4.3 EARTH RESOURCES

4.3.1 EXISTING CONDITIONS

The Fairfield Suisun area lies north of Suisun Bay in the southeastern part of the Coast Ranges geomorphic province. The project site is located in the Potrero Hills, adjacent to Suisun Bay and Marsh. Before landfilling, elevations at the existing landfill site ranged from 40 to 70 feet above mean sea level (msl) along the southern boundary and from 70 to 230 feet above msl along the northern boundary.

The Potrero Hills are an isolated east-west trending ridge of Pliocene and Eocene consolidated sediments along the eastern edge of the California Coast Ranges. The hills are separated from the main ridges of the Coast Ranges by the alluvial valleys of the Fairfield-Suisun area and Suisun Bay and Marsh. Progressing northward from the southern hills toward the site, various geologic areas can be identified, including Paleocene Eocene bedrock foothills, Pleistocene foothill slopes, and Pleistocene Recent alluvium in the low-lying area. Each area grades into the next so that no clearly defined boundaries are found.

The foothills are composed of a fairly homogeneous series of light colored sandstones, shales, and siltstones consisting of Domengine sandstone, Capay Formation shale and mudstone, Martinez Formation sandstone, Nortonville shale, and Markley sandstone.

A gentle Pleistocene alluvial slope extends northward from the foothills. The slope material, older alluvium derived from upslope weathered bedrock, grades into younger sediments along the base of the foothills that consists primarily of silty clays, with occasional clayey sand and clayey gravel lenses.

SITE SOILS

The soil phases underlying the project site were mapped by the U.S. Soil Conservation Service in 1977 and include the following series: Altamont, Antioch San Ysidro, Clear Lake, Diablo Ayar, Gaviota, and Millsholm. The valley section of the site is dominated by clay soils; the upland section is a complex of clay, loam, and sandy loam types.

The soils have been formed from the weathered, sedimentary rock of the Capay and Domengine Formations. Depths to weathered bedrock range from 0.5 foot to 3.5 feet. The weathered material extends to a depth of 25 feet in the Capay Formation (EMCON 1983). Table 4.3-1 lists the generalized physical properties of the soil series mapped on the site.

SITE SLOPE STABILITY

The Potrero Hills surrounding the site are an eroded anticlinal structure, composed primarily of folded marine sediments and younger, unconsolidated material. The upfolded marine strata have been eroded to form a horseshoe shaped group of low hills with an interior valley that slopes gently to the west. A limited amount of alluvial material is present along the major drainages in the valley. This includes a small area on the southern border of the project site.

Table 4.3-1
Physical Characteristics of Soils in the Potrero Hills Landfill Area (Phase I Project)

Soil Series and Map Symbol	Bedrock (feet)	Depth to Seasonal High Water (feet)	Profile Depth from Surface (inch)	U.S. Department of Agriculture Texture	Permeability (inches per hour)	Shrink/Swell Potential	Erosion Hazard
Altamont: AcC, AcE, AcF2	2-3.5	(1)	0-28 28-38 38	Clay Silty clay loam Siltstone	0.06-0.2 0.06-0.2	High Moderate	Slight
Antioch: AoA	5+	(1)	0-19 19-60	Loam Clay	0.63-2.0 <0.06	Low High	None
Ayar: DaE2	3.5-5+	(1)	0-41 41-51 51	Clay Clay loam Weakly consolid. sediments	0.06-0.2 0l06-0.2	High Moderate	Moderate
Clear Lake: CeA	5+	4-5+	0-60	Clay	0.06-0.20	High	None
Diablo: DaE2	2.5-4	(1)	0-36 36	Clay Consolid. sediments	0.06-0.2	High	Moderate
Gaviota: GaG2	0.5-1	(1)	0-12 12	Sandy loam Sandstone and shale	2.0-6.3	Low	High
Millsholm: MmE	1-3	(1)	0-17 17	Loam Sandstone	0.63-2.0	Low-Moderate	Moderate
San Ysidro: AoA	5+	(1)	0-14 14-68	Sandy loam Clay loam	2.0-6.3 <0.06	Low High	None

(1) = No water table with depth of observation; normally at a depth of 5 feet unless limited by bedrock or hardpan.

