# SOIL BACKGROUND REPORT
# SANTA SUSANA FIELD LABORATORY
# VENTURA COUNTY, CALIFORNIA

*FINAL*

**Prepared for:**

**THE BOEING COMPANY**

**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**

**U.S. DEPARTMENT OF ENERGY**

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# LIST OF ACRONYMS

| | |
|---|---|
| AMEC | AMEC Earth and Environmental |
| AOC | area of concern |
| Boeing | The Boeing Company |
| BBI | Brandeis-Bardin Institute |
| Cal-EPA | California Environmental Protection Agency |
| Calscience | Calscience Environmental Laboratories, Inc. |
| CAS | Columbia Analytical Services |
| COPC | chemical of potential concern |
| CPEC | chemical of potential ecological concern |
| CV | coefficient of variation |
| DHS | California Department of Health Services |
| dioxins/furans | (a) - *see table below* |
| DOE | U.S. Department of Energy |
| DTSC | Department of Toxic Substances Control |
| FAL | field action level |
| FSDF | Former Sodium Disposal Facility |
| GC/MS | gas chromatography/ mass spectrometry |
| GPS | global positioning satellite |
| GRC | Groundwater Resources Consultants, Inc. |
| GSU | Geological Services Unit |
| HERD | Human and Ecological Risk Division |
| HML | Hazardous Materials Laboratory |
| ICF | ICF Kaiser Engineers |
| IT | IT Corporation |
| MDL | method detection limit |
| MWH | MWH Americas, Inc. |
| McLaren/Hart | McLaren/Hart Environmental Engineering Corporation |
| NASA | National Aeronautics and Space Administration |
| Ogden | Ogden Environmental and Energy Services Co., Inc. |
| ppt | parts per trillion |
| QAPP | Quality Assurance Project Plan |
| QA/QC | quality assurance/ quality control |
| RCRA | Resource Conservation and Recovery Act |
| RFI | RCRA Facility Investigation |
| RL | reporting limit |
| SMMC | Santa Monica Mountains Conservancy |
| SOP | standard operating procedure |
| SRAM | Standardized Risk Assessment Methodology |
| SSFL | Santa Susana Field Laboratory |
| SWMU | Solid Waste Management Unit |
| TEQ | Total Equivalency Quotient |

## LIST OF ACRONYMS (continued)

| | |
|---|---|
| TIC | tentatively identified compound |
| UCL | upper confidence limit |
| USEPA | United States Environmental Protection Agency |
| WPA | Work Plan Addendum |
| WPAA | Work Plan Addendum Amendment |

### (a) Definition of dioxin/furan congeners

| **PCDD/PCDFs** | **Polychlorinated dibenzo-p-dioxins/dibenzofurans** |
|---|---|
| 2,3,7,8-TCDD | 2,3,7,8-tetrachlorodibenzo-p-dioxin |
| 1,2,3,7,8-PeCDD | 1,2,3,7,8-pentachlorodibenzo-p-dioxin |
| 1,2,3,4,7,8-HxCDD | 1,2,3,4,7,8-hexachlorodibenzo-p-dioxin |
| 1,2,3,6,7,8-HxCDD | 1,2,3,6,7,8-hexachlorodibenzo-p-dioxin |
| 1,2,3,7,8,9-HxCDD | 1,2,3,7,8,9-hexachlorodibenzo-p-dioxin |
| 1,2,3,4,6,7,8-HpCDD | 1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin |
| OCDD | 1,2,3,4,6,7,8,9-octachlorodibenzo-p-dioxin |
| 2,3,7,8-TCDF | 2,3,7,8-tetrachlorodibenzofuran |
| 1,2,3,7,8-PeCDF | 1,2,3,7,8-pentachlorodibenzofuran |
| 2,3,4,7,8-PeCDF | 2,3,4,7,8-pentachlorodibenzofuran |
| 1,2,3,4,7,8-HxCDF | 1,2,3,4,7,8-hexachlorodibenzofuran |
| 1,2,3,6,7,8-HxCDF | 1,2,3,6,7,8-hexachlorodibenzofuran |
| 2,3,4,6,7,8-HxCDF | 2,3,4,6,7,8-hexachlorodibenzofuran |
| 1,2,3,7,8,9-HxCDF | 1,2,3,7,8,9-hexachlorodibenzofuran |
| 1,2,3,4,6,7,8-HpCDF | 1,2,3,4,6,7,8-heptachlorodibenzofuran |
| 1,2,3,4,7,8,9-HpCDF | 1,2,3,4,7,8,9-heptachlorodibenzofuran |
| OCDF | 1,2,3,4,6,7,8,9-octachlorodibenzofuran |

# SECTION 1

# SCOPE AND PURPOSE OF THE SOIL BACKGROUND DATA SET

This report presents the comprehensive data set that defines ambient background concentrations of metals, polychlorinated dioxin and furan compounds, fluoride, and pH in soil at the Santa Susana Field Laboratory (SSFL) in Ventura County, California. This report has been prepared by MWH Americas, Inc. (MWH) for The Boeing Company (Boeing), National Aeronautics and Space Administration (NASA), and the United States Department of Energy (DOE) to support the Resource Conservation and Recovery Act (RCRA) Program at the SSFL. This final document replaces an earlier version published in June 2005, and incorporates requested revisions by the California Environmental Protection Agency (Cal-EPA) Department of Toxic Substances Control (DTSC).

Background sampling locations for the SSFL were established to provide data representative of ambient or local soil conditions, unaffected by site-related activities. To accomplish this, sampling locations were selected within and surrounding the SSFL in areas not impacted by site activities. Figure 1-1 shows the locations of the SSFL and surrounding areas. The background sampling locations were chosen based on extensive review and input by the DTSC, Geological Services Unit (GSU) Branch. An overview of the sampling events from which the data set was assembled, and details of recent soil sampling to supplement the existing metals background data set, are also provided herein.

The comprehensive soil background data set will be used to assist site characterization and risk assessments for the ongoing RCRA Corrective Action Program at the SSFL. To guide onsite RCRA Facility Investigation (RFI) site characterization decisions, comparison values derived from the data set will be used to determine if soil at a given investigational unit (solid waste management unit [SWMU] or area of concern [AOC]) has metals, fluoride, or dioxins concentrations above ambient background. In both the human and ecological risk assessment, the comprehensive soil background data set will also be used in the selection of chemicals of potential concern (COPCs) or chemicals of potential ecological concern (CPECs).

This report is organized as follows:

- Section 1 presents the scope and purpose of the soil background data set;
- Section 2 describes the sampling events from which the final data set are comprised;
- Section 3 summarizes agency oversight throughout development of the data set;
- Section 4 presents compilation of the final comprehensive soil background data set;
- Section 5 describes how the comprehensive soil background data set will be used for characterization and risk assessment;
- Section 6 provides references cited in this document; and
- Appendices contain field boring logs, location photographs, laboratory and validation information, and data set distribution and rank order plots.

For the purposes of this report, the term ‘dioxins’ refers to the group of chlorinated dibenzo-p-dioxin and chlorinated dibenzofuran congeners being evaluated during the RCRA Program at the SSFL. These congeners are listed in the List of Acronyms.

# SECTION 2

# OVERVIEW OF SOIL BACKGROUND DATA SET DEVELOPMENT

The soil background data set for metals, dioxins, fluoride, and pH is comprised of a subset of soil data collected over six discrete sampling events between 1992 and 2005. Each of these investigations was conducted in accordance with DTSC-approved work plans, and included analytical suites designed for the specific purposes of that sampling program. Background sample locations for each investigation were selected based on DTSC input, and were visited by DTSC personnel. In some cases, described further below, other agency and public review also occurred. Samples at each location were collected within the upper 1 foot of soil; a depth of zero feet was assigned to surface samples (i.e., the top 3 inches of soil), and the bottom depth of the sample interval was assigned to samples collected from 0.5 feet or 1 foot bgs. Samples from three background locations were collected at both 0.5 feet and 1 foot bgs. Improvement in laboratory analytical techniques over the course of these investigations resulted in different analytical methods, metals suites, and/or laboratory reporting limits (RL) for each metal analyzed. Sample locations are shown on Figure 2-1; detailed descriptions and photographs of each sampling location are provided in Appendix A.

This section presents a summary of the soil sampling events from which the comprehensive background metals and dioxins data sets were compiled. Table 2-1 presents this information in tabular form. As the soil background data set was developed for the SSFL RCRA Program, DTSC reviewed the data collected in the sampling programs described in this section. Decisions regarding inclusion or exclusion of data for the RCRA Program were made by DTSC as the investigation proceeded at the site. At the end of each of these following sections is the DTSC determination of sampling locations approved for use in the SSFL RCRA Program based on a comprehensive review during the Spring of 2005.

## 2.1 MULTI-MEDIA SAMPLING AT THE BRANDEIS-BARDIN INSTITUTE AND SANTA MONICA MOUNTAINS CONSERVANCY (1992 - 1994)

Initial assessments of the potential for offsite contamination at properties adjacent to and north of SSFL were conducted according to the DTSC-approved *Work Plan for Multi-Media Sampling at the Brandeis-Bardin Institute (BBI) and Santa Monica Mountains Conservancy (SMMC)* (McLaren/Hart 1992) and the *Work Plan for Additional Soil and Water Sampling at the Brandeis-Bardin Institute and Santa Monica Mountains Conservancy* (McLaren/Hart 1993a). The investigations were conducted between 1992 and 1994, and included sampling of soil, surface water, groundwater, and produce at both properties (Figure 2-1). In consultation with the USEPA, personnel from Brandeis-Bardin and Rocketdyne, and the general public, six local background sample locations were selected to provide data on background concentrations of metals and radionuclides (McLaren/Hart 1992). These data were also used for interpretation of sampling results at the two properties.

- Rocky Peak (Sample Location BG01, approximately 5.1 miles north-northeast of the SSFL);
- Santa Susana Park (Sample Location BG02, approximately 2 miles northeast of the SSFL);
- Bell Canyon (Sample Location BG03, approximately 1 mile south-southeast of the SSFL);
- Western Sampling Site (Sample Location BG04; approximately 0.4 miles west of the SSFL);
- Happy Camp (Sample Location BG05, approximately 12.5 miles northwest of the SSFL); and
- Santa Monica Mountains National Recreation Area (Sample Location BG06, approximately 4.3 miles south-southwest of the SSFL).

At each of these areas, soil samples were collected from three locations within the upper 1 foot of soil and assigned a depth of 0 to 1 foot bgs. The three locations were laterally spaced using a random sampling methodology (Gilbert 1987) in which a hypothetical 100 square-foot grid is utilized. Samples were named according to the area (e.g. BG02) and the 3-digit code designating the block (numbered 001-099) within the grid where the sample was collected (e.g. BG02074). Samples were analyzed for 13 priority pollutant metals by USEPA Method 6010/7000 at McLaren/Hart. Sampling results for these events are presented in the *Multi-Media Sampling Report for the Brandeis-Bardin Institute and the Santa Monica Mountains Conservancy* and *Additional Soil and Water Sampling at the Brandeis-Bardin Institute and the Santa Monica Mountains Conservancy* (McLaren/Hart 1993b and 1995).

Based on the 2005 DTSC determination and criteria described in Section 3, the sampling locations from this event approved for use in the SSFL RCRA Program background data set include Sample Locations BG01, BG02, and BG04 (Figure 2-1).

## 2.2 FSDF CLOSURE FIELD INVESTIGATION (JULY 1995)

During 1995 investigation activities for the Former Sodium Disposal Facility (FSDF) (SWMU 7.3) in the SSFL Area IV, 12 background soil sampling locations were selected for comparison with site sampling metals and dioxins data. This sampling event was conducted according to the DTSC-approved *Sampling and Analysis Workplan, Former Sodium Disposal Facility (ICF 1995).* Soil samples collected at each location were collected from the surficial soils and analyzed for 17 Title 22 metals by SW846 Method 6010/7000 and dioxins/furans by USEPA Method 8290 (ICF 1997). Soil metals and dioxins data from 7 of the 12 sampling locations (BKND-1 through BKND-7) were approved by DTSC for use in the background data set for the FSDF Interim Measures (IT Corporation [IT] 2002, DTSC 2004) and 5 of the 12 were not selected for the background data set. Five of the seven selected locations are within undeveloped land in the southern portion of the SSFL; the other two selected are along the SSFL property boundary adjacent to Area IV, away from any known site activities (Figure 2-1).

Based on the 2005 DTSC determination and criteria described in Section 3, the sampling locations from this event approved for use in the RCRA Program background data set for SSFL include sampling locations BKND-1 through BKND-7 (Figure 2-1).

## 2.3 METALS SAMPLING FOR THE RFI WORK PLAN ADDENDUM (MAY 1996)

Soil sampling was conducted by Ogden Environmental and Energy Services Co., Inc. (Ogden) within and adjacent to the SSFL in May 1996 in accordance with the *Metals Sampling and Analysis Plan* (Ogden 1996a). This sampling event was performed at onsite and offsite locations to provide total and soluble metals data for development of groundwater-protective field action levels (FALs) for the RFI. This event included sampling at 11 background locations selected in conjunction with DTSC in undisturbed areas away from and upslope of developed areas (buildings, roads, etc.) to minimize the potential for anthropogenic influences (Ogden 1996b). Soil data collected from these background locations were used to augment and expand the existing background metals data set, and used with other preliminary metals sampling data to propose preliminary background comparison concentrations for the RFI. Fifteen soil samples were collected from the 11 background locations during this event. Sample location identifiers are BGSS01 through BGSS07 (seven locations, nine samples) and BZSS01 through BZSS04 (four locations, six samples) (Figure 2-1).

Samples were collected from the upper 1 foot of soil (generally 0.5 feet or 1 foot below ground surface [bgs]); samples from two locations were collected at both 0.5 feet and 1 foot bgs. Each sample was analyzed for metals by USEPA Method 6010/7000 at Ceimic Corporation in San Diego, California. Sampling protocol followed standard operating procedures outlined in the RFI Work Plan Addendum (Ogden 1996b) in progress at the time; this document was approved by DTSC in September 1996.

Metals data collected from these 11 background locations during this event were combined with previous background sample data collected during the Brandeis-Bardin and FSDF investigations described above, and used to develop FALs for the RFI.

Based on the 2005 DTSC determination and criteria described in Section 3, data collected from all 11 of the sampling locations from this event were approved for use in the background data set for the RCRA Program at the SSFL.

## 2.4 BELL CANYON AREA SAMPLING (JUNE 1998)

Background soil and/or surface sediment samples were collected from six locations within undeveloped portions of Bell Canyon and the southern portion of the SSFL for comparison with data collected during the investigation, and to reflect non-impacted areas. Soil sampling in accordance with the DTSC-approved *Bell Canyon Residence Soil Sampling Work Plan* (Ogden 1998a) was conducted in June 1998, following RFI sampling protocol outlined in the *RFI Work Plan Addendum* (Ogden 1996b). The background locations were selected in conjunction with DTSC based on geological rock type and accessibility (Ogden 1998b). Samples were collected from the upper 1 foot of soil overlying the primary rock types within Bell Canyon (Chatsworth and Lindero Canyon formations) (Figure 2-2). Samples were analyzed at Columbia Analytical Services (CAS) in Canoga Park, California. Samples were analyzed for 19 metals by USEPA Method 6010/7000 and dioxins by USEPA Method 8290.

Sampling results were presented in the *Bell Canyon Area Soil Sampling Report* (Ogden 1998b). Sample identifiers for this event are indicated with “BC” as the first two characters. BC<u>SS</u>xx indicates a surface soil or sediment sample, while BC<u>BS</u>xx indicates a boring sample collected below the surface (generally 0.5 feet bgs).

Based on the 2005 DTSC determination and criteria described in Section 3, data collected from all six sampling locations during this event were approved for use in the background data set for the RCRA Program at the SSFL.

## 2.5 ADDITIONAL SAMPLING FOR THE RFI STANDARDIZED RISK ASSESSMENT METHODOLOGY WORK PLAN (MARCH 2000)

In 2000, after review of the soil background metals and dioxins data collected in the events described above, DTSC requested additional sampling to improve sample distribution at and surrounding the SSFL and increase the number of samples in the dioxins data set. Three additional sampling locations were selected in conjunction with DTSC within undeveloped land in the northern and southern portions of the SSFL. Sampling was conducted on March 22, 2000 following RFI sampling protocol outlined in the RFI WPA (Ogden 1996) and RFI WPAA (Ogden 2000b). Samples collected at two of these locations (BGSS07 and SGSS01) were analyzed for metals and dioxins using USEPA Methods 6010/7000 and 8290, respectively. The sample collected at location BZSS05 was analyzed only for dioxins by Method 8290. All samples were analyzed at Calscience in Garden Grove, California. The resulting metals and dioxins background data sets were approved by DTSC (2000c) as part of the *Standardized Risk Assessment Methodology (SRAM) Work Plan* in June 2000.

Based on the 2005 DTSC determination and criteria described in Section 3, data collected from all three sampling locations from this event were approved for use in the background data set for the RCRA Program at the SSFL.

## 2.6 METALS BACKGROUND SAMPLING (APRIL 2005)

After discussions with DTSC during late 2004 and early 2005, it was agreed that additional sampling at DTSC-approved background locations was necessary to supplement the existing soil metals background data set. This was accomplished by collecting samples and either completing the analyses not previously performed on all samples, or by adding new analytes not previously included (MWH 2004b). This sampling event was conducted in April 2005. During this event, analysis of the following sampling suites was performed at the locations described:

1. **Aluminum, antimony, barium, cobalt, mercury, molybdenum, selenium, and vanadium:** The background data set for these eight metals was augmented by collecting samples at locations either not previously analyzed for these metals, or where previously collected data were deemed unusable during validation (Appendix B).
2. **Zirconium, fluoride, lithium, sodium, potassium and pH:** these target compounds were added to the soil background analytical suite to support closure of RCRA-permitted units in the SSFL Area IV.
3. **Thallium:** A background range for thallium was established by recollecting samples from all background locations and analyzing them at the lower laboratory detection limits currently attainable for RFI samples.
4. **Boron and manganese**: These metals were added to the soil background analytical suite to support RFI risk assessment for metals.
5. **Iron** was added to the soil background analytical suite and sampled at all locations to aid in evaluation of the chemistry of other metals, and to support groundwater data evaluation.
6. **All metals** were analyzed in samples collected from location BZSS05, where a sample was previously analyzed only for dioxins.

### 2.6.1 Sampling Procedures

Sampling to supplement the soil metals background data set, as described in Section 2.6, was conducted by MWH between April 12th and 19th, 2005. This sampling event was conducted following RFI standard operating procedures (SOPs) (Ogden 1996b and 2000b). Field documentation of each sampling location included recording soil properties on field boring logs, recording global positioning satellite (GPS) survey coordinates, and taking photographs (Appendix A). Laboratory analytical data and validation information are provided in Appendix B.

To ensure consistency in the sample data, samples from background locations were collected from the same locations and depths as previous samples. At all locations, vegetation was carefully removed by scraping it aside with a pre-cleaned trowel. Surface soil samples assigned a depth of "0" feet were collected from the upper 2 to 3 inches of soil beneath vegetation by a grab sampling technique (using a capped sample sleeve). Samples from 0.5 feet bgs (or deeper) were collected by advancing the sample sleeves by hand to the desired depth. The depth assigned to these samples was the bottom of the sample interval.

### 2.6.2 Sample Analytical Results

Analytical results of April 2005 soil metals sampling are summarized in Section 4. All metals sample data from this event were validated according to USEPA Level IV requirements as specified in the Quality Assurance Project Plan (QAPP) in Appendix A of the RFI WPAA (Ogden 2000b). Laboratory method detection limits (MDLs) for all new analyses met RFI requirements specified in the QAPP (Ogden 2000b); the MDLs for all new analyses were at least as low as, or lower than, previous soil background sample limits. Data validation of the final soil background data set is discussed further in Section 4.

# SECTION 3

# REGULATORY REQUIREMENTS, OVERSIGHT AND APPROVAL

This section describes regulatory agency requirements for background soil sampling and agency involvement throughout compilation of the soil background data set for the RCRA Program at the SSFL.

## 3.1 REGULATORY REQUIREMENTS

The criteria for selecting background sampling locations representative of ambient conditions are listed in several regulatory agency guidance documents. DTSC (1997) guidance defines 'ambient conditions' as concentrations of metals in the vicinity of a site but which are unaffected by site-related activities (also known as 'local background'). USEPA (2002) guidance defines 'ambient' as having characteristics that include levels of both naturally occurring (not influenced by humans) and anthropogenic (human made, non-site) chemicals. USEPA (2002) guidance also states that the background reference area should have the same physical, chemical, geological and biological characteristics as the site being investigated, but has not been affected by activities at the site.

The DTSC 1997 policy for selection of inorganic chemicals of potential concern (COPCs) consists of eight steps. These steps are:

1. Expand the data set
2. Test the distribution
3. Display summary statistics for the expanded data set
4. Plot concentration vs. cumulative probability
5. Identify the population nearest the origin
6. Select a value to represent the upper range of ambient conditions
7. Include or exclude metals as a COPC
8. Perform Wilcoxon Rank Sum Test (optional)

Steps 1 though 6 of the DTSC policy are used to define the background data set and establish comparison values, and Steps 7 and 8 are used when conducting the site risk assessment to determine COPCs. Specific application of these steps to the SSFL background data set are described in Section 4 (definition of the data set), and in Section 5 (use of the data set). The overall approach used to develop the SSFL background soil data set is consistent with the intent and generally follows the procedures of the DTSC policy. The approach for the SSFL background data set is described in this section.

