APPENDIX C.

CONCEPTUAL SITE MODEL

This appendix presents the Conceptual Site Model (CSM) for the Folsom Corporation Yard Landfill (Site) located at 1300 Leidesdorff Street in Folsom, California. The regional stratigraphy and hydrogeology are discussed first followed by Site stratigraphy and hydrogeology. References cited in this appendix are provided in Section 7.0 of the main report.

Regional Setting

This section discusses the regional stratigraphy and hydrogeology.

Regional Stratigraphy

The Site is located where fluvial deposits of the ancestral and modern American River flood plain abut the foothills of the Sierra Nevada. The current American River flood plain deposits overlie a thick succession of gravels, sands, and clays that have been interpreted to represent deposits of the ancestral American River system of Pliocene to Pleistocene age. Geomorphically, this area is near the boundary of the "dissected alluvial uplands" and "Sierra Nevada" geomorphic provinces (Olmsted and Davis, 1961). The dissected alluvial uplands are typified by rolling topography, rounded knolls and ridges, separated by minor intermittent streams (U. S. Geological Survey [USGS], 1985). The underlying sediments are being uplifted with the foothills of the Sierra Nevada and are eroding. The Sierra Nevada geomorphic province is underlain by hard, non-water bearing rocks, and is characterized by steep-sided hills and narrow, rocky stream channels.

Based on work conducted at the Aerojet facility (approximately 2.5 miles to the south of the Site), the geology in the vicinity of the Site includes sedimentary formations ranging in age from Cretaceous to Recent periods that thin to the east and are uncomfortably juxtaposed with a Jurassic metamorphic basement complex (Woodward-Clyde, 1997). Figure C-1 illustrates the subsurface geology of the region surrounding the Site. As seen on this figure, at the approximate longitude of the landfill, sedimentary formations underlying the Site include dredged and undisturbed portions of the Laguna Formation, Mehrten Formation, and depending upon depth to bedrock, possibly the Valley Springs Formation. Depth to bedrock in this area is reported to be between 150 feet and 170 feet below ground surface (bgs). Bedrock outcrops within 100 to 200 feet east of the Site suggesting that the sedimentary formations at the Site may be thinner than observed at the Aerojet facility. A brief description of the Laguna, Mehrten, and Valley Springs formations and bedrock are presented below.

- Laguna Formation: Numerous formations have been designated in the area that overlie the Laguna Formation. However, these formations have been identified based on soil profile, depositional environment, or

geomorphic features, and thus are for the most part indistinguishable, especially in the subsurface, from the Laguna Formation. As such, and consistent with the North American Commission on Stratigraphic Nomenclature (NACSN, 1983), these younger units have been included with the Laguna Formation for the purposes of this investigation. Therefore, this formation includes deposits varying from latest Holocene to Quaternary in age.

The Laguna Formation consists of poorly bedded layers of silt, clay, sand, and gravel deposited by meandering rivers and streams such as the American River. The sands and gravels were deposited during high velocity flows that occur during times of flooding.

Outside the ribbon-like strips of coarse channel deposits, lower velocity waters deposited silts and clays. The percentage of coarse channel deposits increase towards the mountains from which the streams and rivers emanate. Sediments are generally non-volcanic and predominantly arkosic (feldspar-rich) in contrast to the underlying formations. The underlying Mehrten Formation is distinguished from the Laguna Formation by the first occurrence of sediments composed predominantly of andesitic material.

Historical gold mining operations in the area included extensive dredging of the Laguna Formation to reported depths of 40 to 90 feet bgs. Unaltered dredge tailings consist predominantly of cobbles with interbedded fine-grained layers and on the surface appear as arcuate (curved or bowed) serrated low hills of 10 to 30 feet in relief.

- Mehrten Formation: The Mehrten Formation consists of clays, conglomerates, and mudflows predominantly of andesitic detritus. The conglomerates are poorly sorted, well-rounded porphyritic andesitic cobbles with a matrix composed of ashy clay, silt, and sand. The mudflow, or lahar, consists of moderate to cobble size clasts cemented in an ash matrix. At the Aerojet facility, a general lithologic sequence included: indurated sandstones, siltstone, and brown to purple clays; interbedded silts, sand, and gravel with some clay; green to blue-green interbedded sandstone, sand, cobbles, and clay; green to blue-green silty clay; and blue-gray sand with clay occurring at the bottom of the Mehrten (Woodward-Clyde, 1997). Both the Mehrten and Laguna Formations represent deposits of the paleo-American River and, depending on the amount of andesitic material within the Mehrten, can be difficult to distinguish from each other in the subsurface.

