4.0 GEOLOGY AND SOILS

This chapter describes geology, soils, and seismicity in the local area in general and in the project site specifically. It includes the regional and project settings to provide a context for analyzing the effects of the project. The information presented in this section was compiled largely from information provided by the Bahia Wetlands Restorations Project Preliminary Design Report (Appendix A) and the CALFED Bay-Delta Program Final Programmatic EIS/EIR and Record of Decision issued August 28, 2000 (including CEQA certification). Previous geotechnical work, including a number of regional and site-specific geotechnical investigations, have been performed at the project site. The site specific studies were performed in connection with past proposals for residential development and for the Bahia Homeowners Association (HOA) proposed navigation lock/dredging project (Cooper 1964, Cooper, 1969; Cooper 1971; Cooper, 1977; Donald, 1986; Miller, 1991; Miller 1997). References to other documents are provided as appropriate.

This chapter discusses characteristics of existing deposited sediments (sand silt and clay), soils, and fill materials at the project site and briefly addresses the issue of soil subsidence at the site. However, this chapter does not address sediment deposition in detail. Sediment deposition is affected by site and regional hydrology, and site and regional hydrology is conversely affected by the sediment deposition rates and distribution. Therefore, sediment deposition is more appropriately addressed in the context of site and regional hydrology (see Section 3.1.1).

This chapter also does not address hazardous materials in detail. Review of available data determined that this was not an issue requiring detailed study in this EIR. While fill at East Bahia and soils at Central and West Bahia have not been analyzed for toxic constituents, in 1993 the Bahia HOA collected data from sediments adjacent to the project site. Results from the HOA testing are probably very similar to what would be found on the site. Chemical, physical, and bioassay testing of lagoon sediments in 1993 documented constituents of concern (COCs) which include poly-aromatic hydrocarbons (PAHs), petroleum hydrocarbons, and metals in Bahia sediments (City of Novato, 1999). The COCs in the Bahia lagoon were at or below background levels found in the sediments at the mouth of the Petaluma River. Additionally, a Phase I Site Assessment was performed on the project site in when the property was purchased by the California Department of Fish and Game (DFG). No evidence of contamination was found.

4.2 AFFECTED ENVIRONMENT

4.2.1 Regional Geology

The site is within the Coast Range Geomorphic Province, which includes San Francisco Bay and the northwest-trending mountains that parallel the coast of California. These features were formed by tectonic forces resulting in extensive folding and faulting of the area. Previous geologic mapping indicates that the western portion of Novato is underlain by bedrock of the Franciscan Formation. This unit is Jurassic to Cretaceous in

age, and typically consists of a highly heterogeneous mixture of sandstone, sheared shale, metavolcanic rock, serpentine, and chert. The eastern portion of Novato is generally underlain by conglomerates of the Great Valley Sequence. This formation is believed to range from 1,300 to 2,600 feet thick, and to have been tectonically thrust over the Franciscan basement rocks. Within the Petaluma Valley, the conglomerates are generally blanketed with Quaternary age alluvial and estuarine deposits (Rice, Smith and Strand, 1973).

4.2.2 Underlying Geology and Soils

The hill area adjacent to the site on the ridge is underlain by Novato Conglomerate, a dense, massive, well-cemented conglomerate consisting of rhyolite and chert pebbles, cobbles, and boulders in a sandy, clay matrix. The soils formed on the Novato Conglomerate are thin, gravelly, well drained, and non-swelling (Rice, 1973). The diked bayland is underlain by Holocene Bay Mud deposits as much as 80 feet thick. These mud deposits are composed of soft, low density, highly compressible, impermeable silty clays, with peaty deposits dispersed throughout. The soft mud overlies firm soils composed of stiff silty clays and sand underlain by Novato Conglomerate (Cooper-Clark and Associates, 1977, Diagram 29).

4.2.3 Fill at the Project Site

There is a long history of fill at the project site. The levees were constructed by dredging ditches and piling the Bay Mud to create the levees and low berms at West and Central Bahia. Filling continued in the 1960's when the Bahia development was constructed.

