 1993, 216 pp.

Shaw, J.H., et al., 2002, Puente Hills Blind-Thrust System, Los Angeles, California: Bulletin of the Seismological Society of America, Vol. 92, No.8, pp. 2946-2960, December 2002.

South Coast Geological Society, 1992, The Regressive Pleistocene Shoreline Coastal Southern California: Annual Field Trip Guide Book No. 20.

U.S. Geological Survey, 1985, Evaluating Earthquake Hazards in the Los Angeles Region-An Earth-Science Perspective (J.I. Ziony, Editor): U.S. Geological Survey Professional Paper 1360.

________________________________, 2001, Preliminary Digital Geologic Map of the Santa Ana 30' x 60' Quadrangle, Southern California (Version 1), scale 1:100,000: compiled by D.M. Morton, U.S. Geological Survey, Dept. of Earth Sciences at University of California, Riverside.

________________________________, 2008, United States National Seismic Hazard Maps.

Woodward-Clyde, 1998, Site Investigation Report for Soil and Groundwater Huntington Beach Generating Station, Huntington Beach, California: consultants final report prepared for Morrison & Forester, dated May, 1998, project no. 97SB044.

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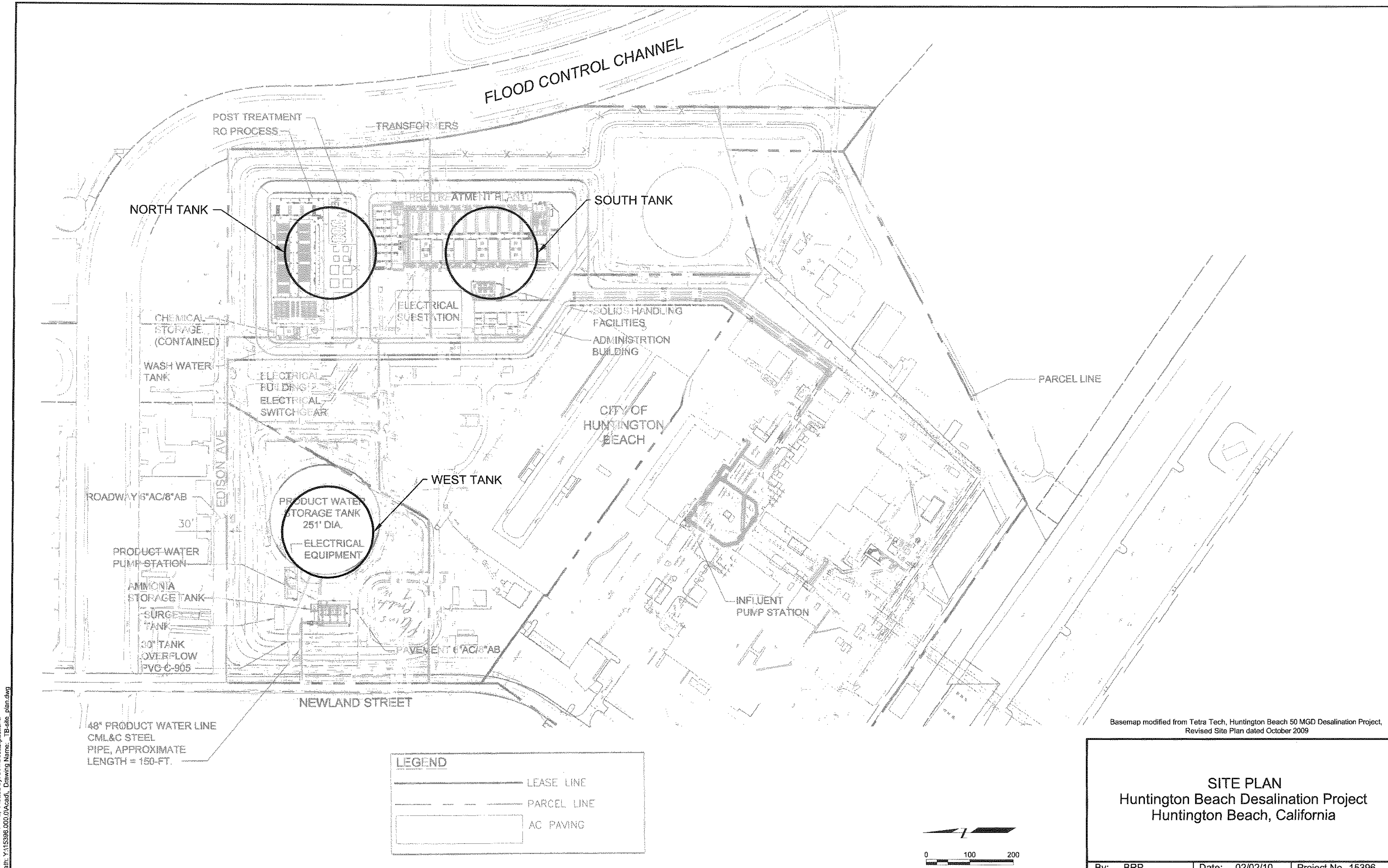

Basemap modified from Tetra Tech, Huntington Beach 50 MGD Desalination Project, Revised Site Plan dated October 2009

SITE PLAN
Huntington Beach Desalination Project
Huntington Beach, California

By: BRP	Date: 02/02/10	Project No. 15396
D. Scott Magorien, C.E.G. Consulting Engineering Geologist		Figure 1

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