The purpose of the 1997 DTSC policy is to establish the ambient or background concentrations of metals in soil. This policy allows inclusion of site data collected during the investigation to supplement the background samples when developing the background data set for a facility (DTSC 1997). The purpose of adding the site data is to increase the number of background samples. However, this approach of using site data was not used in defining the SSFL background data set. Rather, a modified approach was used to achieve the goal of the policy and to reflect the size and complexity of the SSFL site conditions.

The approach used for the SSFL background data set was to collect a sufficient number of samples that represent ambient conditions. Only samples from agency-approved locations representing ambient soil conditions were included for evaluation. These locations were selected in undeveloped portions of the SSFL and surrounding areas to be representative of ambient conditions including the wide range of geomorphic and geologic settings present at the SSFL investigational units. Only locations situated on geologic units found within the SSFL were chosen for background sampling to ensure the data set is representative of ambient conditions. The background soil sampling locations were visited by DTSC and determined to represent ambient conditions, unaffected by site activities (DTSC 2000c). All data were reviewed and validated by qualified chemists. As described in Section 2, the data set was expanded (Step 1 of the DTSC policy) by the addition of sampling locations in 2000 to meet the policy criteria of both a sufficient number of samples and representative of ambient conditions.

By limiting the background sampling for the SSFL to only agency-approved locations not affected by site operations, the background data set derived from sampling those locations represents ambient background conditions and meets the regulatory criteria for background data and satisfies the intent of the DTSC policy. Samples were collected from 29 widespread locations in areas outside of site operations (up to 3 miles away), and results are representative of the range of ambient geologic units and soil types at the SSFL. Background concentrations are expected to vary in onsite soils, since the SSFL:

- comprises a large area (over 2,800 acres);
- includes a variety of soil types (clays, sands, silts), and geologic units (Chatsworth formation, Santa Susana formation, Quaternary alluvium); and,
- is characterized by variable geomorphic conditions, vegetation, and hydrology.

In contrast to smaller investigation sites, more naturally occurring variability in sampling results is expected in the SSFL background data set because of the factors listed above. This data variability is reflected in the distribution of some metals which show a range of concentrations related to the type of source rock forming the soils. As explained in Section 4, this factor was considered in application of the 1997 DTSC policy Steps 2 though 6.

An additional modification to the DTSC policy was that a background data set was developed for dioxins. A subset of the metals sampling locations were sampled for dioxins (17 locations). This was done with DTSC concurrence since dioxins are widespread throughout the environment and their background levels have been well characterized by USEPA (2000). Known ambient sources of dioxins in soil include brush fires at and near the site, and contributions from bedrock (i.e. shale and clay) (Cleverly, et al. 1997, Ferrario 2000). These sources have not only contributed to dioxin concentrations in soil on and in the vicinity of the SSFL, but also to a regional dioxin background value. Measurements of background dioxins in the western United States result in a Total Equivalency Quotient (TEQ) less than 2 parts per trillion (ppt) (USEPA

2001). A dioxin TEQ is the sum of the 17 dioxin and furan congener concentrations after those concentration have been multiplied by a toxicity equivalency factor. A TEQ value represents a total dioxin concentration.

## 3.2 AGENCY OVERSIGHT

DTSC was involved in the selection of background soil sample locations for each of the field events described in this report. All background sample locations in the final data set have been visited by the DTSC. Additionally, the DTSC has observed field sampling procedures and collected split soil samples to confirm laboratory findings. The background locations sampled by McLaren/Hart in 1992 were also reviewed by public representatives and other regulatory agencies (USEPA and DHS), and the background locations sampled by Ogden in 1996, 1998, and 2000 were selected and sampled in the presence of DTSC staff (Ogden 2000a).

## 3.3 DTSC REVIEW AND APPROVAL OF THE SOIL BACKGROUND DATA SET

An overall evaluation of the background data set by the DTSC's Geological Services Unit (GSU) and Human and Ecological Risk Division (HERD) in 2000 confirmed that the soil sampling locations have not been impacted by site activities, and reflect ambient or local background conditions (DTSC 2000b). DTSC approved the soil background data set as part of the SRAM Work Plan (DTSC 2000e). However, additional DTSC review of the background data in 2004/2005 resulted in modification of the data set. As a result, soil data from sample location BG03 were removed from the data set due to differing geologic conditions for onsite evaluations (DTSC 2005). This DTSC review also resulted in the recommendation of the supplemental metals data discussed in Section 2.6.

The DTSC GSU and HERD have reviewed all metals and dioxins sampling results, and provided input on the selection of comparison values for both metals and dioxins

(Section 4). In addition, both GSU and HERD reviewed and provided comments on the June 2005 version of this report. This August 2005 final soil background report reflects requested DTSC revisions to that document. DTSC Hazardous Materials Laboratory (HML) chemists have reviewed previously published soil background sample data and determined that they are satisfactory for project use (DTSC 2000a and 2000d). HML has also reviewed the most recent sampling data and concurred with the data validation findings (see Section 4.1 and Appendix B).

DTSC review and approval of this document serves as approval of the soil background data set for metals, dioxins, fluoride, and pH for use in the SSFL RCRA Corrective Action Program as described below in Section 5. The following section presents and summarizes the final soil background data set for the onsite RCRA Program.

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# SECTION 4

# DESCRIPTION OF THE FINAL SOIL BACKGROUND DATA SET

The inorganic soil background data set consists of metals, fluoride and pH data from 41 soil samples collected at 29 agency-approved locations. A total of 27 samples were collected at 21 locations within the SSFL property boundary, and 14 samples were collected from offsite locations (Figure 2-2). The dioxins soil background data set consists of 17 samples from 16 of the metals sampling locations. Twelve of the locations were onsite and four of the dioxins sampling locations were offsite (Figure 2-2).

Background metals, fluoride and pH data are presented in Table 4-1, and dioxins data are presented in Table 4-2. Sampling information (e.g. dates collected, sample depths, and validation qualifiers) is also presented in these tables.

The SSFL soil background data set meets regulatory criteria established for background data. This includes both the California (DTSC 1997) and Federal (USEPA 2002) criteria described in Section 3. DTSC has reviewed and approved each of the sampling locations. Each location was reviewed to ensure similar geology to the SSFL and evaluated for potential site impacts. The following sections describe data quality review findings, steps followed, and samples included in each of the background data sets for the SSFL.

## 4.1 DATA QUALITY

After laboratory analysis and review, all sampling results were validated by qualified chemists at AMEC Earth and Environmental, Inc. (AMEC). In addition DTSC reviewed and validated several of the soil background samples (DTSC 2000a and 2000d), and a April 2005 data package as described below. Overall, data quality was determined to meet project requirements and data were deemed acceptable by validation and included in the final soil background data set. This section summarizes the laboratory and data validation procedures used, and the data review findings for the background samples.

The ICF Kaiser and McLaren/Hart laboratory programs are described in the appropriate work plans (ICF Kaiser 1995; McLaren/Hart 1993b). For samples collected by Ogden and MWH, laboratory procedures, methods, and requirements followed the quality assurance criteria specified in the Quality Assurance Project Plans (QAPPs) prepared for the RFI and characterization programs at the SSFL (Ogden 1996 and 2000b).

Laboratory information and data validation results for the final soil background data are provided in Appendix B.

### 4.1.1 Data Review and Validation Procedures

All background sample data were validated at either Level IV or Level V, in accordance with the requirements in the USEPA *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (USEPA 1994a), the USEPA *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (USEPA 1994b), the analytical methods referenced by the laboratory, laboratory SOPs, and the appropriate AMEC data validation procedures. Level IV validation includes review of the following items (when applicable): sample management, gas chromatography/mass spectrometry (GC/MS) instrument performance, initial and continuing calibration, method blank results, calibration blank results, matrix spike sample results, surrogate results, laboratory and field quality control (QC) sample results, internal standard performance, target compound identification, compound quantification and reported detection limits, tentatively identified compounds (TICs), and a definitive review of the raw data. Level V validation includes review of sample management, method blanks, matrix spike samples, surrogates, laboratory control samples, and field QC samples.

Data used to characterize the background samples include acceptable validated data without qualifiers, and estimated data (“J” or “UJ” qualifiers). Unusable data are denoted with an “R,” qualifier, indicating that the data were rejected (Appendix B). Rejected data were not included in the soil background data set.

### 4.1.2 Data Validation Findings

Based on validation, all data were usable, except for a few metals data collected by McLaren/Hart (1992). Six antimony, six mercury, and nine selenium results were rejected due to matrix spike recovery outliers (Appendix B). These samples were recollected during the April 2005 sampling event; therefore all sample data included in the final background data set were deemed usable for purposes described in this document.

A more detailed summary of the data validation findings is included in Appendix B. These data validation findings include:

- Some metals and dioxins data were qualified as non detect or as estimated non detects due to detects in the associated method blanks and field QC samples. No metals or dioxins qualifications appeared related to significant laboratory contamination.
- Fluoride was detected below the reporting limit in several laboratory method blanks and calibration blanks, as well as in most background soil samples. The blank detects resulted in the qualification of most fluoride detects as estimated non detects, at the level of laboratory contamination in the samples. Therefore, the final fluoride results for these samples are all estimated values below the reporting limit.
- Most pH results were qualified as estimated because analysis exceeded holding times. The holding time for pH is “immediate.” Therefore, exceeded holding times are not uncommon and are not indicative of poor laboratory or field quality assurance/ quality control (QA/QC) procedures.
- Some data (all methods) were qualified as estimated detects and non detects due to laboratory QC results that were outside of the laboratory or method control limits. For the most part, these qualifications were related to interference caused by the soil matrix and were not indicative of laboratory quality control issues.

- Some analytical results for antimony were determined to be suspect due to poor instrument sensitivity near the instrument detection limit as indicated by positive results for antimony in the calibration blanks. All antimony results were reviewed by data validators and, when necessary, the antimony method detection limits (MDLs) were raised to the value of the interference.

Some dioxin results were qualified for interferences related to sample preparation, instrument calibration, and identification criteria. For the most part, these qualifications were related to interference inherent in the method or caused by the soil matrix and were not indicative of laboratory QC issues.

Comparison of field duplicate data generally indicated good agreement between the field duplicate pairs.

In addition to previous data reviews, HML reviewed metals and mercury data from one April 2005 background data deliverable group and concurred with the qualification of the data described above (Appendix B). Furthermore, HML noted that "sample results associated with satisfactory QA/QC results should be acceptable. Sample results associated with unsatisfactory QA/QC results should be qualified as estimations.” In this comment, DTSC re-states the definition of the use data qualifiers in the data validation process; data qualification was performed as indicated during the data review.

A more detailed summary of the validation findings is presented in Appendix B. Also in Appendix B are data summary tables, data validation reports, and annotated laboratory result forms for each validated soil sample included in the final soil background data set. Recent April 2005 sampling event laboratory reports and chain-of-custody information are also included in Appendix B.

## 4.2 FINAL SOIL BACKGROUND METALS DATA SET

The metals background data set consists of data from the 41 soil samples collected at 29 agency-approved locations over the course of 6 sampling events. The metals sampling analytical suites for each event are summarized as follows:

- Nine samples collected by McLaren/Hart in 1992 (3 samples each from BG01, BG02, and BG04) for analysis of 13 metals (antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc);
- Seven samples collected by ICF Kaiser in 1995 (locations BKND-1 through BKND-7) for analysis of 17 metals (barium, cobalt, molybdenum, and vanadium in addition to the target list utilized by McLaren/Hart);
- Fifteen samples collected by Ogden in 1996 (locations BGSS01 through BGSS04; BGSS06, BGSS07, BZSS01 through BZSS04) for analysis of 18 metals (aluminum added to the analytical suite);
- Seven samples collected by Ogden in 1998 (locations BCBS09, BCSS09, and BCSS11-14) for analysis of 19 metals (boron added to the analytical suite);
- Three samples collected by Ogden in 2000 (locations SGSS01 and BZSS05-06 and analyzed for the same 19 metals; and
- Forty supplemental samples collected by MWH in 2005, which added fluoride and six metals (iron, lithium, manganese, potassium, sodium, and zirconium) to the target list, resulting in a total of 25 metals in the validated analyses.

Metals sampling locations are shown on Figure 2-1 and data presented in Table 4-1. As described in Steps 2 and 3 of the 1997 DTSC background policy, the data distributions were tested for all constituents and data set statistics summarized (Table 4-3). Cumulative probability plots (Step 4 of the DTSC policy) were prepared and are provided in Appendix C. As noted in Table 4-3, several constituents had a low frequency of detection (e.g., antimony, molybdenum, silver). Because of this, additional cumulative probability plots were prepared in which non detects were eliminated so that the data distribution of detected values could be considered (Appendix C). In addition, per DTSC request, probability plots are also provided showing non detects substituted with one half the detection limit and with the minimum detected value.

### 4.2.1 Evaluation of the Background Metals Data Distributions

As described in this section, the background metals data are acceptable for use in characterization and risk assessment based on a review of results, distributions, summary statistics, and probability plots. The data meet the DTSC policy criteria since all data are within two orders of magnitude (most detected data are within or near one order of magnitude), and almost all probability plots yielded a coefficient of variation (CV) less than 1 (Table 4-3). Two metals have a CV greater than 1 (antimony at 1.1, and molybdenum at 1.3). Review of the probability plots in Appendix C and soil boring logs in Appendix A indicates that this is mostly caused by either (1) the influence of non detects in the distribution, and/or (2) the influence of soil type and source rock composition. Distributions influenced by non detect data include antimony, boron, cadmium, fluoride, mercury, selenium, silver, and thallium. As noted above, probability plots for these metals were prepared with non detects eliminated to evaluate the data distributions (Appendix C). This additional evaluation of data distribution augments the procedure described in the DTSC policy and was performed because some data have a high proportion of non detects.

Influence of soil type on background metal concentrations is related to the amount of silt or clay in the soil sample and source rock composition. Silt and clay content varies in soils and this grain size fraction has a different mineralogy and chemistry than sands, which are primarily silica. As a result, soils with high clay content can contain higher concentrations of some metals. Some metals (e.g., magnesium, iron, and aluminum) are constituents of the clay mineral structure, and various other metals can ‘substitute’ for these (Hurlbut and Klein, 1977). Also, because of the open crystal structure metals can be trapped in the clay minerals. Fine grain size and higher organic content typically found in silts and clays also increases the capacity of clay rich soils to adsorb metals. This enrichment of metals can occur over a wide range, sometimes even resulting in economically valuable metal ore deposits in clay and shale (a fine-grained rock containing many clay minerals) (Sethi and Schieber, 1998). SSFL background sample soil types are predominately silts and silty sands (Appendix A), but also include clays, clayey sands, and well sorted sands. Soil types for the background sampling locations are summarized in Table 4-4. Soil types vary across the SSFL and can vary within investigational units.

"Source rock" is the parent bedrock that degrades to form soils. In terrain like the SSFL, where there is much exposed bedrock and generally thin soil cover, soil is formed by the weathering and breakdown of parent bedrock materials. Because of this, soil types and composition are dependent in part on the type of source rock present. At the SSFL, bedrock composition varies and includes shale, siltstone, fine- to coarse-grained sandstone, and conglomerate. Similar to the soil types described above, these bedrock types represent a range in clay content, with shale containing a high proportion of clay minerals. As such, source rock influences soil type, and ultimately the mineralogy and chemistry of the soil. Furthermore, faults are present within areas where some background samples were collected, and the mineralogy associated with these geological structures also adds to sample heterogeneity. In addition, it is worth noting that drainages at the SSFL tend to contain finer-grained soils since they typically form where softer shale bedrock is located.

Based on a comparison of data presented in Table 4-1, population and rank order plots (Appendix C), soil types, percentage of fine-grained material, and location above differing rock types (Table 4-4; Figure 2-1), most background metals data distributions appear to be influenced by soil type and/or source rock composition. In general, the higher concentrations of almost all metals in background samples are associated with higher percentages of clay and silt in the sample (with copper, silver and vanadium as possible exceptions) (Table 4-4, Appendix C).

Background sampling metals results were also compared to published background values for California soils (Kearney 1996; Hunter et al. 2005). Information regarding the range of metals in California soils is provided for each metal in Table 4-1. As shown in this table, all background sampling results are within the published range of metals in California soils.

Finally, in addition to the statistical and regional comparisons described above, an evaluation of the geographic and vertical distribution of metals data within the data set was conducted to evaluate the potential of airborne impacts from SSFL operations. These evaluations and findings are described below.

The prevailing wind pattern at the SSFL is bimodal, from both the northwest and southeast (MWH 2004a). Engine testing locations and thermal treatment areas are shown on the figures used for the following evaluations.

The geographic distribution of metals concentrations was evaluated by plotting the location of upper populations or maximum concentrations in the data set, and comparing the resulting distribution to prevailing wind directions, onsite testing locations, and the soil and rock types at the sampling location (Figure 4-1). For each metal, upper populations or maximum concentrations were identified on rank order or probability plots. Upper populations were generally small and somewhat distinct from the overall data distribution pattern. Figure 4-1 displays the sampling locations where the upper population or maximum metals concentrations were detected. If an upper, distinct population was not noted because of an overall linear data distribution, then the maximum detected concentration was shown on the figure. Based on the results of this analysis depicted on Figure 4-1, there is a wide geographic distribution of higher metals concentrations around the SSFL (i.e., higher concentrations for different metals are located at a variety of locations). This suggests airborne releases from SSFL operations have not affected background soil metals concentrations because higher concentrations do not occur only in northwest-southeast directions.

Four sampling locations (BG04, BCBS09, BCSS14, BZSS03), represent locations with some of the higher concentrations of several metals, including antimony, aluminum, arsenic, boron, beryllium, iron, lithium, and zinc, among others. These four sampling locations are in the southwest and southeast, both onsite and outside of the facility (Figure 4-1). Each of these soil samples is characterized by a high percentage of fines (65 to 100 percent) as indicated in Table 4-4. It is worth noting that at least two of these samples, BCBS09S01 and BCSS14S01, were collected from thin soils developed above a shale bedrock unit (the geology at the western sampling location has not been mapped in detail).

Based on data shown on Figure 4-1, the only pattern observed in the geographic distribution of higher metals concentrations in the soil background data set is associated with source rock composition. The widespread distribution of many higher metals concentrations, the lack of higher concentrations in samples nearest the testing or thermal treatment areas, and association of higher results with fine-grained soils shown on Figure 4-1, indicates that airborne dispersion of contaminants from SSFL has had no significant affect on background data set soils.

To further test this conclusion, an evaluation of the vertical distribution of metals in soil was also performed. Results from shallow and deeper samples (“depth pairs”) at the same location were compared. Both shallow (0.5 foot bgs) and deeper (1 foot bgs) soil samples were collected at three locations, BGSS02, BZSS03, and BGSS03 (Figure 4-2; Table 4-5). Metal concentrations in these depth pair samples were compared to determine if any metals were consistently higher in the shallower sample, since this is the expected distribution if airborne impacts were present. As noted in Appendix A, “0.5 feet bgs” samples are collected from soil extending from the ground surface to 0.5 feet deep, and “1 foot bgs” samples were collected from soil extending from 0.5 to 1 foot deep. Without removing surficial soils, all samples were collected after the vegetation was cleared by hand from the designated sampling location.

Evaluation of metals results in the three depth pair samples indicates both increasing and decreasing metals concentrations with depth. The results shown in Table 4-5 indicate no consistent vertical distribution pattern or metals in the depth pairs (i.e., no pattern of higher metals concentrations in the shallower samples), with the exception of lead (as described below). As shown at the bottom of Table 4-5, the ratio for background metal depth pair concentrations (shallow concentration divided by deeper concentration) is close to 1 (ranging from 1 to 1.3), for individual sample pairs with higher surface concentrations, indicating similar concentrations in both samples (i.e., no significant vertical gradient).

As noted above, the only metal consistently detected at higher concentrations in shallow depth pair soil background samples was lead. Lead impacts in ambient air of urban environments are well documented (USEPA 1998). Although the SSFL is mostly rural land, it is surrounded by major metropolitan areas with a long history of air quality impacts. The higher concentrations of lead in the shallow depth pair background soil samples is attributed to ambient air quality associated with the Los Angeles metropolitan area. It is worth noting that two of these depth pairs are located southeast of the rocket testing locations. If airborne impacts due to rocket engine testing were present in these two sample pairs, higher concentrations of other metals in addition to lead would be expected in the shallow samples at these locations. As shown in the table, this is not the case.

In summary, based on the available data, there is no pattern in the geographic or vertical distribution of soil background metals sampling results to indicate airborne dispersion and deposition of metal contaminants from SSFL operations. Based on this finding, the overall consistency in the data set indicated by the range of detected results and CVs near or below 1, and because the detected concentrations are within the range of California soils, the entire metals background data set has been determined acceptable for use and representative of ambient conditions (i.e., background).

### 4.2.2 Selection of Comparison Values for the Metals Background Data Set

Comparison values for background metals were selected using the entire data set based on the finding presented above. Application of Step 5 of the DTSC policy (selection of the population nearest the origin) was modified for some metals because their distributions reflected multiple populations. This was due to either non detected values, or because the range of detected values was considered related to natural variability caused by thin soil conditions and proximity of variable source rock materials (i.e., shale or sandstone), and the presence of geologic structures (i.e., faults). As described in Section 3, this variability is expected because of the range of geomorphic and geologic conditions at and surrounding the SSFL. Therefore, multiple populations were retained in the background data set since all sampling locations were agency-approved and the data determined as described above to be representative of unimpacted ambient conditions.