The East Bahia peninsulas were constructed out of fill material over several years, beginning in 1965. In 1972 and 1987, spoils from dredging the lagoon were used as peninsula fill. Spoils were again used in 1987 to fill the Eastern Peninsula. The peninsulas have been built up to an elevation of +8 to +9 feet National Geodesic Vertical Datum (NGVD). The lagoon waterways were originally dredged to a depth of –11 feet mean sea level (MSL). The Eastern and Central Peninsulas are composed of Bay Mud and the Western Peninsula is composed of a Novato Conglomerate fill of clayey gravel. The peninsulas are surrounded by levees +12 to +14 feet NGVD. The Bay Mud fill of the peninsulas is compacted, and is substantially less compressible, stronger, and lower in water content than undisturbed Bay Mud.

Dredge spoils from the lagoon have also been deposited on areas of Central Bahia. Twelve acres were set aside as a dredge spoil area and a decant pond was constructed. Additionally, fill was used to construct the parking lot and the levee along the HOA channel (Bahia Master Plan, 1997).

4.2.4 Seismicity

The site is not within any current Earthquake Hazard Zone (formally an "Alquist-Priolo Special Study Zone"), which defines zones that are considered to contain active faults. A minor fault trace of the Burdell Mountain Fault is located near H Lane, running approximately parallel to H Lane and crossing Bugeia Lane. This fault is not currently zoned and previous work discussing the potential activity of the fault indicates that it is typically not considered to have been active within the last 11,000 years (Rice 1973).

In the event of an earthquake, the expected ground motions at the site will depend on the type of generating fault, distance to the epicenter, magnitude of the earthquake and geologic site conditions. Deep deposits of soft Bay Mud will experience more severe shaking, due to amplification of seismic waves, than the adjacent hillside areas. Rice (1973) classified the adjacent hillside area (underlain by firm, well cemented Novato Conglomerate) as a low probable earthquake damage zone and the diked baylands area of the project site (underlain by deep Bay Mud deposits) as a highest probable earthquake damage zone. Cooper, Clark and Associates (1977) determined that the site is not underlain by deposits of sand and, therefore, the hazards associated with liquefaction are negligible.

4.2.5 Slope Stability

The slopes on the conglomerate hill section adjacent to the project site have been classified by Rice (1973) as having high to moderate stability, with Novato Conglomerate being characteristically a stable rock unit. The sediment (Novato Conglomerate) making up the hills is relatively stable and the risk that of a landslide on the hills that could impact the project site marshlands below is low.

4.2.6 Soil Subsidence

Subsidence problems exist in the diked baylands areas because of the highly compressible nature of the existing fills. These fills have already settled approximately 6 to 18 inches in the past 40 years (Donald Herzog & Associates, Inc., 1986).

4.3 CRITERIA FOR DETERMINING SIGNIFICANCE OF EFFECTS

Impacts on geology and soils were analyzed based on a review of soils and existing geologic data of the project site. Criteria based on the *CEQA Guidelines* and professional judgment were used to determine the significance of geology, soils, and seismicity related impacts. According to these criteria, the project would have a significant impact on geology, soils, and seismicity if it would result in:

- Substantial removal, filling, grading, or disturbance of soils.
- Substantial degradation of the quantity or quality of native soil types or their environmental and water quality protection characteristics in significant watersheds.
- Releases of toxic materials from soils or sediments.
- Substantial adverse changes in rates of sedimentation or erosion.
- Substantial adverse changes in soil drainage or salinity.

- Increases in soil subsidence rates that produce adverse effects.
- Changes in soil conditions that cause undesirable seepage to adjacent lands.
- Increased potential for soil erosion by wind, waves, or currents.
- Oxidation of, or drainage from, peat soils that may cause adverse effects.
- Increased potential for erosion and mass failure-induced landslides.
- Increased potential for seismic activity or vulnerability of soil-comprised structures to seismic events.
- Disruption of natural or favorable soil profiles and horizons.