- Valley Springs Formation: The Valley Springs Formation consists primarily of rhyolitic material and is distinguished from the overlying Merthen Formation by the complete absence of andesitic material. The formation

contains varying amounts of rhyolite ash, vitreous tuff, quartz sand containing abundant glass shards, pale beds of ashy clay, and fragments of pumice (USGS, 1985). Based on the occurrence of bedrock exposures near the Site, the Valley Springs Formation most likely does not extend to areas underlying the Site.

- Bedrock: The basement complex of the Sierra Nevada has been encountered within numerous boreholes drilled in the area (USGS, 1985; Woodward-Clyde, 1997). The unit consists of hard, non-water-bearing metamorphic and granitic rock (USGS, 1985). Granitic rock can be observed in outcrop within 100 to 200 feet from the Site. Metamorphic rocks beneath the Aerojet facility consist of the Salt Springs Slate and Gopher Ridge Volcanics. Exposures observed east of Prairie City Road are black to dull gray-green slates with interbedded very dense, light gray-green metavolcanics and fine-grained metasediments (Woodward-Clyde, 1997).

Regional Hydrogeology

The regional aquifer in the vicinity of the Site consists of a series of discontinuous layers of permeable and low permeable sediments. Permeable units consist of sand and gravel that correspond to the channel deposits of the Mehrten and Laguna Formations. Low permeability units consist of interbedded clays and silts of the Mehrten and Laguna Formations and form local aquitards and confining units. In areas located within the main portion of the paleo-river channels, Laguna paleo-channel deposits cut through permeable units of the Mehrten Formation so that permeable gravels of the Laguna are juxtaposed against gravels of the Mehrten Formation. Because these gravels exhibit very similar hydraulic properties, in many areas gravel from both units appear to act as a single hydrostratigraphic unit.

As reported in Brown and Caldwell (2001b), Regional groundwater in the vicinity of the Site occurs at approximately 120 feet above mean sea level (30 to 35 feet bgs). During the period from 1954 to 1982, USGS (1985) reports that water levels in the area have declined an average of 2.5 feet per year possibly due to extensive groundwater pumping for irrigation and slow recharge. Seasonal fluctuations average from 5 to 10 feet. In general, groundwater flow in this area is towards the American River. Steep gradients occur when materials of low permeability present partial barriers to groundwater movement.

Perched water has been observed in the area within the Laguna Formation and dredge tailings (Woodward-Clyde, 1997). At the nearby Aerojet facility, where present, depth to water within these discontinuous water bearing units occurs approximately at 15 feet bgs. Groundwater flow within these zones is dependent upon the slope of the underlying low permeability unit.

Site Setting
This section describes the Site stratigraphy and hydrogeology.

Site Stratigraphy
The landfill is located on a terrace of the American River, adjacent to what is now called Lake Natoma. A geologic map of the Site is provided in Figure C-1. As seen on this map, two surface units have been identified at the Site, the undisturbed Laguna Formation (Tl) and dredged material of the Laguna Formation (dt). Surface exposures of the Laguna Formation occur east and north of the landfill. The landfill was constructed within and is directly underlain by dredge tailings. More extensive dredge tailings can be observed to the west and south of the Site towards the American River. Off-site, the characteristic serrated shape of the dredge tailings can be observed. On-site, this material has been leveled and currently a large area has been paved for parking at the adjacent corporation yard.

The subsurface stratigraphy for the Site is described from the geologic well logs produced during previous investigations at the Site (Brown and Caldwell, 1991; 1994, 2001b). The maximum depth obtained in borings from this Site is approximately 93 feet bgs (73 feet above mean sea level) in the borehole drilled for monitoring well FCY-7. Figures C-2 and C-3 represent generalized hydrogeologic cross-sections across the Site and are constructed from the geologic well logs. As seen on these figures, the subsurface material observed at the Site includes the dredge tailings, Laguna Formation, and the Mehrten Formation.

Sub-units within each of these units were distinguished based on relative permeabilities and include:

- Low permeability clays, silts, and clayey sands; and
- Permeable sands and gravels.