A single concentration value was selected for each inorganic constituent to represent the upper range of ambient conditions in the metals data set (Step 6 of the DTSC policy). This upper range concentration value is called in this document the soil background "comparison value." The comparison value selected for each constituent was the maximum detected concentration. Use of these values for characterization is described in Section 5. Table 4-6 provides a summary of the metals background data set comparison values. Also included in Table 4-6 are regional California values for background. These are based on published information (Kearney 1997; Hunter et al. 2005). As shown in Table 4-6, the SSFL soil background comparison values for metals are within the range of published California values, and for most results are considerably below the maximum value.

## 4.3 FINAL SOIL BACKGROUND DIOXINS DATA SET

The dioxins background sampling locations are shown on Figure 2-1, and the data set is provided in Table 4-2. The final dioxins data set consists of validated data from 17 soil samples collected at 16 DTSC-approved locations (one duplicate). All dioxins samples were collected at locations where background metals samples were collected, as follows:

- Seven samples collected from seven locations during July 1995 FSDF closure activities (BKND-1 through BKND-7);
- Seven samples collected from six locations in June 1998 within and near Bell Canyon (BCBS09, BCSS09, and BCSS11through BCSS14); and
- Three samples collected from three background locations during March 2000 (BZSS05, BZSS06, and SGSS01).

Evaluation of the validated soil background dioxins data set in 2004/2005 did not indicate that any additional data were needed and the dioxins data set is reproduced here as reported and approved (Ogden 2000a, DTSC 2000e).

Similar to the metals background data set, the dioxins data distributions were tested for all congeners and data set statistics summarized as outlined in Steps 2 and 3 of the DTSC policy (Table 4-3). Cumulative probability plots (Step 4) were prepared and are provided in Appendix C. As noted on Table 4-3, many dioxins had a low frequency of detection (e.g., 2,3,7,8-TCDD, 1,2,3,7,8-PeCDD). Because of this, additional cumulative probability plots were prepared where non detects were eliminated so that the data distribution of detected values could be considered (Appendix C).

It should be noted that laboratory reported data for dioxins include “Total” results. These Total dioxins results reflect a combination of the 2,3,7,8-substituted and non-2,3,7,8-substituted congeners. These results are included on Table 4-2 for completeness only and are not used in either characterization or risk assessment decisions (Section 5).

### 4.3.1 Evaluation of the Background Dioxins Data Distributions

As described in this section, the background dioxins data are acceptable for use in characterization and risk assessment based on review of the results, distributions, summary statistics, and probability plots. The data meet the DTSC policy criteria since all data are within two orders of magnitude (most detected data are within or near one order of magnitude), and almost all probability plots have a coefficient of variation (CV) less than 1 (Table 4-3). Eight dioxin congeners (including groups called ‘Total’) have a CV greater than 1, ranging up to 1.3 (Table 4-3). Overall, there are fewer detected concentrations in the dioxins data set than in the metals data set. The most frequently detected congeners in the background data set are those most commonly detected throughout the United States (e.g., OCDD) (USEPA 2000). Review of the probability plots in Appendix C indicates that the variability in dioxins results is primarily caused by the influence of non detects in the distribution. As with metals, probability plots for dioxin results with a low frequency of detection were prepared with non detects eliminated to evaluate the data distributions (Appendix C). In addition, per DTSC request, probability plots are also provided showing non detects substituted with one half the detection limit and with the minimum detected value.

Although the influence of soil types and parent source rock on the dioxins data distribution is less pronounced than in the metals data set, several of the samples with the greatest number of detects were associated with fine-grained soils (Appendix A and Table 4-2). As described in Section 3, another source of dioxins are related to natural brush fires (USEPA 2000).

The detected dioxin results are within the ambient range of measurements of dioxins measured in the western United States where regional TEQ values are typically less than 2 ppt (USEPA 2001). TEQs calculated for the SSFL background dioxin samples are shown in Table 4-2. The background dioxin TEQs range up to 0.98 ppt, slightly less than half of the western regional value.

An evaluation of the geographic distribution of the dioxins data was also conducted to evaluate the potential or airborne impacts within the data set. (A vertical distribution evaluation could not be performed since all were surficial samples, collected at 0 feet bgs). To evaluate the geographic distribution, the background dioxins TEQ values were plotted adjacent to each sampling location (Figure 4-3). Higher TEQs in the data set are widely distributed around the site, with a suggestion that the values may be lower in the southeastern area. Based on the results shown on Figure 4-3, there is no pattern in the geographic distribution of the dioxins data set indicating higher concentrations relative to SSFL engine testing locations or thermal treatment areas onsite, prevailing wind patterns, or source rock contributions. The highest concentrations of dioxin TEQs are found distributed around the site instead of in upwind or downwind areas. In addition, the lack of a pattern in either the geographic or vertical distribution of the metals data set also supports the conclusion that background soil has not been affected by SSFL combustion activities since both metals and dioxins are present in airborne emissions from combustion sources.

In summary, based on the available data, there is no pattern in the geographic distribution of soil background dioxins sampling results to indicate airborne dispersion and deposition of dioxin contaminants from SSFL operations. Based on this finding, the overall consistency in the data set indicated by the range of detected results and CVs near or below 1, and by the lower values compared to regional studies, the entire dioxins background data set has been determined acceptable for use and representative of ambient conditions unimpacted by site operations (i.e., background).

### 4.3.2 Selection of the Comparison Values for the Dioxins Background Data Set

Comparison values for background dioxins were selected based on the entire data set based on the finding described above. Application of Step 5 of the DTSC policy (selection of the population nearest the origin) was modified for dioxins since most distributions reflected multiple populations. These resulted from either a large number of non detected values or because the range of detected values was considered related to natural variability caused by thin soil conditions, and proximity of variable source rock materials (i.e., shale or sandstone). As described in Section 3.1, this variability is expected because of the range of geomorphic and geologic conditions at and surrounding the SSFL. Therefore, multiple populations were retained in the background data set since all sampling locations were agency-approved and the data were determined (as described above) to be representative of ambient conditions.

A single concentration was selected for each congener to represent the upper range of ambient conditions in the dioxins data set (Step 6 of the DTSC policy). Similar to the metals data set, this upper range concentration value is called the soil background “comparison value.” The comparison value selected for each congener was the maximum detected concentration, or a recent laboratory detection limit for congeners with all non detect data. Use of these values for characterization is described in Section 5. Table 4-7 provides a summary of the dioxins background data set comparison values. As noted in Table 4-7, a comparison value was not selected for the ‘Total’ dioxin congener groups, since these results represent the concentrations of multiple congeners, including those listed in the table. As described in Section 5, ‘Total’ dioxin concentrations are also not used for characterization or risk assessment decisions.

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# SECTION 5
# USES OF THE SOIL BACKGROUND DATA SET

This section summarizes uses of the soil background data set for SSFL RCRA Program onsite investigational unit characterization and risk assessment. Uses of the soil background data set presented here are also described in the SRAM Work Plan, Revision 2 (MWH 2005).

## 5.1 COMPARISON FOR INVESTIGATIONAL UNIT CHARACTERIZATION

The comprehensive background metals, dioxins, fluoride, and pH data sets will be used to guide investigational unit characterization decisions (e.g., additional step-out sampling). Metals, fluoride and pH data collected from investigational units will be directly compared to background data set concentrations to determine whether soil at a given location contains concentrations above ambient background. The concentration of each metal in the investigational unit data will be evaluated against the soil background comparison value developed from the final background data set (see Table 4-6).

If a metal concentration in the investigational unit data is below this soil background comparison value, no further characterization would be required unless multiple lines of evidence suggest the site data set is incomplete and additional sampling warranted. Lines of evidence to be considered include: site operations/history, soil and groundwater sampling data trends, and risk-based standards. If the metal concentration in the investigational unit data exceed the soil background comparison value, further evaluation will be necessary to determine whether site characterization is complete. As discussed with DTSC, this includes evaluating other site information (historical operations, sampling data trends, and risk assessment findings) in a best professional judgement approach to making decisions regarding additional sampling needs (DTSC 2005).

For dioxins, the soil concentrations at investigational units are evaluated using an approach that considers each of the seventeen 2,3,7,8-substituted congeners separately (these are the individual congeners listed in Tables 4-2 and 4-3). The comparison value approach is used to determine if any of the individual congeners are present above the background comparison value (Table 4-7). If any are present above the background comparison value, additional sampling may be performed after all dioxins sampling results are reviewed in the context of other site data. If additional samples are collected, all 17 dioxin/furan congeners will be included in the analysis.

## 5.2 COMPARISON FOR INVESTIGATIONAL UNIT RISK ASSESSMENTS

The comprehensive background data set will also be used to guide selection of chemicals of potential concern (COPCs) and/or chemicals of potential ecological concern (CPECs) during investigational unit risk assessments (MWH 2005) following a procedure outlined in the DTSC policy. This policy states that metals should be included as COPCs or CPECs if the site-specific analytical data indicate conditions are in excess of an upper limit of ambient concentrations (Step 7), or if a statistical test indicates that the investigational unit data are higher than the background data (Step 8) (DTSC 1997). While the procedure for comparison of site investigational unit data to background data is focused on metals in the DTSC guidance, the methods of comparison are also applicable to dioxins. Because the statistical test method reduces the potential for errors in selection of COPC/CPECs, and because it allows quantification of those error rates, it will be used for the SSFL risk assessments as described below. The comparison of site data to an upper limit of background will not be done in the risk assessments.

### 5.2.1 Comparison with Investigational Unit Metals Data

Data from soil samples collected at investigational units will be statistically compared to the background data set by application of the Wilcoxon Rank Sum (WRS) Test (MWH 2005) as specified in Step 8 of the DTSC policy. The WRS Test is a non-parametric statistical evaluation that compares the entirety of investigational unit metals data set to the entirety of the metals background data set to determine if the unit data are higher than the background data. In instances where more than 40 percent of the site or background data sets are non detect values, then the Gehan Test will be used instead of the WRS Test (Department of the Navy 2002). The Gehan Test is a modification of the WRS Test for data sets with a low frequency of detection. For metals with less than five detected concentrations statistical evaluation is not appropriate, and best professional judgement using a 'weight of evidence' approach will be used to select COPC/CPECs for the risk assessment. Rationales for COPC/CPEC selection will be documented in the risk assessment report.

If the investigational unit data are determined to be higher than the background data, then that constituent is selected as a COPC/CPEC for the investigational unit. If applicable, portions of the investigational data set may be compared to the background data set (e.g., if the investigational unit data have distinct areas of higher concentrations). As described in the DTSC policy, the WRS Test reduces the error in selection of COPC/CPECs. It is also worth noting that there is a final data comparison step for risk assessment, described in the SRAM, that includes inspection of the site data for any apparent anomalous conditions (MWH 2005)

### 5.2.2 Comparison Method for Dioxins

The same approach used to evaluate metals is used to evaluate investigational unit and background dioxins data sets. Similar to the process described above for metals, the entirety of the investigational unit dioxins data set will be compared to the entirety of the background dioxins data set using the WRS Test, the Gehan Test (if 40 percent or more non detect data), or best professional judgement (if less than five detected concentrations). Using these methods, if the investigational unit data are determined to be higher than background, then dioxins will be selected as a COPC/CPEC. As for metals, there is a review of the entire data set for any apparent anomalous conditions (MWH 2005). Rationales for COPC/CPEC selection will be documented in the risk assessment report.

For background comparison purposes, the pertinent dioxins data include the 2,3,7,8-substituted tetra-, penta-, hexa-, hepta-, and octa-chlorinated dioxin and furan congeners. The individual congener background data are presented in Table 4-2 and Table 4-3. Consistent with a DTSC memorandum on establishing dioxin background (DTSC 1998), a graphical representation of relative dioxins concentrations in samples (a “radar” plot) will be compared to similar presentations for background to determine qualitatively if the site samples are similar to background. This would be done for the five 2,3,7,8-substituted congener groups listed above. The five group concentrations are calculated as the sum of the concentrations of each 2,3,7,8-substituted congener within the chlorination group, on a per-sample basis. In cases where a congener is detected a least once in a given media at an investigational unit, it will be assumed to be present in other samples of the same media at that unit. When a congener is thus assumed to be present at an investigational unit, but is not detected in a sample, then the concentration in that sample will be estimated as one-half the sample RL. In cases where a specific congener is never detected in a given media at an investigational unit, then that congener is assumed to not be present in that media at that unit, and will not be included in the summation of congeners within its respective congener group at that unit.

Following the qualitative graphical evaluation, the dioxin data sets are further evaluated by application of the WRS Test (or as applicable, the Gehan Test or best professional judgement using criterion described above) to determine consistency with soil background concentrations. For dioxins, these evaluation methods will be performed on the five 2,3,7,8-substituted congener groups listed above. Because dioxins frequently appear as mixtures, an additional requirement for evaluation of investigational unit data is that all “groups” of congeners must be shown to be consistent with soil background concentrations. If such a demonstration cannot be made, all the seventeen 2,3,7,8-substituted dioxin congeners will be selected as COPC/CPECs in the risk assessment.

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# Table 2-1

# Chronology of the SSFL Soil Background Data Set
(Page 1 of 2)

| Sample Collection Date | Reference | Investigator | Agency or Public Review | Original Purpose and Use of Data |
|---|---|---|---|---|
| March 1992 | McLaren/ Hart 1993 (Multi-Media Report) | McLaren/Hart | USEPA, DHS, DTSC, SSFL Work Group | Interpretation of northern offsite soil sampling results for Brandeis-Bardin and Santa Monica Mountains Conservancy properties. SSFL Work Group requested sampling outside of SSFL boundaries. |
| July 1995 | ICF 1997 (FSDF Characterization Report) | ICF Kaiser | DTSC | Interpretation of FSDF sampling results and definition of soil impacts. |
| May 1996 | Ogden 1996 (RFI Work Plan Addendum) | Ogden | DTSC | Augment and expand previous soils background data set (three datasets now combined). Collected following DTSC-approved work plan (Ogden 1996). Work included sampling at metals-impacted sites also. Both data sets used to develop FALs for RFI.<br>Soil background metals data included in RFI work plan as histograms (sample IDs labeled), and in distribution plots. |
| June 1998 | Ogden 1998 (Bell Canyon Report) | Ogden | DTSC, DHS, USEPA | Interpretation of southern offsite soil sampling results on Bell Canyon property.<br>Determination made regarding offsite impacts using this data in Bell Canyon Report and subsequent DTSC Memo (Ogden 1998; DTSC 1999). |
| April 2000 | Ogden 2000 (SRAM) | Ogden | DTSC | DTSC visited and reviewed each of the above locations for appropriateness. Based on their review findings, 2 locations (6 samples) not approved for inclusion in the data set because of distance from the SSFL.<br>Also based on DTSC review findings, 3 additional locations added and sampled to achieve an adequate distribution at and surrounding the facility.<br>Prior to submittal in SRAM, rank order plots prepared and reviewed by GSU and HERD staff (sample IDs labeled). |

# Table 2-1

## Chronology of the SSFL Soil Background Data Set
## (Page 2 of 2)

**Acronyms**

DHS = California Department of Health Services
DTSC = Department of Toxic Substances Control
FAL = field action level
FSDF = Former Sodium Disposal Facility
GSU = DTSC Geological Services Unit
HERD = DTSC Human and Ecological Risk Division
RFI = RCRA Facility Investigation
SRAM = Standardized Risk Assessment Methodology
SSFL = Santa Susana Field Laboratory
USEPA = U.S. Environmental Protection Agency