4.4 ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

The Proposed Project and two proposed alternatives (Alternatives 1 and 2) would positively impact site and regional geology and soils in a number of ways. These proposed actions would reverse the subsidence and erosion processes that have already occurred at the site and would eventually reintroduce natural bay marshland soil conditions, conducive to the re-establishment of native vegetation. The No Project Alternative would not have these beneficial impacts.

The Proposed Project and Alternatives 1 and 2 will all require extensive grading and soil excavation. Under all three of these alternatives, levees will be breached and lowered in a controlled manner, and portions of the levees will be left in place to protect the Bahia HOA channel from wind and wave erosion. Under all three of these alternatives, lowering and breaching of the levees would overall reduce potential impacts from levee failure resulting from erosion or a geologic disaster, such as an earthquake, strong seismic ground-shaking or liquefaction. Under all three project alternatives, sediment deposition at the site would increase and subsidence, which is a current problem at the site, would eventually be reversed. Substantial removal, filling, grading, and disturbance of site soils would occur under all three alternatives; however, this would be mitigated by implementation of Best Management Practices (BMPs) to protect soils.

The No Project Alternative would not cause any impacts from soil excavation, grading, and compaction; however, existing levees would continue to be subject to damage from geologic disasters. Levees at the site already appear to be showing signs of years of wear, and it is possible that one or more unplanned levee breaches have apparently already occurred. Levee failure resulting from erosion or geologic disaster could have significant negative impacts on existing marshlands upstream of the project site (e.g., Rush Creek and Cemetery Marsh) as the site would capture most of the tide from Black John Slough, potentially impacting upstream sedimentation patterns. In addition, site soils and sediments would continue to subside.

As discussed above, hazardous materials are not addressed in detail in this EIR, and negative and positive impacts related to site sedimentation are discussed in detail in Chapter 3.

4.4.1 Proposed Project

Under the Proposed Project the previously placed fill at East Bahia will be either reconfigured or removed to restore the site to pre-disturbance conditions to the degree feasible. Approximately 23,000 cubic yards (cy) of fill will be excavated from the East Bahia Peninsulas and used at the Central Peninsula of East Bahia and at Central Bahia to create transitional and seasonal wetland habitat. This will require extensive excavation, grading, and compaction. The benefits of this disturbance appear to outweigh the potential impacts.

Geologic Impact-1. Substantial removal, filling, grading, or disturbance of soils. The site has been disturbed by the construction of levees and the placement of large quantities of fill to create the peninsulas at East Bahia. The purpose of the project is to restore the site to pre-disturbance conditions to the maximum extent feasible. This will require fill removal, grading, and the disturbance of soils.

Significance: Potentially significant

Mitigation for Geologic Impact 1: Use Best Management Practices (BMPs) to protect soil during and immediately after construction.

The following BMPs would be implemented, as appropriate:

Siltation Controls

Install silt fences, localized silt barriers, construction mats, or other erosion control measures during construction in wetland and aquatic habitats located in creeks and sloughs. No sediment controls will be applied when runoff is directed toward pond interiors unless sensitive wildlife resources are identified.

Maintain siltation controls in properly functioning condition in accordance with the manufacturer's specifications and good engineering practices. Controls will be removed after construction. Should sediment escape the construction site, accumulations of sediment will be removed and placed in a location where it can not impact water quality.

Hazardous Materials

All wastes created during construction (e.g. trash, excess construction material, etc.) would be removed from the construction area and disposed of in an approved disposal site. No trash or other solid waste pollutants will be buried within the construction area or discharged into waters of the United States. The project with comply with all applicable State and or local waste disposal regulations.

Generation of fugitive dust would be minimized by accepted practices. If precipitation occurs during construction, vehicular traffic along the construction corridor will be minimized to reduce the potential for erosion.