Source: U.S. Soil Conservation Service 1977

The residual soils that have formed over the exposed marine sediment on the north facing slopes of the interior valley are subject to slides, slumps, and earth flows during the rainy season. The entire Potrero Hills area is listed as slope instability Type B (extensive landslide prone areas intermixed with more stable soils) in the Health and Safety Element of the Solano County General Plan (Solano County Planning Department 1977). Each of the geologic formations present in the Potrero Hills is described in detail by EMCON Associates (1983). Although some shallow landsliding activity is present in the Potrero Hills, none is mapped in the Phase I landfill boundaries. Most of the sliding has occurred on the southern interior perimeter of the hills.

REGIONAL AND SITE SEISMICITY

The project is located northeast of the seismically active San Francisco Bay Area. Earthquakes have occurred throughout the entire Bay Area; most of these have had epicenters along the San Andreas, Hayward, and Calaveras Fault Zones. Epicenter locations are generally within 1 mile or so of known fault traces.

Major active faults that could be sources of strong shaking at the project site are the San Andreas Fault (43 miles west of the site) and the Hayward Fault (25 miles west of the site). The Birds Landing Seismic Zone in the Central Valley Coast Ranges Fault (6 miles west of the site) and the Green Valley Fault (9 miles west of the site) could subject the site to strong shaking because of their proximity.

Table 4.3-2 shows the maximum credible earthquake (MCE) magnitude and median horizontal peak ground acceleration for the major active faults in the area. The California Division of Mines and Geology defines the MCE as the largest earthquake that has a reasonable chance of occurring under the currently known tectonic framework. Class II landfills are required to be designed to withstand the MCE. The maximum probable earthquake is defined as the earthquake likely to occur in a 100-year interval. Class III landfills, such as the Potrero Hills Landfill, are required to be designed to withstand the MPE (EMCON, May 1999).

Table 4.3-2
Regional Faulting and Preliminary Site Groundshaking Parameters

Fault Name	Approximate Near Distance to Site (miles)	Maximum Credible Earthquake Magnitude	Maximum Probable Earthquake Magnitude
Birds Landing Seismic Zone	6	6.0	0.26
Central Valley Coast Ranges	6	6.4	0.33
Green Valley	9	6.0	0.16
Calaveras	25	6.6	0.080
Hayward	25	7.0	0.095
San Andreas	43	8.0	0.101

Source: EMCON file data

To estimate ground acceleration at the site, the MCE for each fault is located at the fault's closest point to the site and the median ground motion is computed based on the natural attenuation that occurs over distance (EMCON, May 1999).

Studies that have been conducted concerning the soils and geology, and the site's static and dynamic stability include:

- review of subsurface exploratory data for development of a description of the soil stratigraphy beneath the site;
- review of laboratory test data on soil samples to define relevant soil index and strength parameters;
- analysis of the static stability of the landfill; and
- analysis of the possible seismic deformations at the site during maximum credible earthquakes on the Hayward, San Andreas, and other fault systems.

During the processing of the original Waste Discharge Requirements (WDRs) for the site, the Regional Water Quality Control Board (RWQCB) required that a slope stability analysis be conducted. EMCON conducted the analysis for the Phase I Project and reported results in September 1985. The project seismic design report is included as Appendix P in the Joint Technical Document (PHLF Environmental Management Division, January 2003). Additional studies in 1994 and 1998 are described below.

SITE SUBSURFACE CONDITIONS

Investigations were conducted in compliance with regulatory agency landfill location criteria and to develop site design constraints and criteria for landfill development. The underlying clay soils are considered impermeable and generally preclude downward percolation from the base of the landfill. Two claystone and shale deposits provide hydraulic separation from the groundwater-bearing sediments in the outlying valley area to the north and Suisun Marsh area to the south.

STATIC AND DYNAMIC SLOPE STABILITY ANALYSES

As noted above, the analyses of static and dynamic slope stability, deformation analysis, and potential for liquefaction for the site are described in the Joint Technical Document (Appendix P, Slope Stability Investigation) (Potrero Hills Landfill Environmental Management Division. January 2003).