# Table 4-1
# SSFL Soil Background Metals Data Set
## (Page 1 of 2)

| SAMPLE ID | Depth (ft. bgs) | Aluminum | | | Antimony | | | Arsenic | | | Barium | | | Beryllium | | | Boron | | | Cadmium | | | Chromium | | | Cobalt | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BGSS01S01 | 0.5 | 12,800 | | 2 | 5.3 | J | 2 | 9.2 | | 2 | 101 | | 2 | 0.64 | | 2 | **3** | | 6 | 0.06 | U | 2 | 22.1 | | 2 | 8.5 | | 2 |
| BGSS02S01 | 0.5 | 7,380 | | 2 | 3.1 | J | 2 | 3.3 | | 2 | 50.7 | | 2 | 0.41 | | 2 | **1.2** | UJ | 6 | 0.06 | U | 2 | 8.8 | | 2 | 2.9 | | 2 |
| BGSS02S02 | 1 | 6,470 | | 2 | 3.9 | J | 2 | 3.5 | | 2 | 38.6 | | 2 | 0.36 | | 2 | **1.2** | UJ | 6 | 0.06 | U | 2 | 11.6 | | 2 | 3 | | 2 |
| BGSS03D01 | 0.5 | 12,200 | | 2 | 7.4 | J | 2 | 2.4 | | 2 | 91.8 | | 2 | 0.59 | | 2 | **5** | UJ | 6 | 0.06 | U | 2 | 17.3 | | 2 | 5.8 | | 2 |
| BGSS03S01 | 0.5 | 11,800 | | 2 | 7 | J | 2 | 2.1 | | 2 | 96.6 | | 2 | 0.45 | | 2 | **5** | UJ | 6 | 0.06 | U | 2 | 15.5 | | 2 | 6.4 | | 2 |
| BGSS03S02 | 1 | 12,400 | | 2 | 6.5 | J | 2 | 2.5 | | 2 | 93.2 | | 2 | 0.62 | | 2 | **5.1** | UJ | 6 | 0.06 | U | 2 | 17.4 | | 2 | 5.5 | | 2 |
| BGSS04S01 | 0.5 | 12,200 | | 2 | 6.7 | J | 2 | 3.2 | | 2 | 44.2 | | 2 | 0.47 | | 2 | **7** | UJ | 6 | 0.06 | U | 2 | 36.8 | | 2 | 5.3 | | 2 |
| BGSS06S01 | 0.5 | 9,960 | | 2 | 6.7 | J | 2 | 4 | | 2 | 62.7 | | 2 | 0.54 | | 2 | **2.9** | UJ | 6 | 0.06 | U | 2 | 16 | | 2 | 4.4 | | 2 |
| BGSS07S01 | 0.5 | 14,300 | | 2 | 5.3 | J | 2 | 2.6 | | 2 | 77 | | 2 | 0.65 | | 2 | **4.5** | UJ | 6 | 0.06 | UJ | 2 | 25 | | 2 | 6.8 | | 2 |
| BKND-1 | 0 | **14,000** | | 6 | 1 | U | 3 | 3.9 | | 3 | 54 | | 3 | 0.28 | | 3 | **8** | J | 6 | 0.25 | | 3 | 28.3 | | 3 | 6.1 | | 3 |
| BKND-2 | 0 | **10,000** | | 6 | 1.1 | U | 3 | 5.1 | | 3 | 65.7 | | 3 | 0.11 | U | 3 | **5.5** | UJ | 6 | 0.46 | | 3 | 19.8 | | 3 | 8 | | 3 |
| BKND-3 | 0 | **9,300** | | 6 | 1 | U | 3 | 4.3 | | 3 | 69.8 | | 3 | 0.43 | | 3 | **2.5** | | 6 | 0.21 | U | 3 | 14.3 | | 3 | 5.6 | | 3 |
| BKND-4 | 0 | **10,000** | | 6 | 1 | U | 3 | 3.9 | | 3 | 77.5 | | 3 | 0.37 | | 3 | **3.9** | UJ | 6 | 0.22 | | 3 | 14 | | 3 | 5.3 | | 3 |
| BKND-5 | 0 | **10,000** | | 6 | 1 | U | 3 | 3.2 | | 3 | 77.2 | | 3 | 0.34 | | 3 | **2.7** | UJ | 6 | 0.25 | | 3 | 13.9 | | 3 | 5 | | 3 |
| BKND-6 | 0 | **8,500** | | 6 | 1.1 | U | 3 | 6.3 | | 3 | 110 | | 3 | 0.37 | | 3 | **2.7** | | 6 | 0.23 | | 3 | 15.8 | | 3 | 5.8 | | 3 |
| BKND-7 | 0 | **11,000** | | 6 | 1.1 | U | 3 | 3.9 | | 3 | 109 | | 3 | 0.48 | | 3 | **4.5** | | 6 | 0.4 | | 3 | 21.9 | | 3 | 10 | | 3 |
| BZSS01D01 | 0.5 | 10,300 | | 2 | 8.7 | J | 2 | 5.9 | | 2 | 58.6 | | 2 | 0.63 | | 2 | **2.7** | | 6 | 0.06 | UJ | 2 | 16.3 | | 2 | 7.2 | | 2 |
| BZSS01S01 | 0.5 | 10,700 | | 2 | 6.4 | J | 2 | 5.8 | | 2 | 62.8 | | 2 | 0.59 | | 2 | **2.3** | | 6 | 0.06 | UJ | 2 | 16.7 | | 2 | 7.5 | | 2 |
| BZSS02S01 | 0.5 | 11,900 | | 2 | 4.4 | J | 2 | 4.2 | | 2 | 69.2 | | 2 | 0.47 | | 2 | **1.2** | U | 6 | 0.06 | UJ | 2 | 16.6 | | 2 | 5.4 | | 2 |
| BZSS03S01 | 0.5 | 15,800 | | 2 | 7.4 | J | 2 | 8.4 | | 2 | 103 | | 2 | 0.85 | | 2 | **5.3** | UJ | 6 | 0.06 | UJ | 2 | 23.2 | | 2 | 7.5 | | 2 |
| BZSS03S02 | 1 | 18,100 | | 2 | 8.7 | J | 2 | 8.5 | | 2 | 106 | | 2 | 0.99 | | 2 | **6.2** | UJ | 6 | 0.06 | UJ | 2 | 26.2 | | 2 | 8.4 | | 2 |
| BZSS04S01 | 0.5 | 14,500 | | 2 | 6.3 | J | 2 | 3.2 | | 2 | 91.8 | | 2 | 0.63 | | 2 | **2.6** | | 6 | 0.06 | UJ | 2 | 18.8 | | 2 | 6.2 | | 2 |
| SGSS01S01 | 0 | 12,000 | | 5 | 0.982 | U | 5 | 0.982 | U | 5 | 106 | | 5 | 0.463 | | 5 | 1.31 | U | 5 | 0.655 | U | 5 | 18.3 | | 5 | 7.59 | | 5 |
| BZSS06S01 | 0 | 12,400 | | 5 | 1.03 | U | 5 | 1.03 | U | 5 | 90.4 | | 5 | 0.468 | | 5 | 1.37 | U | 5 | 0.685 | | 5 | 18.4 | | 5 | 8.1 | | 5 |
| BZSS05S01 | 0 | **10,000** | | 6 | **0.66** | UJ | 6 | **4.1** | | 6 | **66** | | 6 | **0.48** | | 6 | **3.6** | UJ | 6 | **0.39** | | 6 | **15** | | 6 | **4.9** | | 6 |
| BG01005 | 0 - 1 | **12,000** | | 6 | **0.47** | UJ | 6 | 2.1 | J | 1 | **75** | | 6 | 0.66 | | 1 | **0.97** | U | 6 | 0.5 | U | 1 | 21 | | 1 | **5.4** | | 6 |
| BG01008 | 0 - 1 | **13,000** | | 6 | **0.48** | UJ | 6 | 2.2 | J | 1 | **72** | | 6 | 0.61 | | 1 | **0.98** | U | 6 | 0.5 | U | 1 | 21 | | 1 | **6.9** | | 6 |
| BG01100 | 0 - 1 | **12,000** | | 6 | **0.49** | UJ | 6 | 1.7 | J | 1 | **69** | | 6 | 0.71 | | 1 | **1** | U | 6 | 0.5 | U | 1 | 22 | | 1 | **5.4** | | 6 |
| BG02007 | 0 - 1 | **9,600** | | 6 | **0.5** | UJ | 6 | 3.6 | J | 1 | **71** | | 6 | 0.53 | | 1 | **8** | UJ | 6 | 0.5 | U | 1 | 14 | | 1 | **4.7** | | 6 |
| BG02074 | 0 - 1 | **9,500** | | 6 | **0.5** | UJ | 6 | 1.7 | J | 1 | **76** | | 6 | 0.46 | | 1 | **5.2** | UJ | 6 | 0.5 | U | 1 | 16 | | 1 | **21** | | 6 |
| BG02076 | 0 - 1 | **9,200** | | 6 | **0.55** | UJ | 6 | 2.9 | J | 1 | **68** | | 6 | 0.54 | | 1 | **4.6** | UJ | 6 | 0.5 | U | 1 | 14 | | 1 | **4.5** | | 6 |
| BG04025 | 0 - 1 | **20,000** | | 6 | 2.5 | UJ | 1 | 3.3 | J | 1 | **92** | | 6 | 0.65 | | 1 | **9.7** | J | 6 | 0.5 | U | 1 | 23 | | 1 | **9.3** | | 6 |
| BG04029 | 0 - 1 | **14,000** | | 6 | 2.5 | UJ | 1 | 3 | J | 1 | **84** | | 6 | 0.73 | | 1 | **8.5** | J | 6 | 0.5 | U | 1 | 23 | | 1 | **8.3** | | 6 |
| BG04090 | 0 - 1 | **13,000** | | 6 | 2.5 | UJ | 1 | 3 | J | 1 | **80** | | 6 | 0.65 | | 1 | **8.6** | J | 6 | 0.5 | U | 1 | 24 | | 1 | **8.1** | | 6 |
| BCSS09S01 | 0 | 5,600 | | 4 | **0.18** | UJ | 6 | 9 | | 4 | 36 | | 4 | 0.5 | U | 4 | **3** | UJ | 6 | 1 | U | 4 | 9 | | 4 | 4 | | 4 |
| BCSS11S01 | 0 | 13,000 | | 4 | **0.46** | UJ | 6 | 5 | U | 4 | 97 | | 4 | 0.7 | | 4 | **5.9** | UJ | 6 | 1 | | 4 | 17 | | 4 | 5 | | 4 |
| BCSS12S01 | 0 | 11,000 | | 4 | **0.6** | UJ | 6 | 6 | U | 4 | 82 | | 4 | 0.7 | | 4 | **4** | | 6 | 1 | U | 4 | 16 | | 4 | 6 | | 4 |
| BCSS13S01 | 0 | 13,000 | J | 4 | **0.38** | UJ | 6 | 5 | U | 4 | 84 | J | 4 | 1.1 | | 4 | **6.6** | UJ | 6 | 1 | U | 4 | 22 | | 4 | 8 | | 4 |
| BCBS09S01 | 0 | 18,000 | J | 4 | -- | | | 14 | | 4 | 140 | J | 4 | 1.1 | | 4 | -- | | | 1 | U | 4 | 29 | | 4 | 12 | | 4 |
| BCSS14S01 | 0 | 16,000 | J | 4 | **0.56** | UJ | 6 | 16 | | 4 | 87 | J | 4 | 1 | | 4 | **5.6** | | 6 | 1 | U | 4 | 25 | | 4 | 10 | | 4 |
| BCSS14D01 | 0 | 16,000 | J | 4 | **0.58** | UJ | 6 | 14 | | 4 | 91 | J | 4 | 1.1 | | 4 | **9** | | 6 | 1 | U | 4 | 26 | | 4 | 11 | | 4 |
| California Benchmark Soils (Kearney Study, March 1996) | Mean | 73,000 | | | 0.6 | | | 3.5 | | | 509 | | | 1.28 | | | 19 | | | 0.36 | | | 122 | | | 14.9 | | |
| | min | 30,000 | | | 0.15 | | | 0.6 | | | 133 | | | 0.25 | | | 1 | | | 0.05 | | | 23 | | | 2.7 | | |
| | max | 106,000 | | | 1.95 | | | 11 | | | 1,400 | | | 2.7 | | | 74 | | | 1.7 | | | 1,579 | | | 46.9 | | |
| California Air Force Bases (Hunter et al 2005) | 95th | 23,000 | | | 12.5 | | | 12.7 | | | 320 | | | 1.1 | | | 140 | | | 2.3 | | | 49.4 | | | 22 | | |
| | 99th | 31,300 | | | 25 | | | 23.2 | | | 584 | | | 5.6 | | | 201 | | | 7.7 | | | 100 | | | 35.9 | | |

| SAMPLE ID | Depth (ft. bgs) | Copper | | | Fluoride | | | Iron | | | Lead | | | Lithium | | | Manganese | | | Mercury | | | Molybdenum | | | Nickel | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BGSS01S01 | 0.5 | 12.6 | | 2 | **3.1** | UJ | 6 | **18,000** | | 6 | 13.8 | | 2 | **20** | J | 6 | **190** | | 6 | 0.05 | U | 2 | 0.8 | U | 2 | 13.8 | | 2 |
| BGSS02S01 | 0.5 | 4.5 | | 2 | **2.6** | UJ | 6 | **12,000** | | 6 | 5.3 | | 2 | **17** | | 6 | **190** | | 6 | 0.05 | U | 2 | 0.78 | U | 2 | 5.9 | | 2 |
| BGSS02S02 | 1 | 5.8 | | 2 | **2.2** | UJ | 6 | **14,000** | | 6 | 4.2 | | 2 | **20** | J | 6 | **230** | | 6 | 0.04 | U | 2 | 0.79 | U | 2 | 5.2 | | 2 |
| BGSS03D01 | 0.5 | 8.7 | | 2 | **2.5** | J | 6 | **23,000** | | 6 | 7.5 | | 2 | **32** | J | 6 | **500** | | 6 | 0.05 | U | 2 | 0.95 | UJ | 2 | 12.1 | | 2 |
| BGSS03S01 | 0.5 | 8.1 | | 2 | **2.3** | J | 6 | **23,000** | | 6 | 7.3 | | 2 | **31** | J | 6 | **490** | | 6 | 0.05 | U | 2 | 0.82 | UJ | 2 | 11 | | 2 |
| BGSS03S02 | 1 | 9.2 | | 2 | **3.1** | J | 6 | **24,000** | | 6 | 5.6 | | 2 | **31** | J | 6 | **420** | | 6 | 0.05 | | 2 | 0.78 | U | 2 | 11.8 | | 2 |
| BGSS04S01 | 0.5 | 3.8 | | 2 | **1.8** | UJ | 6 | **25,000** | | 6 | 15.4 | | 2 | **29** | J | 6 | **290** | | 6 | 0.05 | U | 2 | 0.81 | U | 2 | 9.8 | | 2 |
| BGSS06S01 | 0.5 | 6.2 | | 2 | **2.1** | J | 6 | **17,000** | | 6 | 7.9 | | 2 | **21** | J | 6 | **320** | | 6 | 0.04 | U | 2 | 0.76 | U | 2 | 10.4 | | 2 |
| BGSS07S01 | 0.5 | 6.7 | | 2 | **2.4** | UJ | 6 | **19,000** | | 6 | 14 | | 2 | **29** | J | 6 | **310** | | 6 | 0.09 | | 2 | 0.81 | U | 2 | 15.6 | | 2 |
| BKND-1 | 0 | 7.3 | | 3 | **1.8** | UJ | 6 | **20,000** | | 6 | 18.6 | | 3 | **27** | J | 6 | **370** | | 6 | 0.1 | U | 3 | 0.4 | | 3 | 9.7 | | 3 |
| BKND-2 | 0 | 17 | | 3 | **1.4** | UJ | 6 | **18,000** | | 6 | 20.3 | | 3 | **19** | J | 6 | **230** | | 6 | 0.11 | U | 3 | 0.37 | | 3 | 15.4 | | 3 |
| BKND-3 | 0 | 8.2 | | 3 | **1.9** | UJ | 6 | **15,000** | | 6 | 11.2 | | 3 | **18** | J | 6 | **260** | | 6 | 0.1 | U | 3 | 0.36 | | 3 | 9.9 | | 3 |
| BKND-4 | 0 | 8.5 | | 3 | **1.7** | UJ | 6 | **17,000** | | 6 | 13.1 | | 3 | **19** | J | 6 | **300** | | 6 | 0.1 | U | 3 | 0.53 | | 3 | 9.8 | | 3 |
| BKND-5 | 0 | 8 | | 3 | **1.7** | UJ | 6 | **15,000** | | 6 | 21.5 | | 3 | **21** | J | 6 | **280** | | 6 | 0.1 | U | 3 | 0.38 | | 3 | 9.9 | | 3 |
| BKND-6 | 0 | 9.9 | | 3 | **1.8** | UJ | 6 | **15,000** | | 6 | 33.1 | | 3 | **20** | J | 6 | **370** | | 6 | 0.11 | U | 3 | 0.64 | | 3 | 10.9 | | 3 |
| BKND-7 | 0 | 17 | | 3 | **1.9** | UJ | 6 | **15,000** | | 6 | 8.9 | | 3 | **22** | J | 6 | **390** | | 6 | 0.11 | U | 3 | 0.35 | | 3 | 15.4 | | 3 |
| BZSS01D01 | 0.5 | 9.6 | | 2 | **1.9** | UJ | 6 | **17,000** | | 6 | 7.2 | | 2 | **21** | J | 6 | **320** | | 6 | 0.07 | | 2 | 5.4 | | 2 | 13.4 | | 2 |
| BZSS01S01 | 0.5 | 8.7 | | 2 | **1.9** | UJ | 6 | **17,000** | | 6 | 8 | | 2 | **19** | J | 6 | **320** | | 6 | 0.07 | | 2 | 5.2 | | 2 | 13.8 | | 2 |
| BZSS02S01 | 0.5 | 8.2 | | 2 | **2.3** | UJ | 6 | **17,000** | | 6 | 18 | | 2 | **16** | J | 6 | **210** | | 6 | 0.07 | | 2 | 2.6 | | 2 | 12 | | 2 |
| BZSS03S01 | 0.5 | 14.5 | | 2 | **2.9** | UJ | 6 | **24,000** | | 6 | 14.4 | | 2 | **28** | J | 6 | **320** | | 6 | 0.07 | | 2 | 1.1 | | 2 | 16.6 | | 2 |
| BZSS03S02 | 1 | 15.1 | | 2 | **4** | UJ | 6 | **28,000** | | 6 | 10.8 | | 2 | **34** | J | 6 | **330** | | 6 | 0.08 | | 2 | 0.83 | U | 2 | 17.4 | | 2 |
| BZSS04S01 | 0.5 | 8.9 | | 2 | **2** | UJ | 6 | **20,000** | | 6 | 14.3 | | 2 | **16** | J | 6 | **290** | | 6 | 0.09 | | 2 | 0.77 | U | 2 | 11.9 | | 2 |
| SGSS01S01 | 0 | 7.77 | | 5 | **1.7** | UJ | 6 | **18,000** | | 6 | 10.9 | | 5 | **23** | J | 6 | **320** | | 6 | 0.11 | U | 5 | 0.328 | U | 5 | 13.9 | | 5 |
| BZSS06S01 | 0 | 7.99 | | 5 | **1.9** | UJ | 6 | **17,000** | | 6 | 12.8 | | 5 | **21** | J | 6 | **310** | | 6 | 0.115 | U | 5 | 0.343 | U | 5 | 12.2 | | 5 |
| BZSS05S01 | 0 | **11** | | 6 | **2.6** | UJ | 6 | **14,000** | | 6 | **14** | | 6 | **15** | J | 6 | **310** | | 6 | **0.02** | | 6 | **0.62** | | 6 | **11** | | 6 |
| BG01005 | 0 - 1 | 11 | | 1 | **3.2** | J | 6 | **20,000** | | 6 | 18 | | 1 | **16** | J | 6 | **260** | | 6 | **0.027** | | 6 | **0.62** | | 6 | 16 | | 1 |
| BG01008 | 0 - 1 | 11 | | 1 | **2.6** | J | 6 | **13,000** | | 6 | 9.5 | | 1 | **15** | J | 6 | **310** | | 6 | **0.029** | | 6 | **0.69** | | 6 | 16 | | 1 |
| BG01100 | 0 - 1 | 12 | | 1 | **3.1** | UJ | 6 | **20,000** | | 6 | 26 | | 1 | **18** | J | 6 | **300** | | 6 | **0.026** | | 6 | **0.7** | | 6 | 16 | | 1 |
| BG02007 | 0 - 1 | 10 | | 1 | **2.4** | UJ | 6 | **19,000** | | 6 | 34 | | 1 | **19** | J | 6 | **300** | | 6 | **0.031** | | 6 | **0.94** | | 6 | 9.1 | | 1 |
| BG02074 | 0 - 1 | 17 | | 1 | **3.3** | UJ | 6 | **15,000** | | 6 | 6.5 | | 1 | **18** | J | 6 | **350** | | 6 | **0.039** | | 6 | **0.82** | | 6 | 14 | | 1 |
| BG02076 | 0 - 1 | 11 | | 1 | **3.2** | UJ | 6 | **14,000** | | 6 | 12 | | 1 | **16** | J | 6 | **270** | | 6 | **0.029** | | 6 | **0.8** | | 6 | 10 | | 1 |
| BG04025 | 0 - 1 | 20 | | 1 | **3** | J | 6 | **28,000** | | 6 | 18 | | 1 | **37** | J | 6 | **380** | | 6 | **0.034** | | 6 | **0.41** | | 6 | 16 | | 1 |
| BG04029 | 0 - 1 | 14 | | 1 | **2.6** | J | 6 | **26,000** | | 6 | 15 | | 1 | **33** | J | 6 | **350** | | 6 | **0.031** | | 6 | **0.47** | | 6 | 15 | | 1 |
| BG04090 | 0 - 1 | 14 | | 1 | **2.4** | J | 6 | **26,000** | | 6 | 20 | | 1 | **35** | J | 6 | **340** | | 6 | **0.04** | | 6 | **0.47** | | 6 | 14 | | 1 |
| BCSS09S01 | 0 | 6 | | 4 | 2.2 | | 4 | **25,000** | | 6 | 7 | | 4 | **27** | J | 6 | **300** | | 6 | **0.032** | | 6 | **0.76** | | 6 | 7 | | 4 |
| BCSS11S01 | 0 | 8 | | 4 | 1.7 | | 4 | **20,000** | | 6 | 10 | | 4 | **12** | J | 6 | **410** | | 6 | **0.048** | | 6 | **4.4** | | 6 | 14 | | 4 |
| BCSS12S01 | 0 | 9 | | 4 | 4.3 | | 4 | **28,000** | | 6 | 14 | | 4 | **29** | J | 6 | **420** | | 6 | **0.019** | | 6 | **2** | | 6 | 12 | | 4 |
| BCSS13S01 | 0 | 17 | | 4 | 2.7 | | 4 | **23,000** | | 6 | 25 | | 4 | **29** | J | 6 | **370** | | 6 | **0.054** | | 6 | **0.93** | | 6 | 17 | | 4 |
| BCBS09S01 | 0 | 28 | | 4 | 6.7 | | 4 | -- | | | 29 | | 4 | -- | | | -- | | | -- | | | -- | | | 29 | | 4 |
| BCSS14S01 | 0 | 30 | | 4 | 3.5 | | 4 | **27,000** | | 6 | 23 | | 4 | **31** | J | 6 | **390** | | 6 | **0.023** | | 6 | **0.73** | UJ | 6 | 20 | | 4 |
| BCSS14D01 | 0 | 28 | | 4 | 4.2 | | 4 | **24,000** | | 6 | 26 | | 4 | **37** | J | 6 | **370** | | 6 | **0.022** | | 6 | **0.68** | UJ | 6 | 23 | | 4 |
| California Benchmark Soils (Kearney Study, March 1996) | Mean | 28.7 | | | n.a. | | | 37,000 | | | 23.9 | | | 23 | | | 646 | | | 0.26 | | | 1.3 | | | 57 | | |
| | min | 9.1 | | | n.a. | | | 10,000 | | | 12.4 | | | 4 | | | 253 | | | 0.05 | | | 0.1 | | | 9 | | |
| | max | 96.4 | | | n.a. | | | 87,000 | | | 97.1 | | | 90 | | | 1,687 | | | 0.9 | | | 9.6 | | | 509 | | |
| California Air Force Bases (Hunter et al 2005) | 95th | 53.3 | | | 8.9 | | | 36,100 | | | 25 | | | n.a. | | | 823 | | | 0.3 | | | 20 | | | 41.5 | | |
| | 99th | 157 | | | 23 | | | 49,400 | | | 148 | | | n.a. | | | 1,600 | | | 0.6 | | | 44 | | | 85.4 | | |

Notes

(a) Data set is for characterization and risk assessment evaluation of onsite investigational units for the SSFL RCRA Program.