Gasoline, diesel fuels, lubricants and other potential pollutants would be stored in containers that would prevent their accidental release. Any unused lubricants or used engine oil will be removed from the site and disposed of at an approved facility. Additional steps to prevent the accidental discharge of potential pollutants will be described in a project-specific spill prevention plan.

Overnight or out-of-use equipment will be parked on impervious mats/tarps to capture leaking oil and lubricants.

Routine maintenance of equipment will be limited to fueling and lubricating equipment. No major cleaning or major equipment repairs would be conducted at the construction site.

Prior to construction an environmental inspector who will verify the limits of authorized construction work areas and identify any additional stabilization needed or special construction management needed to protect sensitive wildlife. During construction if conditions are identified that should impair water quality or harming wildlife occurs, the construction activity will be ceased and rescheduled or the construction design will be changed to prevent reoccurrence.

Post-mitigation significance: Less than significant

Geologic Impact-2. Potential for seismic activity or vulnerability of soil –comprised structures to seismic events. Proposed temporary structures (e.g., the proposed pump and 48-inch culvert) could be subject to damage in the event of a geologic disaster, such as an earthquake, strong seismic ground-shaking or liquefaction. Given the inactive status of the Burdell Mountain Fault, this fault probably does not pose a significant hazard to the project. Overall, lowering and breaching the site levees would reduce the potential for impacts resulting from a sudden uncontrolled levee failure.

Significance: Less than significant.

4.4.2 No Project Alternative

Geologic Impact-2. Potential for seismic activity or vulnerability of soil –comprised structures to seismic events. Under the No Project Alternative, the temporary structures proposed under the Proposed Project (e.g., the temporary pump and 48-inch culvert) would not be built. Therefore, there would be no concern about these structures being subject to damage in the event of a geologic disaster, such as an earthquake, strong seismic ground-shaking or liquefaction will not be built. However, the site levees would not be lowered and breached. Therefore, these levees would remain subject to sudden uncontrolled levee failure in the event of a geologic hazard. Un-controlled levee breaches may have a negative impact on sedimentation patterns at Rush Creek and Cemetery Marshes. This is a potentially significant impact.

Significance: Potentially significant. Since this alternative will result in the project not being implemented, no mitigation measures are proposed.

Geologic Impact-3. Increased potential for soil erosion by wind, waves, or currents. Under the No Project Alternative, the levees in the project area will continue to deteriorate, primarily through erosion. Erosion may be caused by wind-wave action within the ponds or by scour along the outside of the ponds. Un-controlled levee breaches may have a negative impact on sedimentation patterns at Rush Creek and Cemetery Marshes. This is a potentially significant impact.

Significance: Potentially significant. Since this alternative will result in the project not being implemented, no mitigation measures are proposed.

Geologic Impact-4. Potential for soil subsidence producing adverse effects. Much of the project site has been adversely impacted by soil subsidence. Some locations at the site have subsided more than six feet. Under the No-Project Alternative, the site will continue to subside.

Significance: Potentially significant. Since this alternative will result in the project not being implemented, no mitigation measures are proposed.

4.4.3 Alternative 1 (Reduced Fill Removal from East Bahia)

The impacts (negative and beneficial) to geologic resources that are anticipated if Alternative 1 is implemented are identical to those anticipated for the Proposed Project. Compared to the Proposed Project, Alternative 1 does require less transportation of fill, but it will still require substantial grading and re-configuration of fill on-site. Therefore, this impact is the same as the Proposed Project. Proposed mitigation measures are likewise identical.

4.4.4 Alternative 2 (No Fill Removal from East Bahia)

The impacts (negative and beneficial) to geologic resources that are anticipated if Alternative 2 is implemented are identical to those anticipated for the Proposed Project and Alternative 1. Compared to the Proposed Project and Alternative 1, Alternative 2 requires less transportation of fill, but it will still require substantial grading and re-configuration of fill on-site. Therefore, this impact is the same as the Proposed Project and Alternative 1. Proposed mitigation measures are likewise identical.