Stability analyses were performed to compute the static factor of safety for various configurations and material strengths. This information was used to develop a design basis and obtain the yield acceleration of the slopes to determine seismic deformations.

The potential risk of a slope to fail is often expressed as a factor of safety, which is determined by dividing the forces that resist slope failure (i.e., shear strength) by those that drive the slope to fail (i.e., weight). If the resisting forces are greater, the factor of safety is greater than 1 and the slope is considered stable. If driving forces are greater, the factor of safety is less than 1 and the slope is considered unstable.

EMCON estimated seismic displacement using a rigorous analytical method in lieu of achieving a factor of safety of 1.5 for seismic conditions, pursuant to CCRs Title 27, Section 21750(f). The details required under Title 27, Section 20370 (Seismic Design) are included in Appendix P of the Joint Technical Document (Potrero Hills Landfill Environmental Management Division. January 2003).

FEDERAL AND STATE REGULATIONS THAT ADDRESS EARTH RESOURCES

Federal Regulations Included in 40 CFR 258

These regulations provide guidelines and requirements for management of solid waste disposal facilities, including siting requirements, design, operations, groundwater monitoring, corrective action, and closure and post-closure maintenance requirements. These regulations address issues associated with geologic hazards and unstable soil conditions and are generally the minimum standards to be applied by all states (although each state may propose more stringent regulations). The state is responsible for administering these regulations.

California Regulations Included in CCR Title 27, Division 2, Solid Waste

These regulations apply to all solid waste management facilities and include requirements for siting, design, permitting, construction, operations, monitoring, closure, and post-closure maintenance, and monitoring. Both the RWQCB and the California Integrated Waste Management Board provide oversight and enforce these requirements. With respect to earth resources, the regulations describe and include standards that address:

- geologic siting criteria for landfills in seismic impact zones, unstable areas, or areas of rapid geologic change;
- design criteria to provide static and seismic stability of the waste fill and associated containment and environmental protection facilities;
- minimum grading and material (soil and geosynthetic) requirements;
- construction quality assurance requirements to ensure construction in accordance with approved plans and specifications for the project; and
- requirements for post-closure monitoring and maintenance.

4.3.2 IMPACTS AND MITIGATION MEASURES

THRESHOLDS OF SIGNIFICANCE

The following criteria were used to evaluate the significance of impacts of the proposed project on geology, soils, and seismicity. An impact on geology, soils, or seismicity was considered significant if the project would:

- expose people, structures, or property to major geologic hazards such as earthquakes, landslides, or other ground failure;
- result in substantial disruptions, displacements, compaction, or overcovering of the soil; or
- cause substantial accelerated erosion of soils or siltation, either on or off the site.

Impact **4.3-1**

Faulting and Seismic Shaking. *Fault rupture or strong shaking at the site during a major earthquake could damage the integrity of the landfill containment system (i.e., the liner, cover, and ancillary facilities such as landfill gas management system, leachate collection system, etc.) with associated threats to public health and the environment. This impact would be considered **significant**.*

No known active faults underlie the project area, nor have any older inactive faults been mapped across or adjacent to the site. Therefore, the potential for surface fault rupture affecting the site is low. The San Andreas Fault (43 miles west of the site) and the Central Valley Coast Ranges Fault (6 miles west of the site) could subject the site to strong shaking because of their proximity. The San Andreas Fault has a Maximum Credible Earthquake (MCE) magnitude of 8.0 and an estimated ground acceleration of 0.11g (i.e., 11 % of the acceleration because of gravity). The Central Valley Coast Ranges Fault has an MCE magnitude of 6.8 and an estimated ground acceleration of 0.43g.

In the absence of appropriate engineering measures, such relatively strong ground shaking could cause permanent horizontal displacement of the refuse column; slope failure; liquefaction; damage to the landfill liner, drainage or gas collection systems; damage to structures; or onsite safety hazards. This impact would be considered significant.