All values in milligrams per kilogram (mg/kg) except pH units
"--" indicates sample was not collected (location inaccessible)
**Bold** indicates recent data collected in April 2005.
J = estimated value
U = non detect
UJ = estimated non detect
ft. bgs = feet below ground surface

**Data Source Reference Documents**
1 = Multi-Media Sampling Report for the BBI and the SMMC (McLaren/Hart 1993b)
2 = RFI Work Plan Addendum (Ogden 1996)
3 = FSDF Characterization Report (ICF 1997)
4 = Bell Canyon Area Soil Sampling Report (Ogden 1998b)
5 = SRAM Work Plan (Ogden 2000a)
6 = This report

**Example:**

| Antimony | | |
|---|---|---|
| 5.3 | J | 2 |

Sample Result
Data Qualifier
Data Source Document

# Table 4-1
## SSFL Soil Background Metals Data Set
## (Page 2 of 2)

| SAMPLE ID | Depth (ft. bgs) | Potassium | | | Selenium | | | Silver | | | Sodium | | | Thallium | | | Vanadium | | | Zinc | | | Zirconium | | | pH | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BGSS01S01 | 0.5 | **3,100** | | 6 | 0.47 | U | 2 | 0.76 | U | 2 | **100** | J | 6 | **0.21** | UJ | 6 | 38.2 | | 2 | 70.4 | | 2 | **1.9** | U | 6 | **6.82** | J | 6 |
| BGSS02S01 | 0.5 | **1,800** | | 6 | 0.46 | U | 2 | 0.74 | U | 2 | **50** | | 6 | **0.19** | UJ | 6 | 16.7 | | 2 | 41.8 | | 2 | **1.7** | U | 6 | **7.27** | J | 6 |
| BGSS02S02 | 1 | **2,000** | | 6 | 0.47 | U | 2 | 0.75 | U | 2 | **45** | | 6 | **0.16** | UJ | 6 | 14.7 | | 2 | 40.7 | | 2 | **1.6** | U | 6 | **7.07** | J | 6 |
| BGSS03D01 | 0.5 | **4,300** | | 6 | 0.72 | | 2 | 0.75 | U | 2 | **63** | J | 6 | **0.31** | | 6 | 27.3 | | 2 | 63.6 | | 2 | **3.1** | J | 6 | **8.25** | J | 6 |
| BGSS03S01 | 0.5 | **3,900** | | 6 | 0.59 | | 2 | 0.74 | U | 2 | **57** | J | 6 | **0.31** | | 6 | 25.5 | | 2 | 61.3 | | 2 | **3.3** | J | 6 | **8.08** | J | 6 |
| BGSS03S02 | 1 | **3,900** | | 6 | 0.53 | | 2 | 0.74 | U | 2 | **66** | J | 6 | **0.29** | J | 6 | 28.1 | | 2 | 62.8 | | 2 | **3.2** | J | 6 | **7.8** | J | 6 |
| BGSS04S01 | 0.5 | **4,000** | | 6 | 0.48 | U | 2 | 0.77 | U | 2 | **88** | J | 6 | **0.3** | | 6 | 57.1 | | 2 | 47.3 | | 2 | **6.6** | J | 6 | **7.4** | J | 6 |
| BGSS06S01 | 0.5 | **3,200** | | 6 | 0.45 | U | 2 | 0.72 | U | 2 | **61** | J | 6 | **0.25** | J | 6 | 26.6 | | 2 | 56.9 | | 2 | **5.7** | J | 6 | **7.35** | J | 6 |
| BGSS07S01 | 0.5 | **3,800** | | 6 | 0.48 | UJ | 2 | 0.77 | U | 2 | **65** | J | 6 | **0.28** | UJ | 6 | 35.7 | | 2 | 53.2 | | 2 | **2.8** | J | 6 | **6.98** | J | 6 |
| BKND-1 | 0 | **3,500** | | 6 | 2.1 | U | 3 | 0.21 | U | 3 | **66** | J | 6 | **0.33** | | 6 | 44.5 | | 3 | 47.4 | | 3 | **3.7** | J | 6 | **8.86** | J | 6 |
| BKND-2 | 0 | **2,100** | | 6 | 2.1 | U | 3 | 0.21 | U | 3 | **74** | J | 6 | **0.13** | J | 6 | 31.9 | | 3 | 62.5 | | 3 | **5.8** | J | 6 | **7.68** | J | 6 |
| BKND-3 | 0 | **3,600** | | 6 | 2.1 | U | 3 | 0.21 | U | 3 | **54** | J | 6 | **0.17** | UJ | 6 | 21.4 | | 3 | 50.3 | | 3 | **1.6** | U | 6 | **7.21** | J | 6 |
| BKND-4 | 0 | **3,600** | | 6 | 2 | U | 3 | 0.2 | U | 3 | **48** | J | 6 | **0.46** | | 6 | 22.5 | | 3 | 52.5 | | 3 | **1.8** | J | 6 | **6.78** | J | 6 |
| BKND-5 | 0 | **3,200** | | 6 | 2.1 | U | 3 | 0.21 | U | 3 | **51** | J | 6 | **0.36** | | 6 | 21.7 | | 3 | 62.4 | | 3 | **5.9** | J | 6 | **6.95** | J | 6 |
| BKND-6 | 0 | **3,100** | | 6 | 2.1 | U | 3 | 0.21 | U | 3 | **51** | J | 6 | **0.19** | UJ | 6 | 26.5 | | 3 | 59.3 | | 3 | **1.7** | U | 6 | **7.08** | J | 6 |
| BKND-7 | 0 | **3,000** | | 6 | 2.1 | U | 3 | 0.21 | U | 3 | **51** | J | 6 | **0.24** | UJ | 6 | 37.8 | | 3 | 51.7 | | 3 | **1.9** | U | 6 | **7.08** | J | 6 |
| BZSS01D01 | 0.5 | **4,000** | | 6 | 0.48 | UJ | 2 | 1.1 | | 2 | **78** | J | 6 | **0.23** | J | 6 | 26.6 | | 2 | 48.3 | | 2 | **1.6** | | 6 | **7.2** | J | 6 |
| BZSS01S01 | 0.5 | **3,600** | | 6 | 0.7 | J | 2 | 0.76 | U | 2 | **72** | J | 6 | **0.23** | J | 6 | 27.8 | | 2 | 50.6 | | 2 | **1.9** | | 6 | **6.98** | J | 6 |
| BZSS02S01 | 0.5 | **2,500** | | 6 | 0.46 | UJ | 2 | 0.74 | U | 2 | **47** | | 6 | **0.23** | UJ | 6 | 28.1 | | 2 | 50.3 | | 2 | **1.9** | U | 6 | **6.88** | J | 6 |
| BZSS03S01 | 0.5 | **4,000** | | 6 | 0.48 | J | 2 | 0.74 | U | 2 | **83** | | 6 | **0.045** | UJ | 6 | 32.4 | | 2 | 63.1 | | 2 | **3.3** | | 6 | **7.75** | J | 6 |
| BZSS03S02 | 1 | **3,700** | | 6 | 0.49 | UJ | 2 | 0.79 | | 2 | **110** | | 6 | **0.44** | UJ | 6 | 35.8 | | 2 | 64.1 | | 2 | **4.2** | | 6 | **7.5** | J | 6 |
| BZSS04S01 | 0.5 | **3,800** | | 6 | 0.45 | UJ | 2 | 0.73 | U | 2 | **100** | J | 6 | **0.25** | UJ | 6 | 30.6 | | 2 | 52.7 | | 2 | **1.9** | | 6 | **7.21** | J | 6 |
| SGSS01S01 | 0 | **3,800** | | 6 | 0.982 | U | 5 | 0.328 | U | 5 | **53** | J | 6 | **0.2** | UJ | 6 | 34.6 | | 5 | 54.2 | | 5 | **3.2** | J | 6 | **6.15** | J | 6 |
| BZSS06S01 | 0 | **2,700** | | 6 | 1.03 | U | 5 | 0.343 | U | 5 | **65** | UJ | 6 | **0.29** | UJ | 6 | 38.4 | | 5 | 60.6 | | 5 | **2.3** | J | 6 | **6.17** | | 6 |
| BZSS05S01 | 0 | **2,600** | | 6 | **0.45** | UJ | 6 | **0.19** | U | 6 | **76** | UJ | 6 | **0.3** | UJ | 6 | **26** | | 6 | **44** | | 6 | **2.3** | J | 6 | **6.22** | | 6 |
| BG01005 | 0 - 1 | **2,100** | | 6 | **0.28** | | 6 | 1 | U | 1 | **65** | J | 6 | **0.22** | UJ | 6 | **42** | | 6 | 48 | | 1 | **2** | J | 6 | **6.85** | | 6 |
| BG01008 | 0 - 1 | **3,000** | | 6 | **0.28** | | 6 | 1 | U | 1 | **78** | J | 6 | **0.53** | UJ | 6 | **40** | | 6 | 45 | | 1 | **2.2** | J | 6 | **6.58** | | 6 |
| BG01100 | 0 - 1 | **2,600** | | 6 | **0.2** | U | 6 | 1 | U | 1 | **65** | J | 6 | **0.29** | UJ | 6 | **36** | | 6 | 51 | | 1 | **1.7** | J | 6 | **7.11** | | 6 |
| BG02007 | 0 - 1 | **3,000** | | 6 | **0.21** | U | 6 | 1 | U | 1 | **68** | J | 6 | **0.24** | UJ | 6 | **27** | | 6 | 48 | | 1 | **1.9** | J | 6 | **7.04** | | 6 |
| BG02074 | 0 - 1 | **3,600** | | 6 | **0.27** | | 6 | 1 | U | 1 | **62** | J | 6 | **0.22** | UJ | 6 | **26** | | 6 | 55 | | 1 | **1.7** | J | 6 | **6.85** | | 6 |
| BG02076 | 0 - 1 | **3,200** | | 6 | **0.27** | | 6 | 1 | U | 1 | **73** | J | 6 | **0.2** | UJ | 6 | **26** | | 6 | 49 | | 1 | **7.1** | J | 6 | **6.95** | | 6 |
| BG04025 | 0 - 1 | **6,100** | | 6 | **0.31** | | 6 | 1 | U | 1 | **93** | J | 6 | **0.35** | | 6 | **62** | | 6 | 69 | | 1 | **6** | J | 6 | **8.42** | J | 6 |
| BG04029 | 0 - 1 | **6,400** | | 6 | **0.25** | | 6 | 1 | U | 1 | **81** | J | 6 | **0.33** | | 6 | **56** | | 6 | 67 | | 1 | **5.5** | J | 6 | **7.89** | J | 6 |
| BG04090 | 0 - 1 | **5,400** | | 6 | **0.31** | | 6 | 1 | U | 1 | **81** | J | 6 | **0.31** | | 6 | **57** | | 6 | 70 | | 1 | **5.1** | J | 6 | **7.58** | J | 6 |
| BCSS09S01 | 0 | **4,700** | | 6 | **0.45** | | 6 | 1 | U | 4 | **68** | | 6 | **0.34** | UJ | 6 | 19 | | 4 | 35 | J | 4 | **2.6** | | 6 | **5.85** | J | 6 |
| BCSS11S01 | 0 | **2,400** | | 6 | **0.23** | | 6 | 1 | U | 4 | **98** | J | 6 | **0.27** | UJ | 6 | 28 | | 4 | 32 | J | 4 | **8.6** | J | 6 | **6.9** | J | 6 |
| BCSS12S01 | 0 | **4,800** | | 6 | **0.23** | | 6 | 1 | U | 4 | **88** | J | 6 | **0.39** | J | 6 | 30 | | 4 | 56 | J | 4 | **2.6** | | 6 | **7.48** | J | 6 |
| BCSS13S01 | 0 | **3,700** | | 6 | **0.32** | | 6 | 1 | U | 4 | **76** | J | 6 | **0.31** | UJ | 6 | 43 | | 4 | 78 | J | 4 | **2.8** | J | 6 | **6.93** | J | 6 |
| BCBS09S01 | 0 | -- | | | -- | | | 1 | U | 4 | -- | | | -- | | | 54 | | 4 | 110 | J | 4 | -- | | | -- | | |
| BCSS14S01 | 0 | **3,600** | | 6 | **0.22** | | 6 | 1 | U | 4 | **96** | J | 6 | **0.27** | UJ | 6 | 45 | | 4 | 97 | J | 4 | **7.2** | | 6 | **7.48** | J | 6 |
| BCSS14D01 | 0 | **3,300** | | 6 | **0.19** | | 6 | 1 | U | 4 | **78** | J | 6 | **0.27** | UJ | 6 | 46 | | 4 | 110 | J | 4 | **4.3** | | 6 | **8.2** | J | 6 |
| California Benchmark Soils (Kearney Study, March 1996) | Mean | 17,300 | | | 0.058 | | | 0.8 | | | 15,838 | | | 0.56 | | | 112 | | | 149 | | | 93 | | | n.a. | | |
| | min | 2,100 | | | 0.015 | | | 0.1 | | | 5,580 | | | 0.17 | | | 39 | | | 88 | | | 19 | | | n.a. | | |
| | max | 30,000 | | | 0.43 | | | 8.3 | | | 73,400 | | | 1.1 | | | 288 | | | 236 | | | 610 | | | n.a. | | |
| California Air Force Bases (Hunter et al 2005) | 95th | n.a. | | | 11 | | | 2.1 | | | 1,660 | | | 25 | | | 88.3 | | | 104 | | | n.a. | | | n.a. | | |
| | 99th | n.a. | | | 25 | | | 6.1 | | | 3,980 | | | 173.5 | | | 126 | | | 307 | | | n.a. | | | n.a. | | |

Notes

(a) Data set is for characterization and risk assessment evaluation of onsite investigational units for the SSFL RCRA Program.

All values in milligrams per kilogram (mg/kg) except pH units
"--" indicates sample was not collected (location inaccessible)
**Bold** indicates recent data collected in April 2005.
J = estimated value
U = non detect
UJ = estimated non detect
ft. bgs = feet below ground surface

**Data Source Reference Documents**
1 = Multi-Media Sampling Report for the BBI and the SMMC (McLaren/Hart 1993b
2 = RFI Work Plan Addendum (Ogden 1996)
3 = FSDF Characterization Report (ICF 1997)
4 = Bell Canyon Area Soil Sampling Report (Ogden 1998b)
5 = SRAM Work Plan (Ogden 2000a)
6 = This report

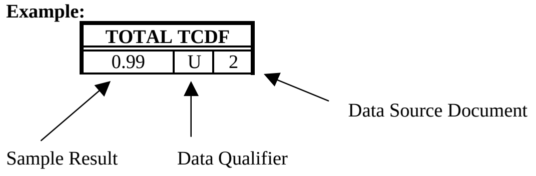
# Table 4-2
## SSFL Soil Background Dioxins Data Set
## (Page 1 of 2)

| SAMPLE ID | Depth (feet bgs) | 2,3,7,8-TCDD | | | 2,3,7,8-TCDF | | | 1,2,3,7,8-PeCDD | | | 1,2,3,7,8-PeCDF | | | 2,3,4,7,8-PeCDF | | | 1,2,3,4,7,8-HxCDD | | | 1,2,3,6,7,8-HxCDD | | | 1,2,3,7,8,9-HxCDD | | | 1,2,3,4,7,8-HxCDF | | | 1,2,3,6,7,8-HxCDF | | | 1,2,3,7,8,9-HxCDF | | | 2,3,4,6,7,8-HxCDF | | | 1,2,3,4,6,7,8-HpCDD | | | 1,2,3,4,6,7,8-HpCDF | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCBS09S01 | 0 | 2 | U | 2 | 2 | U | 2 | 10 | U | 2 | 10 | U | 2 | 10 | U | 2 | 10 | U | 2 | 10 | U | 2 | 10 | U | 2 | 10 | U | 2 | 10 | U | 2 | 10 | U | 2 | 10 | U | 2 | 10 | U | 2 | 10 | U | 2 |
| BCSS09S01 | 0 | 0.99 | U | 2 | 0.99 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 |
| BCSS11S01 | 0 | 1 | U | 2 | 1 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 |
| BCSS12S01 | 0 | 0.99 | U | 2 | 0.99 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 |
| BCSS13S01 | 0 | 1 | U | 2 | 1 | U | 2 | 5.2 | U | 2 | 5.2 | U | 2 | 5.2 | U | 2 | 5.2 | U | 2 | 5.2 | U | 2 | 5.2 | U | 2 | 5.2 | U | 2 | 5.2 | U | 2 | 5.2 | U | 2 | 5.2 | U | 2 | 5 | U | 2 | 5.2 | U | 2 |
| BCSS14D01 | 0 | 1.3 | U | 2 | 1.3 | U | 2 | 6.4 | U | 2 | 6.4 | U | 2 | 6.4 | U | 2 | 6.4 | U | 2 | 6.4 | U | 2 | 6.4 | U | 2 | 6.4 | U | 2 | 6.4 | U | 2 | 6.4 | U | 2 | 6.4 | U | 2 | 6 | U | 2 | 6.4 | U | 2 |
| BCSS14S01 | 0 | 1.4 | U | 2 | 1.4 | U | 2 | 6.8 | U | 2 | 6.8 | U | 2 | 6.8 | U | 2 | 6.8 | U | 2 | 6.8 | U | 2 | 6.8 | U | 2 | 6.8 | U | 2 | 6.8 | U | 2 | 6.8 | U | 2 | 6.8 | U | 2 | 7 | U | 2 | 6.8 | U | 2 |
| BKND-1 | 0 | 0.57 | U | 1 | 0.72 | J | 1 | 0.12 | J | 1 | 0.21 | J | 1 | 0.33 | UJ | 1 | 0.41 | U | 1 | 0.43 | J | 1 | 0.48 | J | 1 | 0.35 | J | 1 | 0.44 | U | 1 | 0.23 | U | 1 | 5.1 | U | 1 | 7 | | 1 | 1.7 | UJ | 1 |
| BKND-2 | 0 | 0.66 | U | 1 | 1.1 | J | 1 | 0.26 | UJ | 1 | 0.4 | J | 1 | 0.38 | J | 1 | 0.27 | J | 1 | 0.63 | J | 1 | 0.77 | J | 1 | 0.48 | J | 1 | 0.58 | U | 1 | 0.21 | U | 1 | 5.4 | U | 1 | 8 | | 1 | 1.6 | UJ | 1 |
| BKND-3 | 0 | 0.78 | U | 1 | 0.45 | UJ | 1 | 0.44 | U | 1 | 0.48 | U | 1 | 0.17 | J | 1 | 0.2 | UJ | 1 | 0.49 | UJ | 1 | 0.69 | J | 1 | 0.23 | UJ | 1 | 0.62 | U | 1 | 0.33 | UJ | 1 | 5 | U | 1 | 9 | | 1 | 1.6 | J | 1 |
| BKND-4 | 0 | 0.44 | U | 1 | 0.29 | J | 1 | 0.24 | U | 1 | 0.32 | U | 1 | 0.12 | U | 1 | 0.13 | UJ | 1 | 0.57 | J | 1 | 0.63 | J | 1 | 0.28 | J | 1 | 0.43 | U | 1 | 0.27 | UJ | 1 | 5.1 | U | 1 | 8 | J | 1 | 1.7 | J | 1 |
| BKND-5 | 0 | 0.52 | U | 1 | 1.4 | | 1 | 0.46 | U | 1 | 0.45 | J | 1 | 0.44 | J | 1 | 0.18 | J | 1 | 0.74 | J | 1 | 0.7 | J | 1 | 0.57 | UJ | 1 | 0.71 | U | 1 | 0.1 | J | 1 | 5.2 | U | 1 | 9 | J | 1 | 2.4 | UJ | 1 |
| BKND-6 | 0 | 0.84 | U | 1 | 1.8 | J | 1 | 0.76 | U | 1 | 0.59 | J | 1 | 0.64 | J | 1 | 0.75 | U | 1 | 0.95 | J | 1 | 1.1 | J | 1 | 0.73 | J | 1 | 1 | U | 1 | 0.43 | J | 1 | 5.3 | U | 1 | 11 | J | 1 | 3.6 | UJ | 1 |
| BKND-7 | 0 | 0.6 | U | 1 | 1.3 | UJ | 1 | 0.18 | J | 1 | 0.34 | U | 1 | 0.5 | J | 1 | 0.2 | J | 1 | 0.76 | UJ | 1 | 0.81 | J | 1 | 0.56 | J | 1 | 0.69 | U | 1 | 0.21 | U | 1 | 5.3 | U | 1 | 9 | | 1 | 2 | UJ | 1 |
| BZSS05S01 | 0 | 0.16 | U | 3 | 0.15 | U | 3 | 0.4 | U | 3 | 0.18 | U | 3 | 0.16 | U | 3 | 0.13 | U | 3 | 0.84 | J | 3 | 1 | J | 3 | 0.16 | U | 3 | 0.16 | U | 3 | 0.1 | U | 3 | 0.14 | U | 3 | 4 | UJ | 3 | 0.8 | J | 3 |
| BZSS06S01 | 0 | 0.15 | U | 3 | 0.18 | U | 3 | 0.31 | U | 3 | 0.31 | U | 3 | 0.28 | U | 3 | 0.21 | U | 3 | 0.22 | U | 3 | 0.2 | U | 3 | 0.11 | U | 3 | 0.11 | U | 3 | 0.088 | U | 3 | 0.09 | U | 3 | 2 | UJ | 3 | 0.49 | | 3 |
| SGSS01S01 | 0 | 0.24 | U | 3 | 0.34 | J | 3 | 0.43 | U | 3 | 0.22 | U | 3 | 0.54 | | 3 | 0.34 | J | 3 | 0.77 | J | 3 | 0.64 | J | 3 | 0.47 | | 3 | 0.3 | | 3 | 0.14 | U | 3 | 0.45 | | 3 | 13 | | 3 | 2.5 | | 3 |

Notes
(a) TEQ values were calculated using detected congener concentrations
and WHO toxicity equivalency factors. For comparison, western United States dioxin TEQs typically range up to 2 pg/g or parts per trillion.
(b) TEQ values do not include total dioxin or total furan concentrations.
(c) Data set is for characterization and risk assessment evaluation
of onsite investigational units for the SSFL RCRA Program.