Dredge tailings were observed within monitoring well soil borings FCY-1, FCY-2, FCY-4, FCY-5 and FCY-6 and ranged in thickness from 15 feet (FCY-4) to 30 feet (FCY-2). This material consists of 60 to 95 percent well-rounded gravel and cobbles with clasts up to 14-inches in diameter. The soil borings for the Site were drilled using air-rotary methods and as such, undisturbed samples of material have not been observed at the Site. However, based on Brown and Caldwell's experience of dredge tailings in other areas, gravel near the upper portions is generally matrix supported with interstices packed with fine-grained material. Lower portions of the tailings are generally still coated with fine material but interstices are generally air-filled or water filled if perched water is present. Dredging operations also deposited lenses of clay and in some areas basal sand units. Thin clay layers (less than 1-foot thick) were observed in several borings and a basal sand was observed in the soil boring for FCY-5.

The Laguna Formation was fully penetrated by the soil borings for FCY-3 and FCY-7 and was approximately 12 feet in thickness at both locations. Since dredging occurred within the Laguna Formation, this material is similar to the dredge tailings. However, as described above, the dredging operations removed a large portion of the matrix material and concentrated the percentage of gravel and cobbles. The Mehrten Formation was partially penetrated by six of the seven monitoring well soil borings, FCY-2 through FCY-7. Depth of penetration ranges from 5 feet (FCY-2) to 81 feet (FCY-7). Distinguishing characteristics between the Laguna and Mehrten Formation are the light gray changes to silty clays characteristic of the andestic material of the Mehrten Formation. The upper portion of this unit consisted predominantly of low permeability silts, clays, and clayey sands with varying degrees of cementation. Channel deposits consisting of sand and gravel were only observed as small lenses within the soil borings for FCY-3, FCY-6, and FCY-7 as illustrated on Figures 2-6 and 2-7 in the Work Plan.

Site Hydrogeology

Nine groundwater monitoring wells, designated FCY-1 through FCY-9, have been installed at the Site and groundwater elevations have been recorded periodically since 1985. Hollow-stem augers were used for the construction of FCY-1 instead of air rotary drilling methods as used for other wells at the site. Because of this drilling method, refusal was encountered near the first observed groundwater during drilling. Since installation of this well, because of the shallow completion, it is often dry. As such, FCY-1 was abandoned in June 2002.

Cumulative groundwater elevation and gradient data for these wells have been presented in the numerous monitoring reports most recently in the *Annual Detection Monitoring Summary Report 2007* (Brown and Caldwell, 2008a). In December 2007, the highest groundwater elevations were observed in monitoring wells FCY-3 and FCY-7 (130.98 to 138.28 feet above mean sea level). Elevations in the other five monitoring wells ranged from 128.00 to 129.34 feet above mean sea level as shown on Figure C-4. As illustrated on Figure C-3, first water at FCY-3 and FCY-7 occurs within the Mehrten Formation (dredge tailings are not present at these locations) whereas first water in the other five wells occurs within the dredge tailings.

Groundwater within the dredge tailings appears to be perched above the low permeability silts and clays of the underlying Mehrten Formation. This perched system terminates along the eastern edge of the landfill where dredging operations ceased. Attempts to install a monitoring well to the east of the landfill were unsuccessful since perched water was not encountered in this area. The perched groundwater is most likely fed by surface infiltration. Groundwater flow within this system is controlled by the slope of the perching layer represented by the low permeable material of the Mehrten Formation. To illustrate the slope of this layer, an isocontour map of the top of the Mehrten Formation was constructed and is presented on Figure C-5. As illustrated on Figures C-2 and C-

3, both the slope of the top of Mehrten and groundwater surface appears to trend away from a slight mound in the Mehrten Formation, illustrated in Figure C-5, near GAS-3 at the eastern edge of the landfill. The presence of this mound suggests that Site groundwater flows radially from the mounded area to the west, southwest and northeast. In December 2007, the hydraulic gradient of the groundwater was relatively flat and ranged from 0.004 to 0.006 foot per foot.

Review of hydrographs for the Site, suggest that the groundwater encountered within the Mehrten Formation at FCY-3 and FCY-7 is not hydraulically connected to the perched groundwater within the dredge tailings. This interpretation is supported by the unlikely steep gradient calculated between FCY-3 and FCY-7 to FCY-6 of 2 percent. Regardless, groundwater in the area of FCY-3 and FCY-7 is higher than the groundwater in the dredge tailings located beneath the landfill and therefore any impacts from the landfill area cannot flow uphill to this area.

Based on observations made during the last sampling round (also see Figures C-2 and C-3), it appears that the upper groundwater in the Mehrten Formation occurs within discontinuous gravel lenses. During this sampling round, the water level in well FCY-7 was monitored for any response while purging well FCY-3, and then well FCY-3 was monitored while purging well FCY-7. In both cases, after purging one well for at least 2 hours, no change in water level was observed in the other well.