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August 18, 2003
In reply refer to 2003RC3113

BOEING

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Subject: Perchlorate Characterization Work Plan
Santa Susana Field Laboratory
Ventura County, CA

Dear Mr. Pappas:

Pursuant to your letter dated June 23, 2003, The Boeing Company (Boeing) hereby submits the requested work plan dated August 18, 2003, prepared by Montgomery Watson Harza. This work plan outlines the scope of work proposed by Boeing to address the Department of Toxic Substance Control Division concern for potential off-site migration of perchlorate from the SSFL.

If you have any questions, please contact me at (818) 586-2577 or Art Lenox at (818) 586-5695.

Sincerely,

Steve Lafflam
Division Director
Safety, Health & Environmental Affairs

AL:po
Enclosure

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BOEING

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PERCHLORATE CHARACTERIZATION WORK PLAN
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

Prepared For:

THE BOEING COMPANY
Rocketdyne Propulsion and Power

Prepared By:

MWH
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August 2003

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MWH

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Boeing	The Boeing Company
CAL-EPA	California Environmental Protection Agency
COCs	Constituents of Concern
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
DTSC	Department of Toxic Substances Control
EPA	Environmental Protection Agency
ft/ft	feet per foot
FSDF	Former Sodium Disposal Facility
LOX	liquid oxygen
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NPDES	National Pollution Discharge Elimination System
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RWQCB	Regional Water Quality Control Board
SAIC	Science Applications International Corporation
SSFL	Santa Susana Field Laboratory
TCE	trichloroethene
TDS	total dissolved solids
TTF	Thermal Treatment Facility
USGS	United States Geologic Survey
VOC	volatile organic compound

1.0 INTRODUCTION

This Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) work plan presents characterization activities to evaluate the potential for off-site migration of perchlorate from the Santa Susana Field Laboratory (SSFL). This work plan has been prepared by MWH on behalf of The Boeing Company (Boeing) in response to a California Environmental Protection Agency (Cal-EPA), Department of Toxic Substances Control (DTSC) requirement specified in a letter dated June 23, 2003 (DTSC, 2003, Appendix A). In this letter, DTSC has requested the submittal of an RFI work plan describing measures to be taken to investigate the potential migration of perchlorate contamination from the SSFL to off-site areas such as the Brandeis-Bardin Institute property. In particular, this RFI work plan presents characterization activities to confirm that perchlorate is absent in groundwater discharging from Bathtub Well #1 and to evaluate the nature and extent of potential perchlorate releases to the Northern Drainage of the SSFL from the Building 359 RFI site. Bathtub Well #1 is an uncapped, flowing artesian groundwater well located on property owned by the Brandeis-Bardin Institute and is located approximately 4,700 feet north of the northern SSFL property boundary (Figure 1). This well is referred to as a "Bathtub Well" because groundwater flowing from the well discharges into a partially buried bathtub. This well was previously labeled by Boeing as OS-9 during the 1980s and will be referenced as such throughout the remainder of this work plan.

Perchlorate occurrence at the SSFL has been previously described in a detailed, comprehensive report entitled *Perchlorate Source Evaluation and Technical Report, Santa Susana Field Laboratory, Ventura County, California* (Perchlorate Report, MWH, 2003a). The characterization of perchlorate in the two areas where it was primarily used at the SSFL was updated in the *Happy Valley Interim Measures Work Plan Addendum, Happy Valley and Building 359 Areas of Concern, Santa Susana Field Laboratory, Ventura County, California* (Interim Measures Work Plan, MWH, 2003c). The Interim Measures Work Plan presented additional perchlorate sampling data collected at the Happy Valley and Building 359 RFI sites between February and May 2003. Additional environmental media have been sampled and analyzed for perchlorate both at the SSFL and in off-site areas since the submittal of the report and work plan mentioned above. A summary of these additional data will be presented in

Section 2.2 of this work plan and a full presentation of all of the data will be provided in an addendum to the Perchlorate Report that will be issued in the fourth quarter of 2003.

1.1 SSFL FACILITY INFORMATION

The SSFL is located approximately 29 miles northwest of downtown Los Angeles, California, in the southeast corner of Ventura County. The SSFL occupies approximately 2,850 acres of hilly terrain with approximately 700 feet of topographic relief near the crest of the Simi Hills. The SSFL has been active since 1948 and is divided into four administrative areas (Areas I, II, III, and IV), with undeveloped land along the northern and southern boundaries (Figure 1).

The primary site activities at the SSFL since 1948 have included research, development, and testing of liquid-propelled rocket engines and associated components (pumps, valves, etc.) (Science Applications International Corporation [SAIC], 1994). Liquid-propellant rocket engine testing activities have been conducted at six major test areas: Bowl, Canyon, Alfa, Bravo, Coca, and Delta. These areas were in operation simultaneously in the late 1950s and early 1960s. The Bowl, Canyon, and Delta test areas were phased out of operation in the late 1960s and 1970s. The Coca test area was shut down in May 1988. The Alfa and Bravo test areas are currently in operation. Engine testing at these areas primarily used petroleum-based compounds as the 'fuel' and liquid oxygen (LOX) as the 'oxidizer.' Solvents were used for cleaning of engine components. Trichloroethene (TCE) was the primary solvent used for cleaning purposes.