Mitigation Measure 4.3-1 Faulting and Seismic Shaking

The final design documents for the proposed landfill expansion shall be prepared pursuant to the requirements of CCR Title 27, Section 20370. These regulations require that the final design documents for the proposed landfill expansion demonstrate the ability of the landfill to withstand ground shaking associated with the Maximum Probable Earthquake (MPE) without damage to the foundations or to the structures which control leachate, surface drainage, erosion, or gas.

In addition, the design recommendations included in the *1999 Geology and Geotechnical Engineering Evaluation* (EMCON, May 1999) for the site shall be implemented. These include the following design elements.

- During excavation of cut slopes, engineering geologic mapping shall be required to confirm the findings of the *1999 Geology and Geotechnical Engineering Evaluation*.
- MSW slopes in the Pre-Subtitle D area shall not be constructed at angles greater than 3:1 with required benching at least every 100 feet.
- MSW slopes in the Subtitle D area shall not be constructed at angles greater than 4:1.
- Site specific geosynthetic materials and geomembrane-clay interface strengths shall be confirmed by testing prior to construction in the Subtitle D area.
- The cover system over the Subtitle D area shall be maintained by providing a minimum interface friction angle of 24 degrees above the geomembrane and an interface shear strength (adhesion) of 200 pounds per square foot between the geomembrane and low-permeability soil under low overburden pressures. The values shall be verified during the final design of the cover system.
- Preliminary dewatering of the saturated sandstone above the proposed base grades shall occur.
- In existing slide areas, the slide material shall be removed before cell development.
- Provisions shall be made to repair potential surficial slides in the temporary and permanent excavation slopes. This may require buttressing, reinforcing, or repairing the slopes.
- Surficial soils beneath composite-lined areas of the landfill shall be removed to minimize foundation settlements.

Level of Significance after Mitigation

With implementation of the identified mitigation measure, potential seismic impacts would be considered less than significant.

Impact **4.3-2**

Slope Stability. *Static stresses to natural or artificial slopes within the project site could cause slope failures and associated impacts. This impact would be considered* ***significant****.*

Static stresses to natural or artificial slopes within the project site could cause slope failures and associated impacts. Static forces are generally defined as gravitational settlement that is not induced by seismic events. Failure can occur because of inconsistent fill compaction, over-steepened slopes, soil creep in soils with high shrink-swell potential, and infiltration of surface water. Failure could occur during project operation, closure, or any time after closure. Failure of refuse slopes could disrupt landfill cover materials, which could expose wastes and result in potential odor, litter, infiltration, and pest impacts. Large quantities of sediment resulting from a slope failure could clog drainage facilities. Slope failures also could damage or destroy drainage, leachate control, and gas collection systems. This would be considered a significant impact.

Mitigation Measure 4.3-2 Slope Stability

The final design documents for the proposed landfill expansion shall be prepared pursuant to the requirements of CCR Title 27, Section 21090. These regulations require that the integrity of the final slopes under both static and dynamic conditions be ensured. Section 21090 specifies maximum final slopes and minimum design requirements, and requires a slope or foundation stability report for final slopes that exceed a horizontal to vertical ratio of 3:1 for slopes in areas subject to liquefaction or unstable areas with poor foundation conditions.

In addition, the design recommendations included in the *1999 Geology and Geotechnical Engineering Evaluation* (EMCON, May 1999) for the site shall be implemented. These design recommendations are identified in Mitigation Measure 4.3-1 above.

Level of Significance after Mitigation

With implementation of the identified mitigation measure, potential slope stability impacts would be considered less than significant.

Impact **4.3-3**

__**Potential Excessive or Differential Landfill Settlement.**__ *Excessive settlement could cause breaches to develop in the final cover, which could allow surface water to infiltrate into the landfill. Design of the proposed landfill would be required to comply with Title 27 requirements for final cover design, final surface grades, and continuing monitoring and maintenance to reduce potential impacts because of settlement. Compliance with these requirements would reduce the potential for landfill settlement to an acceptable level of risk. This impact would be considered* ***less than significant****.*

The surface of the landfill settles over time. Settlement would result from compaction of the refuse under its own weight, compaction from the addition of cover materials, decomposition of organic materials, the formation of voids within the refuse, vibration from earthmoving and landfill equipment, and seismic ground shaking.