All sample results in picograms per gram (pg/g)
bgs = below ground surface

**Example:**



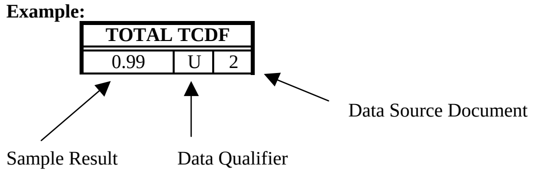
# Table 4-2
## SSFL Soil Background Dioxins Data Set
## (Page 2 of 2)

| SAMPLE ID | Depth (feet bgs) | 1,2,3,4,7,8,9-HpCDF | | | OCDD | | | OCDF | | | TOTAL TCDD | | | TOTAL TCDF | | | TOTAL PeCDD | | | TOTAL PeCDF | | | TOTAL HxCDD | | | TOTAL HxCDF | | | TOTAL HpCDD | | | TOTAL HpCDF | | | TEQ[a] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCBS09S01 | 0 | 10 | U | 2 | 20 | U | 2 | 20 | U | 2 | 2 | U | 2 | 2 | U | 2 | 10 | U | 2 | 10 | U | 2 | 10 | U | 2 | 10 | U | 2 | 10 | U | 2 | 10 | U | 2 | 0 |
| BCSS09S01 | 0 | 5 | U | 2 | 9.9 | U | 2 | 9.9 | U | 2 | 0.99 | U | 2 | 0.99 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 0 |
| BCSS11S01 | 0 | 5 | U | 2 | 46 | J | 2 | 10 | U | 2 | 1 | U | 2 | 3.1 | J | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 0.0046 |
| BCSS12S01 | 0 | 5 | U | 2 | 17 | J | 2 | 9.9 | U | 2 | 0.99 | U | 2 | 0.99 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 5 | U | 2 | 0.0017 |
| BCSS13S01 | 0 | 5.2 | U | 2 | 10 | U | 2 | 10 | U | 2 | 1 | U | 2 | 1 | U | 2 | 5.2 | U | 2 | 5.2 | U | 2 | 5.2 | U | 2 | 5.2 | U | 2 | 5.2 | U | 2 | 5.2 | U | 2 | 0 |
| BCSS14D01 | 0 | 6.4 | U | 2 | 13 | J | 2 | 13 | U | 2 | 1.3 | U | 2 | 1.3 | U | 2 | 6.4 | U | 2 | 6.4 | U | 2 | 6.4 | U | 2 | 6.4 | U | 2 | 6.4 | U | 2 | 6.4 | U | 2 | 0.0013 |
| BCSS14S01 | 0 | 6.8 | U | 2 | 14 | U | 2 | 14 | U | 2 | 1.4 | U | 2 | 1.4 | U | 2 | 6.8 | U | 2 | 6.8 | U | 2 | 6.8 | U | 2 | 6.8 | U | 2 | 6.8 | U | 2 | 6.8 | U | 2 | 0 |
| BKND-1 | 0 | 0.19 | UJ | 1 | 74.6 | | 1 | 3.2 | J | 1 | 1 | U | 1 | 22.3 | U | 1 | 5.1 | U | 1 | 15.5 | U | 1 | 5.2 | J | 1 | 6.6 | U | 1 | 16.4 | | 1 | 3.4 | J | 1 | 0.41 |
| BKND-2 | 0 | 0.21 | UJ | 1 | 44.7 | | 1 | 1.7 | J | 1 | 1.1 | U | 1 | 44.1 | U | 1 | 5.4 | U | 1 | 24.3 | U | 1 | 6.8 | J | 1 | 8.9 | U | 1 | 15.5 | | 1 | 2.9 | J | 1 | 0.62 |
| BKND-3 | 0 | 2.2 | U | 1 | 76.2 | | 1 | 3.9 | J | 1 | 1 | U | 1 | 7.7 | U | 1 | 5 | U | 1 | 8.5 | U | 1 | 5.4 | J | 1 | 8.7 | U | 1 | 17.7 | | 1 | 3.8 | J | 1 | 0.27 |
| BKND-4 | 0 | 0.19 | J | 1 | 83.1 | | 1 | 3.7 | J | 1 | 1 | U | 1 | 6.6 | U | 1 | 5.1 | U | 1 | 6.6 | U | 1 | 5.3 | J | 1 | 5.8 | U | 1 | 18.2 | | 1 | 3.9 | J | 1 | 0.28 |
| BKND-5 | 0 | 1.3 | U | 1 | 110 | | 1 | 3.9 | J | 1 | 1 | U | 1 | 28.3 | U | 1 | 5.2 | U | 1 | 18.3 | U | 1 | 7.3 | J | 1 | 10.2 | U | 1 | 26.3 | | 1 | 4.5 | J | 1 | 0.65 |
| BKND-6 | 0 | 1.3 | U | 1 | 138 | | 1 | 7.9 | J | 1 | 1.6 | UJ | 1 | 54.9 | U | 1 | 5.3 | U | 1 | 32.3 | U | 1 | 10 | J | 1 | 14.8 | U | 1 | 31.5 | | 1 | 6.8 | J | 1 | 0.98 |
| BKND-7 | 0 | 1.3 | U | 1 | 108 | | 1 | 3.4 | J | 1 | 1.1 | U | 1 | 41.9 | U | 1 | 5.3 | U | 1 | 24.4 | U | 1 | 7.9 | J | 1 | 10.8 | U | 1 | 25.1 | | 1 | 3.9 | J | 1 | 0.69 |
| BZSS05S01 | 0 | 0.086 | U | 3 | 25 | | 3 | 1.4 | J | 3 | 0.16 | U | 3 | 0.5 | | 3 | 0.4 | U | 3 | 1.7 | J | 3 | 4.2 | | 3 | 1.1 | J | 3 | 8.4 | | 3 | 1.5 | J | 3 | 0.19 |
| BZSS06S01 | 0 | 0.062 | U | 3 | 15 | | 3 | 0.96 | | 3 | 0.15 | U | 3 | 0.95 | | 3 | 0.31 | U | 3 | 2.5 | J | 3 | 0.91 | J | 3 | 0.97 | J | 3 | 4.2 | | 3 | 0.49 | J | 3 | 0.0065 |
| SGSS01S01 | 0 | 0.25 | U | 3 | 140 | | 3 | 8.1 | | 3 | 0.24 | U | 3 | 4 | | 3 | 0.43 | U | 3 | 4.6 | | 3 | 6.4 | | 3 | 4.2 | | 3 | 26 | | 3 | 6.9 | | 3 | 0.77 |

Notes
(a) TEQ values were calculated using detected congener concentrations and WHO toxicity equivalency factors. For comparison, western United States dioxin TEQs typically range up to 2 pg/g or parts per trillion.
(b) TEQ values do not include total dioxin or total furan concentrations.
(c) Data set is for characterization and risk assessment evaluation of onsite investigational units for the SSFL RCRA Program.

All sample results in picograms per gram (pg/g)
bgs = below ground surface

**Example:**



**Qualifiers**
U = non detect
J = estimated value
UJ = estimated non detect

**Data Source Documents**
1 = FSDF Characterization Report (ICF 1997)
2 = Bell Canyon Area Soil Sampling Report (Ogden 1998b)
3 = SRAM Work Plan (Ogden 2000a)

TCDD = tetrachlorodibenzo-p-dioxin
TCDF = tetrachlorodibenzofuran
PeCDD = pentachlorodibenzo-p-dioxin
PeCDF = pentachlorodibenzofuran
HxCDD = hexachlorodibenzo-p-dioxin
HxCDF = hexachlorodibenzofuran

HpCDD = heptachlorodibenzo-p-dioxin
HpCDF = heptachlorodibenzofuran
OCDD = octachlorodibenzo-p-dioxin
OCDF = octachlorodibenzofuran

TEQ = Toxicity Equivalent

# Table 4-3 (1 of 2)
## Summary of Soil Background Data
## Santa Susana Field Laboratory

| Chemical | Number of Detects | Number of Samples | Range of Detection Limits [a] | Percent Frequency of Detection | Range of Detected Concentrations | Arithmetic Mean [b] | Standard Deviation [b] | Coefficient of Variation [b] | Type of Distribution [c] |
|---|---|---|---|---|---|---|---|---|---|
| Inorganics | | | | | | | | | |
| Aluminum | 38 | 38 | 6.1 - 68 | 100 | 5600 - 20000 | 11958 | 3070 | 0.26 | Normal |
| Antimony | 13 | 37 | 0.18 - 2.5 | 35 | 3.1 - 8.7 | 2.4 | 2.9 | 1.2 | Indeterminate |
| Arsenic | 33 | 38 | 0.56 - 6 | 87 | 1.7 - 15 | 4.4 | 3.2 | 0.73 | Indeterminate |
| Barium | 38 | 38 | 0.37 - 1 | 100 | 36 - 140 | 80 | 21 | 0.27 | Normal |
| Beryllium | 36 | 38 | 0.091 - 0.6 | 95 | 0.28 - 1.1 | 0.58 | 0.23 | 0.39 | Normal |
| Boron | 12 | 37 | 0.97 - 8 | 32 | 2.5 - 9.7 | 3.0 | 2.4 | 0.81 | Indeterminate |
| Cadmium | 9 | 38 | 0.05 - 1 | 24 | 0.22 - 1 | 0.25 | 0.22 | 0.89 | Indeterminate |
| Chromium | 38 | 38 | 0.099 - 2 | 100 | 8.8 - 36.8 | 19 | 5.7 | 0.30 | Normal |
| Cobalt | 38 | 38 | 0.12 - 2 | 100 | 2.9 - 21 | 6.9 | 3.1 | 0.45 | Lognormal |
| Copper | 38 | 38 | 0.26 - 2 | 100 | 3.8 - 29 | 11 | 5.6 | 0.49 | Lognormal |
| Fluoride | 14 | 38 | 1.1 - 5.8 | 37 | 1.7 - 6.7 | 1.9 | 1.2 | 0.65 | Indeterminate |
| Iron | 37 | 37 | 1.1 - 2.5 | 100 | 12000 - 28000 | 19581 | 4693 | 0.24 | Lognormal |
| Lead | 38 | 38 | 0.32 - 6 | 100 | 4.2 - 34 | 15 | 7.5 | 0.50 | Lognormal |
| Lithium | 37 | 37 | 5.8 - 7 | 100 | 12 - 37 | 23 | 6.8 | 0.29 | Lognormal |
| Manganese | 37 | 37 | 0.41 - 0.5 | 100 | 190 - 495 | 319 | 66 | 0.21 | Normal |
| Mercury | 22 | 37 | 0.0065 - 0.115 | 59 | 0.019 - 0.09 | 0.044 | 0.020 | 0.46 | Indeterminate |
| Molybdenum | 24 | 37 | 0.13 - 0.95 | 65 | 0.35 - 5.3 | 0.85 | 1.1 | 1.3 | Indeterminate |
| Nickel | 38 | 38 | 0.29 - 13.9 | 100 | 5.2 - 29 | 13 | 4.3 | 0.33 | Lognormal |
| pH | 37 | 37 | - | 100 | 5.85 - 8.86 | 7.2 | 0.62 | 0.086 | Normal |
| Potassium | 37 | 37 | 8.6 - 10 | 100 | 1800 - 6400 | 3496 | 1031 | 0.29 | Lognormal |
| Selenium | 16 | 37 | 0.19 - 2.1 | 43 | 0.205 - 0.655 | 0.44 | 0.32 | 0.71 | Indeterminate |
| Silver | 2 | 38 | 0.19 - 1 | 5 | 0.74 - 0.79 | 0.38 | 0.18 | 0.48 | Indeterminate |
| Sodium | 35 | 37 | 12 - 76 | 95 | 45 - 110 | 69 | 19 | 0.27 | Normal |
| Thallium | 13 | 37 | 0.04 - 0.53 | 35 | 0.13 - 0.46 | 0.19 | 0.11 | 0.56 | Indeterminate |
| Vanadium | 38 | 38 | 0.18 - 2 | 100 | 14.7 - 62 | 34 | 12 | 0.35 | Lognormal |
| Zinc | 38 | 38 | 0.54 - 1.3 | 100 | 32 - 110 | 57 | 15 | 0.27 | Lognormal |
| Zirconium | 30 | 37 | 1.5 - 1.9 | 81 | 1.7 - 8.6 | 3.2 | 2.1 | 0.64 | Indeterminate |

## Table 4-3 (2 of 2)
## Summary of Soil Background Data
## Santa Susana Field Laboratory

| **Chemical** | **Number of Detects** | **Number of Samples** | **Range of Detection Limits** [(a)] | **Percent Frequency of Detection** | **Range of Detected Concentrations** | **Arithmetic Mean** [(b)] | **Standard Deviation** [(b)] | **Coefficient of Variation** [(b)] | **Type of Distribution** [(c)] |
|---|---|---|---|---|---|---|---|---|---|
| Dioxins | | | | | | | | | |
| 1,2,3,4,6,7,8-HPCDD | 8 | 16 | 1.7 - 10 | 50 | 7.4 - 13 | 5.9 | 3.7 | 0.63 | Normal |
| 1,2,3,4,6,7,8-HPCDF | 5 | 16 | 1.6 - 10 | 31 | 0.49 - 2.5 | 1.9 | 1.2 | 0.60 | Normal |
| 1,2,3,4,7,8,9-HPCDF | 1 | 16 | 0.062 - 10 | 6 | 0.19 - 0.19 | 1.4 | 1.5 | 1.1 | Lognormal |
| 1,2,3,4,7,8-HxCDD | 4 | 16 | 0.13 - 10 | 25 | 0.18 - 0.34 | 1.3 | 1.6 | 1.2 | Indeterminate |
| 1,2,3,4,7,8-HXCDF | 6 | 16 | 0.11 - 10 | 38 | 0.28 - 0.73 | 1.4 | 1.5 | 1.1 | Lognormal |
| 1,2,3,6,7,8-HxCDD | 7 | 16 | 0.22 - 10 | 44 | 0.43 - 0.95 | 1.5 | 1.4 | 0.93 | Lognormal |
| 1,2,3,6,7,8-HXCDF | 1 | 16 | 0.11 - 10 | 6 | 0.3 - 0.3 | 1.3 | 1.5 | 1.2 | Lognormal |
| 1,2,3,7,8,9-HXCDD | 9 | 16 | 0.2 - 10 | 56 | 0.48 - 1.1 | 1.6 | 1.3 | 0.84 | Lognormal |
| 1,2,3,7,8,9-HXCDF | 2 | 16 | 0.088 - 10 | 13 | 0.1 - 0.43 | 1.2 | 1.6 | 1.3 | Indeterminate |
| 1,2,3,7,8-PECDD | 2 | 16 | 0.24 - 10 | 13 | 0.12 - 0.18 | 1.3 | 1.5 | 1.2 | Indeterminate |
| 1,2,3,7,8-PECDF | 4 | 16 | 0.18 - 10 | 25 | 0.21 - 0.59 | 1.3 | 1.5 | 1.2 | Indeterminate |
| 2,3,4,6,7,8-HXCDF | 1 | 16 | 0.09 - 10 | 6 | 0.45 - 0.45 | 2.3 | 1.2 | 0.53 | Indeterminate |
| 2,3,4,7,8-PeCDF | 6 | 16 | 0.12 - 10 | 38 | 0.17 - 0.64 | 1.3 | 1.5 | 1.1 | Lognormal |
| 2,3,7,8-TCDD | 0 | 16 | 0.15 - 2 | 0 | -- - -- | 0.38 | 0.24 | 0.61 | Normal |
| 2,3,7,8-TCDF | 6 | 16 | 0.15 - 2 | 38 | 0.29 - 1.8 | 0.65 | 0.47 | 0.73 | Normal |
| OCDD | 13 | 16 | 9.9 - 20 | 81 | 13 - 140 | 57 | 48 | 0.85 | Lognormal |
| OCDF | 10 | 16 | 9.9 - 20 | 63 | 0.96 - 8.1 | 4.7 | 2.5 | 0.54 | Normal |

Notes:

(a) - The detection limits reported here may vary from the original laboratory reports based on results from data validation.

(b) - The calculations were performed using 1/2 the detection limit for non-detect

(c) - Distribution of data based on the Shapiro-Wilk W-test as tested using ProUCL version 3.0 (USEPA 2004). The Type I alpha = 0.05.

"--" indicates no applicable value since all results were not detectec

Metals are reported in units of mg/kg; dioxins in ng/kg; and pH is unitless.

# Table 4-4
# Soil and Geologic Information for SSFL Background Samples
# (Page 1 of 1)

| Sample ID | USCS | Percentage | | | Presence of Shale or Siltstone[(a)] |
|---|---|---|---|---|---|
| | | Gravel | Sand | Fines | |
| BCBS09 | CL | | 5 | 95 | Yes |
| BCSS09 | ML | 20 | 5 | 75 | Yes |
| BCSS11 | SC | | 15 | 85 | |
| BCSS12 | SM | | 10 | 90 | |
| BCSS13 | SM | 20 | 60 | 20 | |
| BCSS14 | SM | 5 | 35 | 65 | Yes |
| BG01 | SM | | 70 | 30 | |
| BG01 | SM | | 70 | 30 | |
| BG02 | ML | | 40 | 60 | |
| BG02 | ML | | 40 | 60 | |
| BG04 | ML | | 20 | 80 | |
| BGSS01 | ML | 5 | 65 | 30 | Yes |
| BGSS02 | SM | | 70 | 30 | |
| BGSS03 | SM | 20 | 15 | 65 | Yes |
| BGSS04 | ML | | 65 | 35 | |
| BGSS06 | ML | | 15 | 85 | |
| BGSS07 | SM | | | 100 | Yes |
| BKND-1 | SM | | 65 | 35 | |
| BKND-2 | SM | 10 | 55 | 35 | |
| BKND-3 | SM | | 70 | 30 | |
| BKND-4 | ML | | 40 | 60 | |
| BKND-5 | ML | | 45 | 55 | |
| BKND-6 | SM | | 55 | 45 | |
| BKND-7 | ML | | 10 | 90 | |
| BZSS01 | ML | | 5 | 95 | |
| BZSS02 | SM | 20 | 30 | 50 | (b) |
| BZSS03 | ML | | | 100 | (b) |
| BZSS04 | SM | | 55 | 45 | |
| BZSS05 | ML | | 5 | 95 | (b) |
| BZSS06 | SM | | 25 | 75 | |
| SGSS01 | SM | | 30 | 70 | |

Notes:

USCS = Unified Soil Classification System
CL = Clay
ML = Silt
SC = Clayey Sand
SM = Silty Sand
Fines = silt plus clay

(a) Presence of shale or siltstone based on geologic mapping of shales (Figure 4-1) and information in soil boring logs (Appendix A).

(b) This portion of the Lower Chatsworth formation contains a high proportion of shale and siltstone (geologic mapping ongoing).

# Table 4-5
## Summary of Soil Background Metals Results for Colocated Depth Pairs
(Page 1 of 1)

| SAMPLE ID | Depth (ft. bgs) | Aluminum | Antimony | Arsenic | Barium | Beryllium | Boron | Cadmium | Chromium | Cobalt | Copper | Fluoride | Iron | Lead |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BGSS02S01 | 0.5 | 7,380 | 3.1 J | 3.3 | 50.7 | 0.41 | **1.2** UJ | 0.06 U | 8.8 | 2.9 | 4.5 | **2.6** UJ | **12,000** | 5.3 |
| BGSS02S02 | 1 | 6,470 | 3.9 J | 3.5 | 38.6 | 0.36 | **1.2** UJ | 0.06 U | 11.6 | 3 | 5.8 | **2.2** UJ | **14,000** | 4.2 |
| BGSS03S01 | 0.5 | 11,800 | 7 J | 2.1 | 96.6 | 0.45 | **5** UJ | 0.06 U | 15.5 | 6.4 | 8.1 | **2.3** J | **23,000** | 7.3 |
| BGSS03S02 | 1 | 12,400 | 6.5 J | 2.5 | 93.2 | 0.62 | **5.1** UJ | 0.06 U | 17.4 | 5.5 | 9.2 | **3.1** J | **24,000** | 5.6 |
| BZSS03S01 | 0.5 | 15,800 | 7.4 J | 8.4 | 103 | 0.85 | **5.3** UJ | 0.06 UJ | 23.2 | 7.5 | 14.5 | **2.9** UJ | **24,000** | 14.4 |
| BZSS03S02 | 1 | 18,100 | 8.7 J | 8.5 | 106 | 0.99 | **6.2** UJ | 0.06 UJ | 26.2 | 8.4 | 15.1 | **4** UJ | **28,000** | 10.8 |

| SAMPLE ID | Depth (ft. bgs) | Lithium | Manganese | Mercury | Molybdenum | Nickel | Potassium | Selenium | Silver | Sodium | Thallium | Vanadium | Zinc | Zirconium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BGSS02S01 | 0.5 | **17** | **190** | 0.05 U | 0.78 U | 5.9 | **1,800** | 0.46 U | 0.74 U | **50** | **0.19** UJ | 16.7 | 41.8 | **1.7** U |
| BGSS02S02 | 1 | **20** J | **230** | 0.04 U | 0.79 U | 5.2 | **2,000** | 0.47 U | 0.75 U | **45** | **0.16** UJ | 14.7 | 40.7 | **1.6** U |
| BGSS03S01 | 0.5 | **31** J | **490** | 0.05 U | 0.82 UJ | 11 | **3,900** | 0.59 | 0.74 U | **57** J | **0.31** | 25.5 | 61.3 | **3.3** J |
| BGSS03S02 | 1 | **31** J | **420** | 0.05 | 0.78 U | 11.8 | **3,900** | 0.53 | 0.74 U | **66** J | **0.29** J | 28.1 | 62.8 | **3.2** J |
| BZSS03S01 | 0.5 | **28** J | **320** | 0.07 | 1.1 | 16.6 | **4,000** | 0.48 J | 0.74 U | **83** | **0.045** UJ | 32.4 | 63.1 | **3.3** |
| BZSS03S02 | 1 | **34** J | **330** | 0.08 | 0.83 U | 17.4 | **3,700** | 0.49 UJ | 0.79 | **110** | **0.44** UJ | 35.8 | 64.1 | **4.2** |

**For which pairs are surface concentrations higher for each metal?**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BGSS02S01 | 0.5 | H | | | H | H | ▨ | ▨ | | | | ▨ | | H | | | ▨ | ▨ | H | | ▨ | ▨ | H | ▨ | H | H | ▨ |
| BGSS02S02 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BGSS03S01 | 0.5 | | H | | H | | ▨ | ▨ | | H | | | | H | H | H | ▨ | ▨ | | H | H | ▨ | | ▨ | | | H |
| BGSS03S02 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BZSS03S01 | 0.5 | | | | | | ▨ | ▨ | | | | ▨ | | H | | | | ▨ | | H | ▨ | ▨ | | ▨ | | | |
| BZSS03S02 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |

**For those  pairs, what is the ratio (I.e. by how much are surface > subsurface concentrations for each metal?**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BGSS02S01 | 0.5 | 1.1 | | | 1.3 | 1.1 | ▨ | ▨ | | | | ▨ | | 1.3 | | | ▨ | ▨ | 1.1 | | ▨ | ▨ | 1.1 | ▨ | 1.1 | 1.0 | ▨ |
| BGSS02S02 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BGSS03S01 | 0.5 | | 1.1 | | 1.0 | | ▨ | ▨ | | 1.2 | | | | 1.3 | 1.0 | 1.2 | ▨ | ▨ | | 1.0 | 1.1 | ▨ | | ▨ | | | 1.0 |
| BGSS03S02 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BZSS03S01 | 0.5 | | | | | | ▨ | ▨ | | | | ▨ | | 1.3 | | | | ▨ | | 1.1 | ▨ | ▨ | | ▨ | | | |
| BZSS03S02 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |

H = Metals Concentration **Higher** in Surface Sample

▨ Non detected or non analyzed data

**Conclusions:**

1. **For most metals, with exception of lead, there is no trend for surficial elevation (atmospheric deposition) in the 3 depth pairs.**
2. **For those pairs/metals where the surface is higher, ratios are generally below 1.3.**

## Table 4-6 (1 of 2)
## Soil Background Comparison Levels for Metals
## Santa Susana Field Laboratory

| **Chemical** | **Type of Distribution** | **Distribution Excluding Non-Detects** | **Percent Frequency of Detection** | **Number of Detects** | **Soil Background Comparison Level Value** | **California Benchmark Soils (Kearney study, March 1996)** | | | **California Air Force Bases (Hunter et al, 2005)** | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | **Mean** | **min** | **max** | **95th** | **99th** |
| Aluminum | Normal | Normal | 100 | 38 | 20,000 | 73,000 | 30,000 | 106,000 | 23,000 | 31,300 |
| Antimony | Indeterminate | Normal | 35 | 13 | 8.7 | 0.6 | 0.15 | 1.95 | 12.5 | 25 |
| Arsenic | Indeterminate | Indeterminate | 87 | 33 | 15 | 3.5 | 0.6 | 11 | 12.7 | 23.2 |
| Barium | Normal | Normal | 100 | 38 | 140 | 509 | 133 | 1,400 | 320 | 584 |
| Beryllium | Normal | Lognormal | 95 | 36 | 1.1 | 1.28 | 0.25 | 2.7 | 1.1 | 5.6 |
| Boron | Indeterminate | Indeterminate | 32 | 12 | 9.7 | 19 | 1 | 74 | 140 | 201 |
| Cadmium | Indeterminate | Lognormal | 24 | 9 | 1 | 0.36 | 0.05 | 1.7 | 2.3 | 7.7 |
| Chromium | Normal | Normal | 100 | 38 | 37 | 122 | 23 | 1,579 | 49.4 | 100 |
| Cobalt | Lognormal | Lognormal | 100 | 38 | 21 | 14.9 | 2.7 | 46.9 | 22 | 35.9 |
| Copper | Lognormal | Lognormal | 100 | 38 | 29 | 28.7 | 9.1 | 96.4 | 53.3 | 157 |
| Fluoride | Indeterminate | Lognormal | 37 | 14 | 6.7 | **n.a.** | **n.a.** | **n.a.** | 8.9 | 23 |
| Iron | Lognormal | Lognormal | 100 | 37 | 28,000 | 37,000 | 10,000 | 87,000 | 36,100 | 49,400 |
| Lead | Lognormal | Lognormal | 100 | 38 | 34 | 23.9 | 12.4 | 97.1 | 25 | 148 |
| Lithium | Lognormal | Lognormal | 100 | 37 | 37 | 23 | 4 | 90 | **n.a.** | **n.a.** |
| Manganese | Normal | Normal | 100 | 37 | 495 | 646 | 253 | 1,687 | 823 | 1,600 |
| Mercury | Indeterminate | Lognormal | 59 | 22 | 0.09 | 0.26 | 0.05 | 0.9 | 0.3 | 0.6 |
| Molybdenum | Indeterminate | Indeterminate | 65 | 24 | 5.3 | 1.3 | 0.1 | 9.6 | 20 | 44 |
| Nickel | Lognormal | Lognormal | 100 | 38 | 29 | 57 | 9 | 509 | 41.5 | 85.4 |

## Table 4-6 (2 of 2)
## Soil Background Comparison Levels for Metals
## Santa Susana Field Laboratory

| Chemical | Type of Distribution | Distribution Excluding Non-Detects | Percent Frequency of Detection | Number of Detects | Soil Background Comparison Level Value | California Benchmark Soils (Kearney study, March 1996) | | | California Air Force Bases (Hunter et al, 2005) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | **Mean** | **min** | **max** | **95th** | **99th** |
| pH | Normal | Normal | 100 | 37 | 8.86 | **n.a.** | **n.a.** | **n.a.** | **n.a.** | **n.a.** |
| Potassium | Lognormal | Lognormal | 100 | 37 | 6,400 | 17,300 | 2,100 | 30,000 | **n.a.** | **n.a.** |
| Selenium | Indeterminate | Lognormal | 43 | 16 | 0.655 | 0.058 | 0.015 | 0.43 | 11 | 25 |
| Silver | Indeterminate | -- | 5 | 2 | 0.79 | 0.8 | 0.1 | 8.3 | 2.1 | 6.1 |
| Sodium | Normal | Normal | 95 | 35 | 110 | 15,838 | 5,580 | 73,400 | 1,660 | 3,980 |
| Thallium | Indeterminate | Normal | 35 | 13 | 0.46 | 0.56 | 0.17 | 1.1 | 25 | 173.5 |
| Vanadium | Lognormal | Lognormal | 100 | 38 | 62 | 112 | 39 | 288 | 88.3 | 126 |
| Zinc | Lognormal | Lognormal | 100 | 38 | 110 | 149 | 88 | 236 | 104 | 307 |
| Zirconium | Indeterminate | Indeterminate | 81 | 30 | 8.6 | 93 | 19 | 610 | **n.a.** | **n.a.** |

Notes:

1. Metals are reported in units of milligrams per kilogram (mg/kg); and pH is unitless.
2. Data set summary information provided in Table 4-3 and detailed in Appendix B. Distribution of data based on the Shapiro-Wilk W-test as tested using ProUCL version 3.0 (USEPA 2004). The Type I alpha = 0.05.
3. The comparison level value for the inorganic data set was selected as the maximum detected value of the entire data set, where duplicate results have been averaged.

-- = insufficient data to perform distribution test
n.a. = data not available

### Table 4-7 (1 of 2)
### Soil Background Comparison Levels for Dioxins
### Santa Susana Field Laboratory

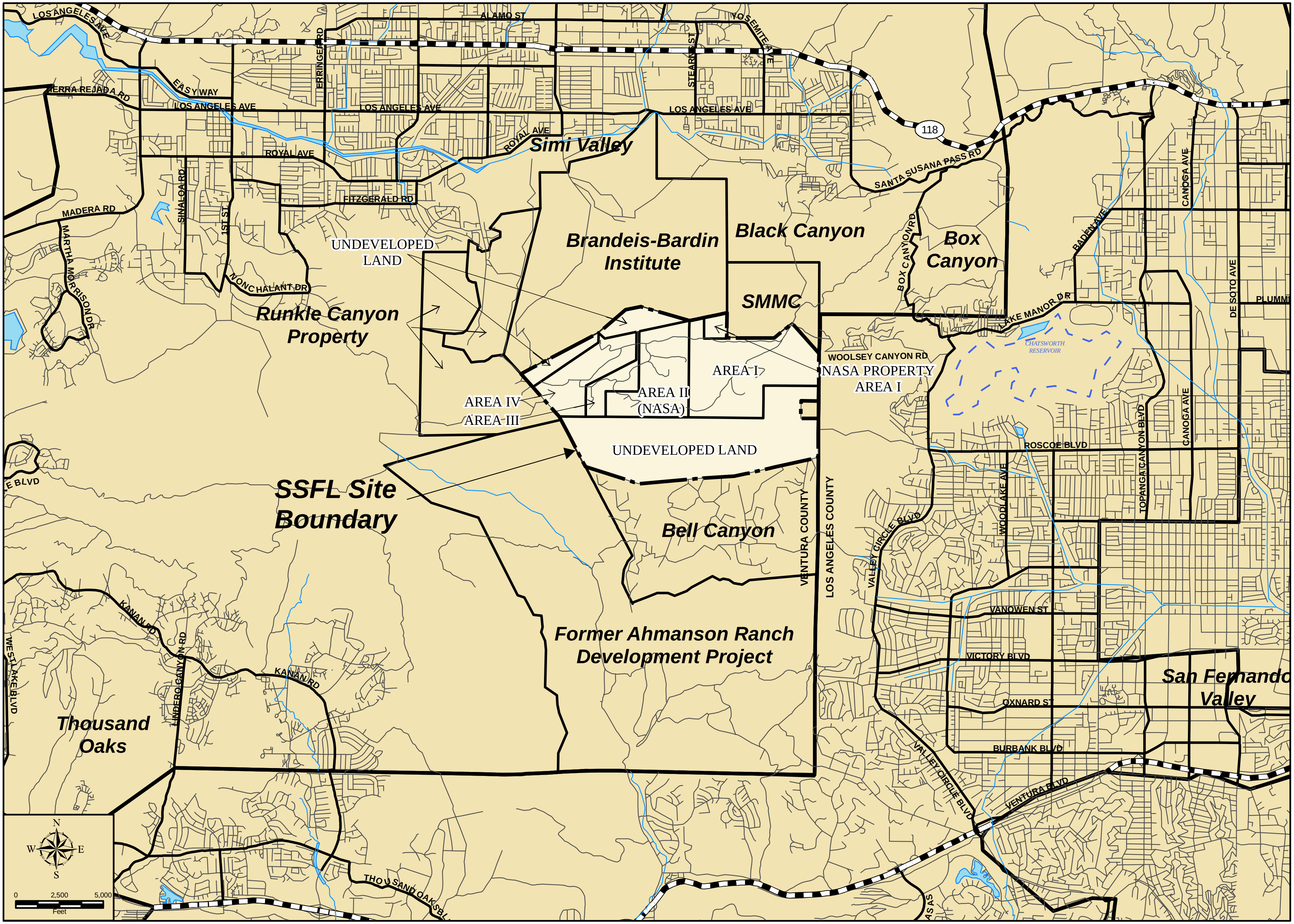
| Chemical | Type of Distribution | Distribution Excluding Non-Detects | Percent Frequency of Detection | Number of Detects | Soil Background Comparison Level Value |
|---|---|---|---|---|---|
| 1,2,3,4,6,7,8-HpCDD | Normal | Normal | 50 | 8 | 13 |
| 1,2,3,4,6,7,8-HpCDF | Normal | Normal | 31 | 5 | 2.5 |
| 1,2,3,4,7,8,9-HpCDF | Lognormal | -- | 6 | 1 | 0.19 |
| 1,2,3,4,7,8-HxCDD | Indeterminate | Normal | 25 | 4 | 0.34 |
| 1,2,3,4,7,8-HxCDF | Lognormal | Normal | 38 | 6 | 0.73 |
| 1,2,3,6,7,8-HxCDD | Lognormal | Normal | 44 | 7 | 0.95 |
| 1,2,3,6,7,8-HxCDF | Lognormal | -- | 6 | 1 | 0.3 |
| 1,2,3,7,8,9-HxCDD | Lognormal | Normal | 56 | 9 | 1.1 |
| 1,2,3,7,8,9-HxCDF | Indeterminate | -- | 13 | 2 | 0.43 |
| 1,2,3,7,8-PeCDD | Indeterminate | -- | 13 | 2 | 0.18 |
| 1,2,3,7,8-PeCDF | Indeterminate | Normal | 25 | 4 | 0.59 |
| 2,3,4,6,7,8-HxCDF | Indeterminate | -- | 6 | 1 | 0.45 |
| 2,3,4,7,8-PeCDF | Lognormal | Normal | 38 | 6 | 0.64 |
| 2,3,7,8-TCDD | Normal | -- | 0 | 0 | 0.5 [(a)] |
| 2,3,7,8-TCDF | Normal | Normal | 38 | 6 | 1.80 |
| OCDD | Lognormal | Normal | 81 | 13 | 140 |
| OCDF | Normal | Normal | 63 | 10 | 8.1 |

## Table 4-7 (2 of 2)
## Soil Background Comparison Levels for Dioxins
## Santa Susana Field Laboratory

Notes:

1. Dioxins are reported in units of nanograms per kilogram (ng/kg).
2. Data set summary information provided in Table 4-3 and detailed in Appendix B. Distribution of data based on the Shapiro-Wilk W-test as tested using ProUCL version 3.0 (USEPA 2004). The Type I alpha = 0.05.
3. The comparison level value for the dioxins data set was selected as the maximum detect of the entire data set (with duplicate values averaged), or a recent laboratory detection limit if the data for constituents with no detects.
4. Total dioxins data not included in this table since these represent a combination of congener data including those individually listed here.

(a) = values correspond to the representative soil reporting limit (as analyzed by Alta Analytical Laboratory).
-- = insufficient data to perform distribution test



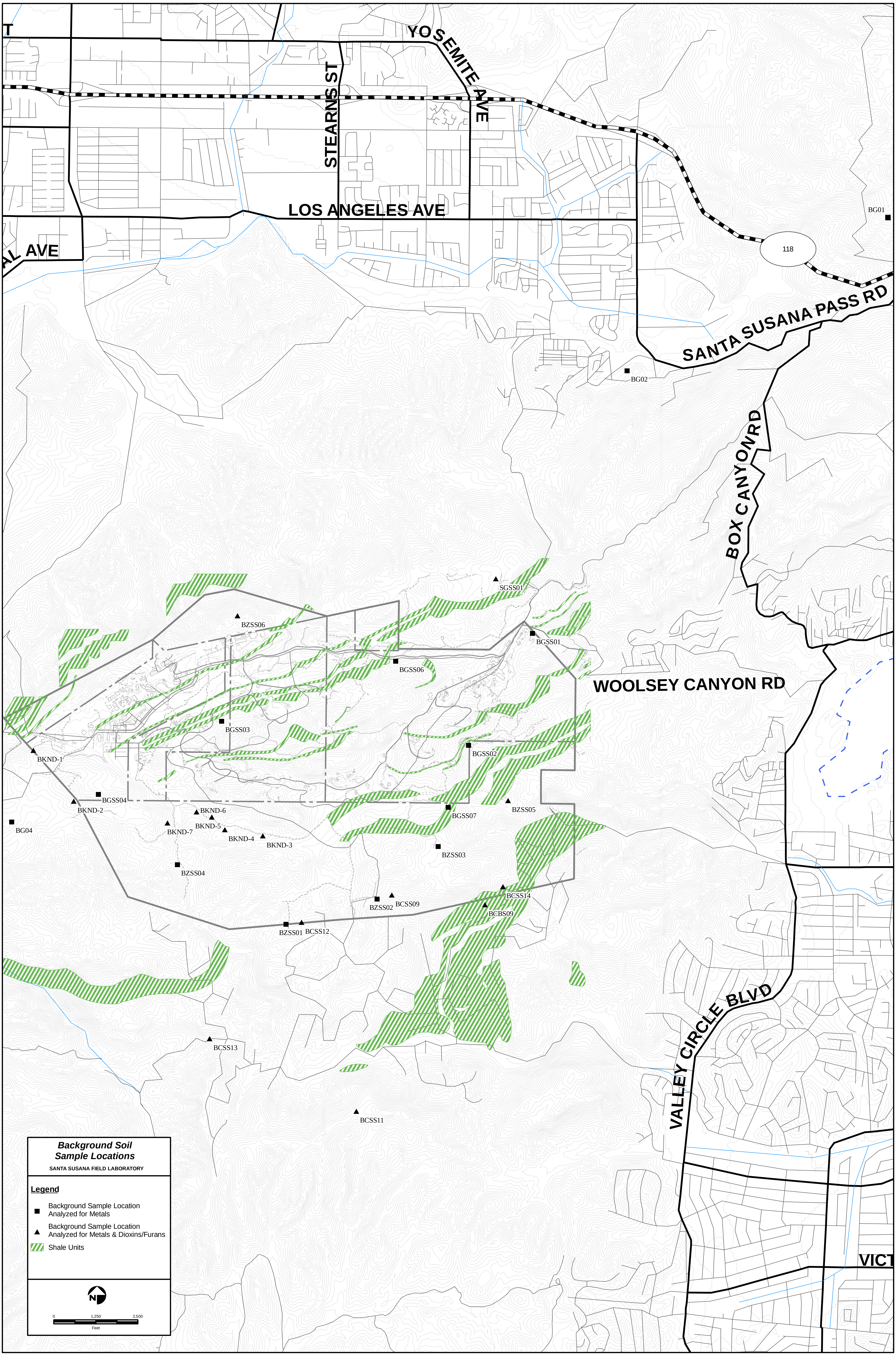
**MWH**

Santa Susana Field Laboratory (SSFL)
Regional Map

FIGURE
1-1

r:/rock/plots/arcmap/regional_map.mxd

06/24/04



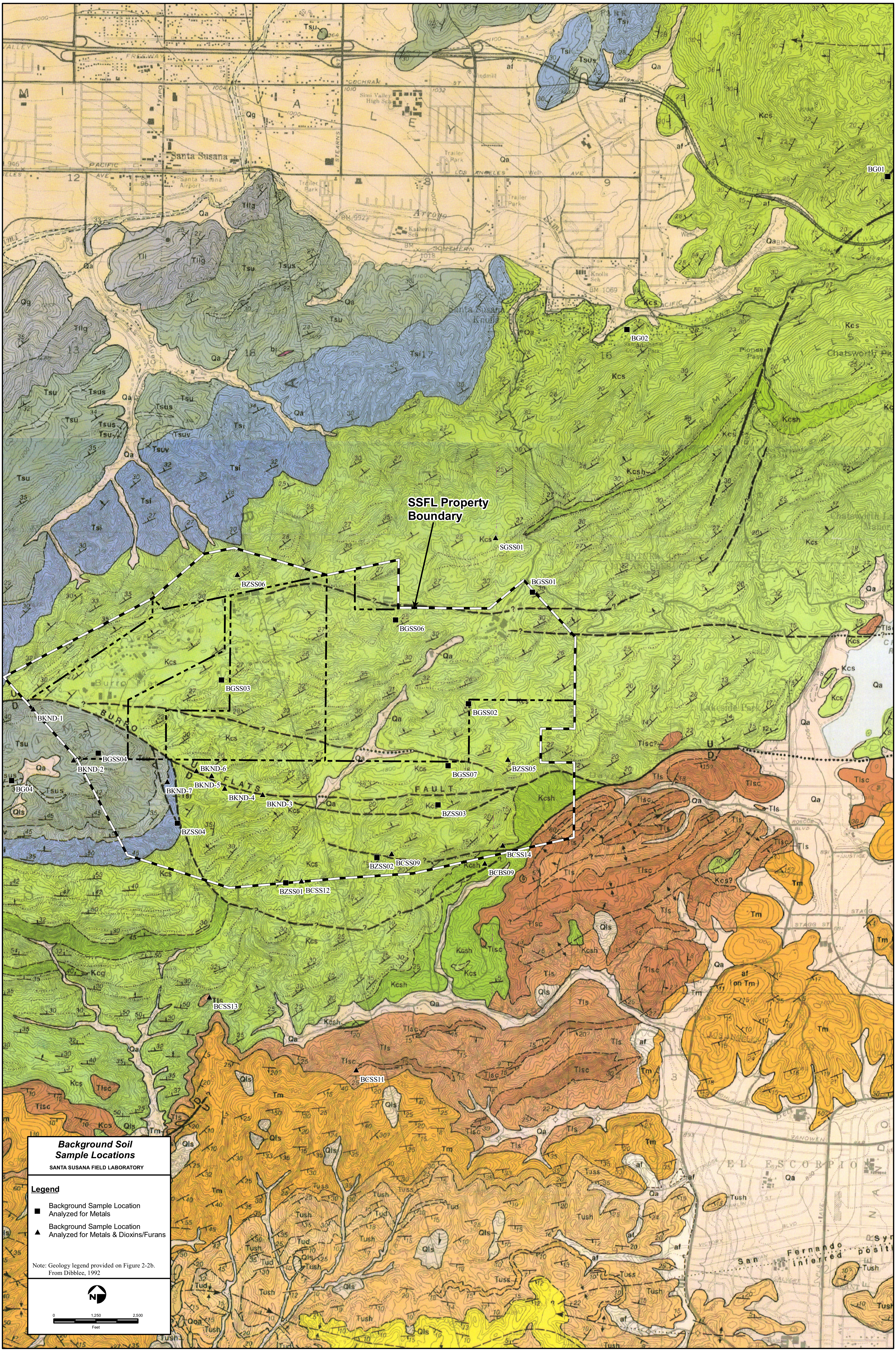
**MWH**

SSFL Background
Soil Sample Locations

FIGURE
2-1

File r:/rock/plots/arcmap/sram_background.mxd

Date: Jun 30, 2005



**Background Soil Sample Locations**

SANTA SUSANA FIELD LABORATORY

**Legend**

- ■ Background Sample Location Analyzed for Metals
- ▲ Background Sample Location Analyzed for Metals & Dioxins/Furans

Note: Geology legend provided on Figure 2-2b.
From Dibblee, 1992

MWH

## Regional Geology
## Santa Susana Field Laboratory

FIGURE
2-2a

File r:/rock/plots/arcmap/sram_background_geo.mxd

Date: Jun 30, 2005

af
Qa

### SURFICIAL SEDIMENTS

**af** *artificial cut and fill*
**Qa** *alluvium: gravel, sand and clay of valley areas, includes gravel and sand of stream channels, gravel and sand of alluvial fans, and slope wash; undissected to slightly dissected*