Differential or uneven settlement could create sags and depression in the liner materials or final cover. Excessive settlement could cause breaches to develop in the final cover, which could allow surface water to infiltrate into the landfill. Infiltration would increase the rate of leachate generation or settlement because of the decomposition of organic wastes. Cracks in the final cover also could damage surface structures (such as roads and drainage facilities) or subsurface structures (such as landfill gas and leachate systems).

Design of the proposed landfill modifications is required to comply with Title 27 requirements for final cover design, final surface grades, and continuing monitoring and maintenance to reduce potential impacts because of settlement. Because the site is situated over consolidated shale or sandstone bedrock, the weight of the landfill is not anticipated to cause significant compression and settlement of the sediments. The settlement analyses completed to date indicate that vertical settlement is not sufficient to interfere with the landfill grades. The settlement of the top surface would be affected by the consolidation of the buried wastes. The 4:1 side slopes proposed for the landfill expansion are anticipated to provide sufficient latitude of horizontal slope so that differential settlement would have negligible consequences.

Estimated settlements from primary consolidation due to the cover load are in the range of 4 to 6 feet. Settlement due to secondary compression is as much as 20 feet for the deepest portion of the landfill. The estimated municipal solid waste (MSW) settlement (primary and secondary) is approximately 9 to 13% of the initial (pre-settlement) MSW depth. Maximum settlement at the deepest portion of the landfill (about 270 feet of MSW) is about 25.6 feet. Although this is a large amount of settlement, secondary compression begins within about a year of waste placement. Much of the settlement, especially in deeper portions of the landfill, would occur prior to final closure. The minimum final design grade of the landfill is 5% at the top deck. Accounting for settlement of the MSW, the top deck slopes are estimated to remain about 4.7% during the postclosure period. Based on the lack of compression anticipated with the underlying bedrock and the incorporation of MSW settlement into the landfill design, significant adverse impacts associated with landfill settlement would not be anticipated.

Mitigation Measure 4.3-3 Potential Excessive or Differential Landfill Settlement

No mitigation measures would be necessary.

Level of Significance after Mitigation

Potential settlement impacts would be considered less than significant.

Impact **4.3-4**

Erosion. *Removal of site vegetation and project grading may result in erosion or unstable soil conditions. The construction and operational activities associated with the project could result in increased soil erosion and loss of topsoil. As a result, potential impacts associated with soil erosion would be considered **significant**.*

Construction and operational activities associated with landfill expansion could increase soil erosion and loss of topsoil because of vegetation removal associated with site grading. In addition, wind and water erosion of landfill slopes and soil stockpiles during the operating and post-closure life of the landfill would increase with the greater total surface area of the landfill mound. Construction and ground-disturbing activities typically accelerate the natural ongoing soil erosion process by exposing loosened and disturbed solids to the elements. Erosion and runoff of material from graded or disturbed areas tend to increase with periods of precipitation or extreme winds, resulting in sedimentation in storm drains or natural watercourses. Potential impacts associated with increased erosion at the site would be considered significant. (For a detailed discussion of the potential impacts of erosion on water quality, please refer to Section 4.4, Hydrology and Water Quality of this report).

Mitigation Measure 4.3-4 Erosion

In order to minimize the potential for increased soil erosion on the site, the landfill expansion shall be designed in accordance with the drainage and erosion control requirements of CCR Title 27 §§20365, 20190, 21150, and 21750. CCR Title 27 requires engineered controls to limit erosion associated with facility operations. These controls typically include diversion of storm water runoff using temporary swales or interceptor ditches, retention of existing vegetation wherever possible, stabilization of barren soils with jute netting or geotextile fabric, installation of erosion-resistant layers, application of straw or mulch after seeding, installation of silt fences, berms, or hay bales to direct runoff away from construction areas, and visqueen sheets (plastic vapor barriers) or tarps to cover stockpiled soils.

In addition, the project applicant shall implement Mitigation Measures 4.4-1 and 4.4-2 identified in Section 4.4, Hydrology and Water Quality of this report.

Level of Significance after Mitigation

With implementation of the identified mitigation measures, potential erosion impacts would be considered less than significant.