Qls

### LANDSLIDE DEBRIS

Qoa

### OLDER SURFICIAL SEDIMENTS

**Qoa** *dissected alluvial gravel, sand and clay*

Holocene
?
Pleistocene
QUATERNARY

—UNCONFORMITY—

Tust
Tush
Tud
Tuss

### UNNAMED SHALE AND SANDSTONE

(upper part of Modelo Formation of Hoots 1931; Soper 1938; Durrell 1954; A.E.G. maps 1982; Modelo Formation of Weber 1984; Modelo and Santa Margarita Formations of Truex and Hall 1969; Hall 1976; equivalent to Sisquoc Shale of Dibblee 1989, in Ventura basin)
*marine clastic and biogenic; late Miocene age (Mohnian-"Delmontian" Stage)*
**Tust** *light gray fine grained sandstone and minor siltstone [Towsley(?) Sandstone of Weber 1983] at Laskey Mesa*
**Tush** *light gray claystone and siltstone, moderately to vaguely bedded; crumbly where weathered*
**Tud** *light gray, white-weathering diatomaceous shale, thin-bedded, soft, semi-punky*
**Tuss** *light gray to tan sandstone, friable, vaguely bedded*

Tm
Tmss
Tmcg

### MONTEREY FORMATION

(lower part of Modelo Formation of Hoots 1931; Soper 1938; Durrell 1954; A.E.G. maps 1982; Modelo Formation of Yerkes and Campbell 1979; Weber 1984; Modelo-Monterey and lower Monterey Formation of Truex and Hall 1969; Truex 1976; equivalent to Monterey Formation of Dibblee 1989, in Ventura basin)
*marine biogenic and clastic;*
*middle and late Miocene age [late Luisian(?) and Mohnian Stages]*
**Tm** *gray-brown, white weathering siliceous shale, thin bedded, moderately hard with platy fracture; includes soft fissile diatomaceous shale, hard, brittle cherty shale, and few layers of hard, yellow-weathering calcareous concretions or lenses*
**Tmss** *light gray to tan, semi-friable bedded sandstone*
**Tmcg** *gray cobble conglomerate of mostly granitic detritus in sandstone matrix*

Tlsc
Tls

### DETRITAL SEDIMENTS OF LINDERO CANYON

(included in Topanga Formation of Weber 1984; unconformable on Chatsworth Formation; best exposed in Lindero Canyon, Thousand Oaks quadrangle; may be equivalent to upper Topanga Formation of Durrell 1954, or Calabasas Formation of Yerkes and Campbell 1989)
*marine transgressive clastic; middle Miocene age [Luisian(?) Stage]*
**Tls** *light gray to nearly white massive sandstone, semi-friable, locally conglomeratic*
**Tlsc** *light gray calcareous sandstone, massive to crudely bedded, with calcite veins; includes gray conglomerate composed of cobbles of metavolcanic, granitic and quartzitic rocks and of sandstone derived from Chatsworth Formation; sparsely fossiliferous*

—UNCONFORMITY—

Ttus
Ttuc
Ttucg

### UPPER TOPANGA FORMATION

(of Durrell 1954; Topanga Formation of Soper 1938; Truex and Hall 1969; Truex 1976; Weber 1984; Calabasas Formation of Yerkes and Campbell 1979, 1980)
*marine clastic; middle Miocene age (Luisian Stage)*
**Ttuc** *gray claystone, bedded; crumbly with ellipsoidal fracture*
**Ttus** *light gray sandstone, semi-friable, thick bedded*
**Ttucg** *gray conglomerate of cobbles of granitic rocks, sandstone, and volcanic rocks in sandstone matrix*

Miocene
TERTIARY

Tcvab
Tcvb
Tcva

### CONEJO VOLCANICS

(of Taliaferro 1924; Yerkes and Campbell 1979, 1980; Weber 1984; middle Topanga Formation of Soper 1938; Durrell 1954; Topanga Volcanics of Truex and Hall 1969; Truex 1976)
*extrusive volcanic flows and volcaniclastic rocks; middle Miocene age*
**Tcvab** *andesitic breccia-conglomerate, composed of subangular to subrounded cobbles and boulders of light pinkish gray andesitic rocks in andesitic detrital matrix, moderately sorted, bedded; deposited as epiclastic (reworked) breccias*
**Tcva** *andesitic breccia, brown, massive to crudely bedded autoclastic flow breccia and some mud-flow (laharic) breccias*
**Tcvb** *basaltic flows and flow-breccias: dark gray to dark brown, composed of basaltic to basaltic-andesitic rocks, crudely bedded, includes some reworked breccias of basaltic detritus; moderately coherent; at Mullholland Highway gray-black, massive, fine grained basalt, weakly coherent where weathered, includes hyaloclastic basaltic breccia, massive to crudely bedded*

db

### DIABASE

**db** *black, fine grained diabase or basalt, intrusive as sills in* **Ttls**

Ttls
Ttlc

### LOWER TOPANGA FORMATION

(of Durrell 1954; Topanga Formation of Soper 1938; Truex and Hall 1969; Weber 1984; Topanga Canyon Formation of Yerkes and Campbell 1979, 1980)
*marine transgressive clastic;*
*early and middle Miocene age [Saucesian-Relizian(?) Stage]*
**Ttls** *light gray to tan sandstone, coherent, thick bedded*
**Ttlc** *gray micaceous clay shale, crumbly with ellipsoidal fracture where weathered*

Miocene

Tsp

### SESPE FORMATION

*nonmarine; primarily Oligocene age*
not exposed in quadrangle, but present in subsurface (see cross section)
in southern part of area and exposed just south of this quadrangle

Oligocene

Tll
Tllg

### LLAJAS FORMATION

(of Cushman and McMasters 1936; Stipp 1943; Squires and Filewicz 1983)
*marine clastic; middle Eocene age (Domengine and Capay molluscan Stages)*
**Tll** *gray micaceous claystone and siltstone, crumbly with ellipsoidal fracture where weathered*
**Tllg** *gray to brown cobble conglomerate of granitic, metavolcanic and quartzitic detritus in sandstone matrix; includes some brown sandstone strata*

Eocene
?

Tsu
Tsus
Tsuv
Tsi

### SANTA SUSANA FORMATION

(of Cushman and McMasters 1936; Stipp 1943; Squires and Filewicz 1983)
*marine and nonmarine(?) clastic; lower Eocene and Paleocene ages*
*(Meganos and Martinez molluscan Stages)*
**Tsu** *gray micaceous claystone and siltstone, few minor thin sandstone beds*
**Tsus** *tan coherent fine grained sandstone; locally contains thin shell-beds and calcareous concretions*
**Tsuv** *Las Virgenes Sandstone Member: tan semi-friable bedded sandstone, locally pebbly*
**Tsi** *Simi Conglomerate Member: gray to brown cobble conglomerate with smooth cobbles of quartzite, metavolcanic and granitic rocks in sandstone matrix that locally includes thin lenses of red clay;marine or nonmarine(?)*

Paleocene
TERTIARY

Kcg
Kcs
Kcsh

### CHATSWORTH FORMATION

(of Colburn et al. 1981; Weber 1984; "Chico" Formation of Sage 1971)
*marine clastic; late Cretaceous age (Maestrichtian and Campanian Stages)*
**Kcs** *light gray to light brown sandstone, hard, coherent, arkosic, micaceous, mostly medium grained, in thick strata separated by thin partings of siltstone*
**Kcg** *gray conglomerate of cobbles of metavolcanic and granitic detritus in hard sandstone matrix*
**Kcsh** *gray clay shale, crumbly with ellipsoidal fracture where weathered; includes some thin sandstone strata in western area*

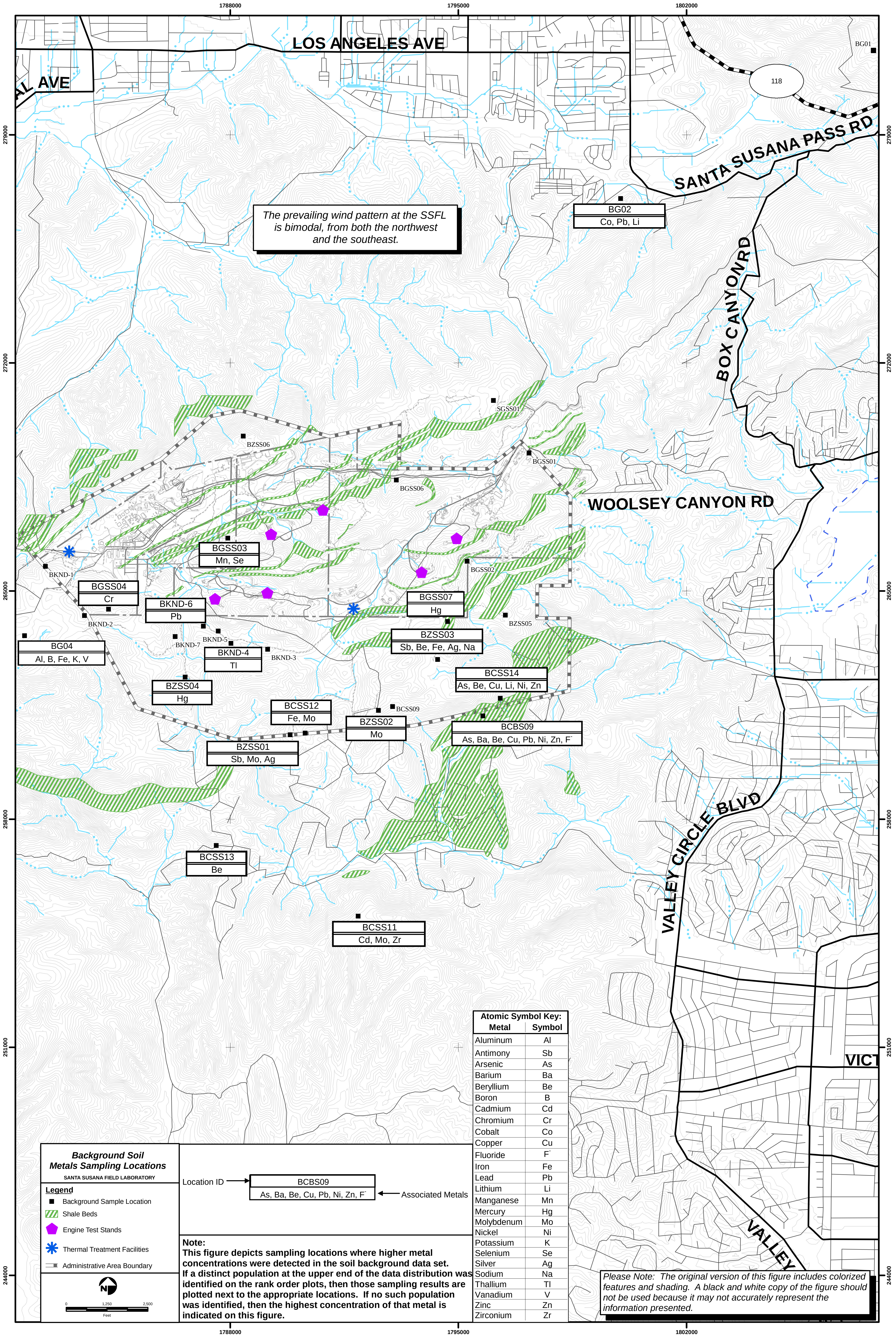
Upper
CRETACEOUS

From Dibblee, 1992

**MWH**

Regional Geology Legend
Santa Susana Field Laboratory

FIGURE
2-2b



*The prevailing wind pattern at the SSFL is bimodal, from both the northwest and the southeast.*

***Background Soil Metals Sampling Locations***

**SANTA SUSANA FIELD LABORATORY**

**Legend**

- ■ Background Sample Location
- ▨ Shale Beds
- ⬟ Engine Test Stands
- ✱ Thermal Treatment Facilities
- ▬ Administrative Area Boundary

Location ID → BCBS09
As, Ba, Be, Cu, Pb, Ni, Zn, F⁻ ← Associated Metals

**Note:**
**This figure depicts sampling locations where higher metal concentrations were detected in the soil background data set. If a distinct population at the upper end of the data distribution was identified on the rank order plots, then those sampling results are plotted next to the appropriate locations. If no such population was identified, then the highest concentration of that metal is indicated on this figure.**

**Atomic Symbol Key:**

| Metal | Symbol |
|---|---|
| Aluminum | Al |
| Antimony | Sb |
| Arsenic | As |
| Barium | Ba |
| Beryllium | Be |
| Boron | B |
| Cadmium | Cd |
| Chromium | Cr |
| Cobalt | Co |
| Copper | Cu |
| Fluoride | F⁻ |
| Iron | Fe |
| Lead | Pb |
| Lithium | Li |
| Manganese | Mn |
| Mercury | Hg |
| Molybdenum | Mo |
| Nickel | Ni |
| Potassium | K |
| Selenium | Se |
| Silver | Ag |
| Sodium | Na |
| Thallium | Tl |
| Vanadium | V |
| Zinc | Zn |
| Zirconium | Zr |

*Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.*

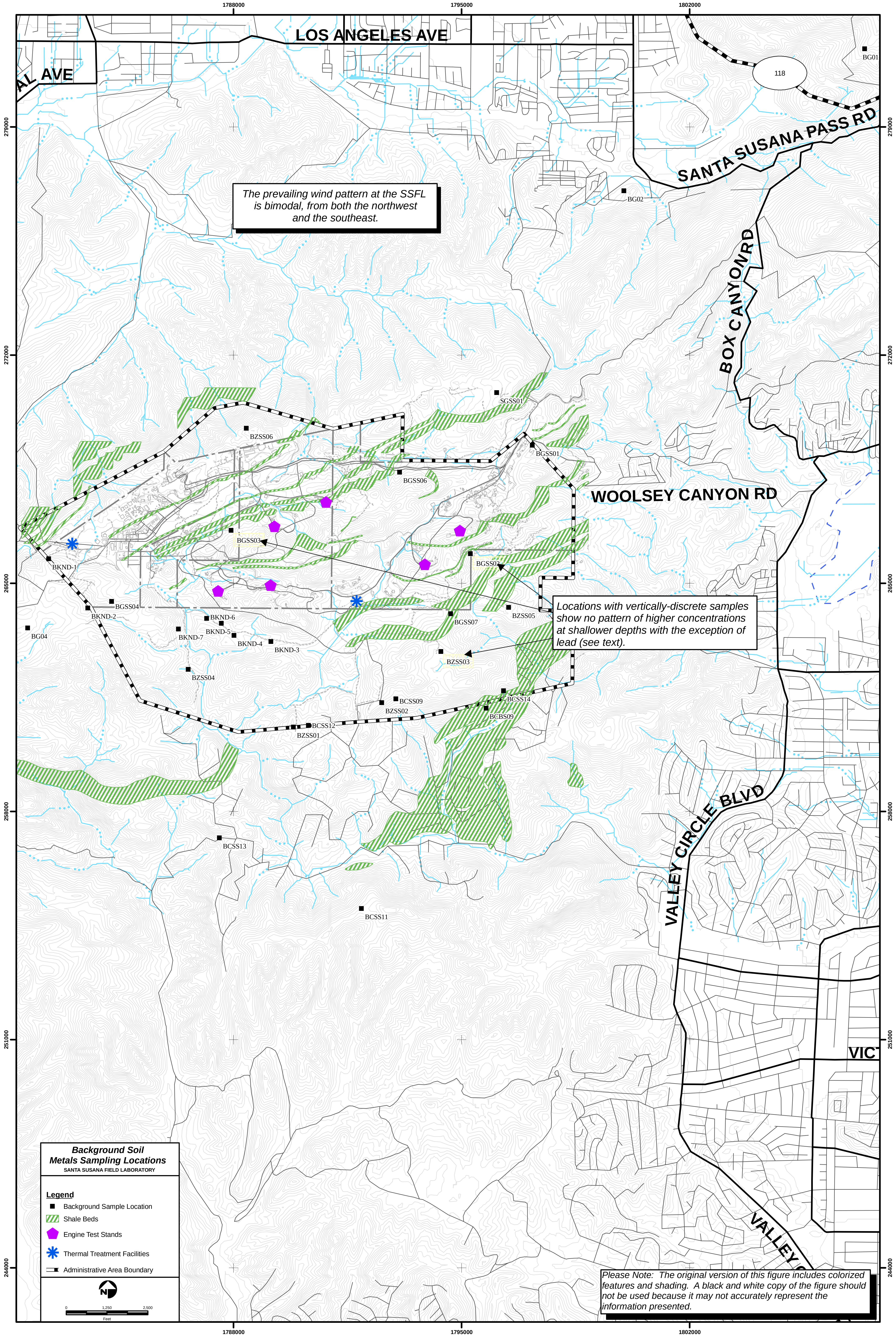
MWH

**Geographic Distribution of Metals in Sampling Results**
**SSFL Soil Background**

FIGURE
**4-1**

File: \\10.10.1.2\gist\projects\rock\plots\arcmap\sram_soil_background_rpt.mxd

Date: Sep 07, 2005



*The prevailing wind pattern at the SSFL is bimodal, from both the northwest and the southeast.*

*Locations with vertically-discrete samples show no pattern of higher concentrations at shallower depths with the exception of lead (see text).*

*Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.*

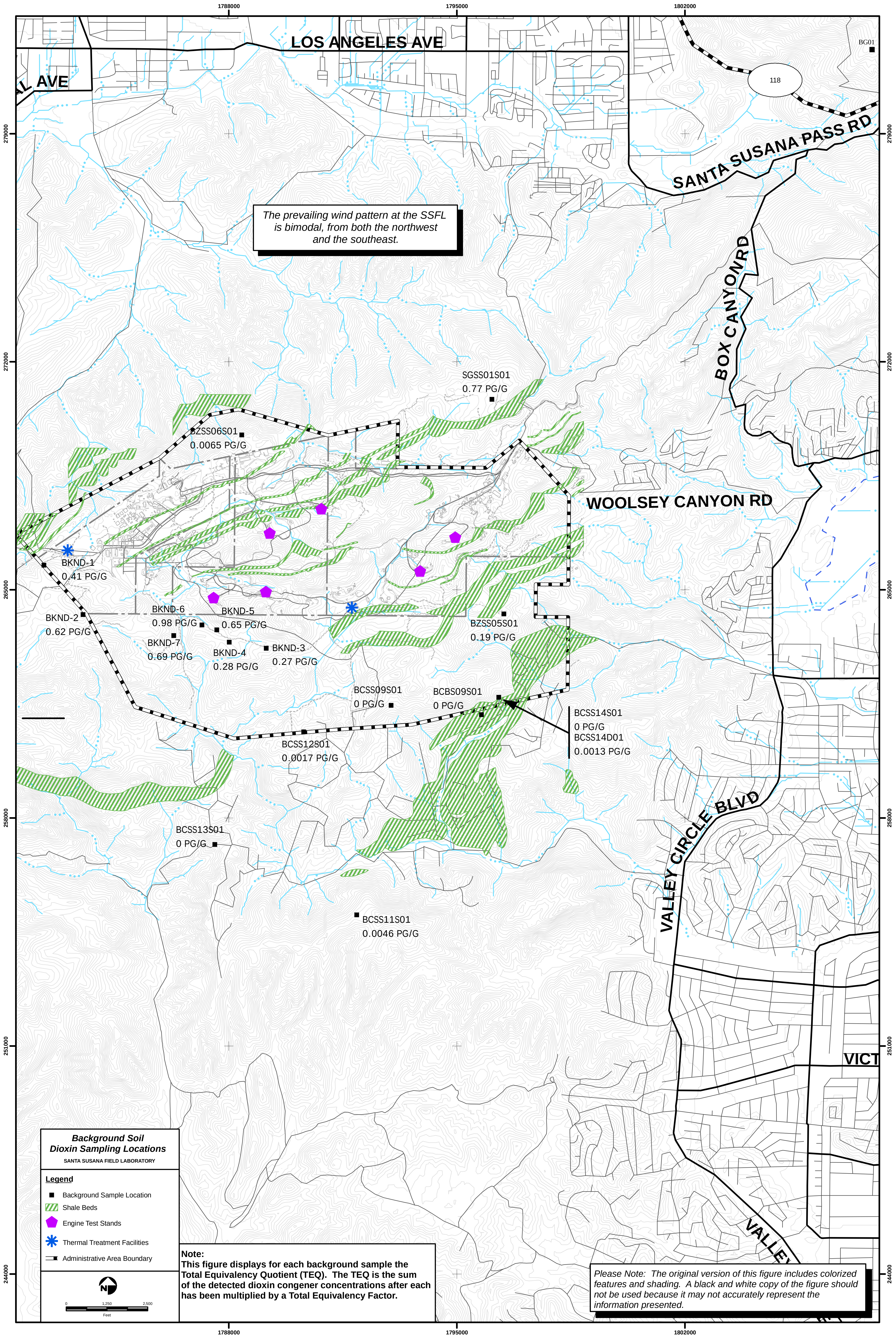
MWH

Vertical Distribution of Metals in Sampling Results
SSFL Soil Background

FIGURE
4-2

File: \\10.10.1.2\gist\projects\rock\plots\arcmap\sram_soil_background_rpt_figure_4-2.mxd

Date: Sep 07, 2005



*The prevailing wind pattern at the SSFL is bimodal, from both the northwest and the southeast.*

***Background Soil Dioxin Sampling Locations***

**SANTA SUSANA FIELD LABORATORY**

**Legend**

- ■ Background Sample Location
- ▨ Shale Beds
- ⬟ Engine Test Stands
- ✱ Thermal Treatment Facilities
- ▬ Administrative Area Boundary

**Note:**
**This figure displays for each background sample the Total Equivalency Quotient (TEQ). The TEQ is the sum of the detected dioxin congener concentrations after each has been multiplied by a Total Equivalency Factor.**

*Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.*

**MWH**

**Geographic Distribution of Dioxins in Sampling Results**
**SSFL Soil Background**

FIGURE
**4-3**

File: \\10.10.1.2\gist\projects\rock\plots\arcmap\sram_soil_back_diox_rpt.mxd

Date: Sep 07, 2005