In addition to the primary facility operation for testing liquid-propelled rocket engines, the SSFL was used for research, development, and testing of water jet pumps, lasers, liquid metal heat exchanger components, nuclear energy research, and related technologies. Solid propellants, including perchlorate compounds, were primarily used, stored, or tested at two locations within the SSFL, the Building 359 and the Happy Valley sites. In total, these two sites cover only about 12 acres of the total 2,850 acres of the SSFL (Figure 1).

The SSFL conducts comprehensive environmental programs under the jurisdiction of several regulatory agencies. The environmental program at the SSFL pertinent to perchlorate

characterization is RCRA. The RCRA-related activities at the SSFL are regulated by the DTSC. RCRA Corrective Action includes the RCRA facility assessment (RFA), the RFI, corrective measures study (CMS), and corrective measures implementation (CMI) phases. The RCRA program at the SSFL is currently in the RFI phase and includes perchlorate as a chemical of potential concern. This program also includes the authority to implement interim measures cleanup actions when and where appropriate. Surface water discharges from the SSFL have been regulated by the Los Angeles Regional Water Quality Control Board (RWQCB) since 1958, and subject to a permit governed under the National Pollutant and Discharge Elimination System (NPDES) issued by this agency beginning in 1984. Surface water discharges from the site are routinely monitored at eight outfall locations shown on Figure 1.

2.0 BACKGROUND INFORMATION ON PERCHLORATE AT AND NEAR THE SSFL

As noted earlier in Section 1.0, DTSC has requested an RFI work plan for investigating the potential off-site migration of perchlorate from the SSFL. This section of the work plan provides background summaries of the findings presented in the Perchlorate Report (MWH, 2003a) and the results of perchlorate sampling conducted at and near the SSFL from January through May 2003. This background information is used to identify areas at the SSFL that require additional investigation for the potential off-site migration of perchlorate.

2.1 OVERVIEW OF FINDINGS PRESENTED IN PERCHLORATE REPORT

It was stated in the Perchlorate Report (MWH, 2003a) that the amount of soil, surface water, groundwater and spring/seep sampling that had been performed at and near the SSFL adequately identified and delineated the primary impacts at the SSFL except in two areas, the Happy Valley drainage and at the Thermal Treatment Facility (TTF). It was also stated in the report that sampling for perchlorate would be conducted at RFI sites to refine potential clean-up areas or potential future risks to on-site receptors.

2.2 PERCHLORATE SAMPLING FROM JANUARY THROUGH MAY 2003

Significant additional data have been collected since the Perchlorate Report was issued in February of 2003. The additional data that have been collected are:

- For evaluating the potential transport of perchlorate and other constituents of concern (COCs) by periodically collecting and analyzing samples from existing monitoring systems,
- For refining the areas targeted for interim measures at the Building 359 and Happy Valley RFI sites,
- For determining the magnitude of potential perchlorate impacts at the TTF, and
- For confirming previously identified sources at the Compound A RFI site and the Former Sodium Disposal Facility.

The on-going monitoring systems that yielded additional data on the occurrence and distribution of perchlorate at and near the SSFL include the NPDES surface water monitoring program and groundwater monitoring for compliance with the RCRA corrective action and post-closure permit programs. A summary of the perchlorate monitoring results for each program from January through May of 2003 is presented in Table 1. A brief discussion of the results of the sampling events that have occurred is provided in the following sections.

2.2.1 Perchlorate Results from Surface Water Monitoring

As shown in Table 2, the data from the NPDES monitoring program continues to demonstrate that perchlorate is not present in surface water leaving the SSFL at concentrations above the reporting limit at seven of the eight outfalls monitored as required by the NPDES permit. At the eighth outfall (Happy Valley-1 or HV-1), perchlorate was detected in surface water during three of four sampling events conducted between January 1 and May 30, 2003 at an average concentration of about 0.007 milligrams per liter (mg/L) and was not detected during the fourth sampling event (MWH, 2003c).

2.2.2 Perchlorate Results from Groundwater Monitoring

Perchlorate results from the first and second quarter 2003 groundwater monitoring program (Haley & Aldrich, 2003a, 2003b) continue to demonstrate that perchlorate has not been transported very far from the source areas (i.e., within hundreds to a few thousands of feet). Perchlorate continues to be detected in groundwater at the Happy Valley, Building 359, Former Sodium Disposal Facility (FSDF) and Compound A RFI Sites, consistent with the current understanding of perchlorate transport in groundwater beneath source areas.

2.2.3 Perchlorate Results for Interim Measures

Additional perchlorate characterization data have also been collected at the Building 359 and Happy Valley RFI sites (MWH, 2003c). These data have been collected to refine potential areas at these locations that are targeted for interim measures. The Interim Measures Work Plan also specified further characterization work to determine if perchlorate was present in bedrock,

beneath building foundations and/or in drainage sediments that could leach perchlorate to surface water runoff through the Happy Valley drainage and downstream of the Building 359 RFI site. The data collected during the interim measures program will be used to determine if any characterization work beyond that proposed in the Interim Measures Work Plan is warranted along the Happy Valley drainage. Also, it was reported in the Interim Measures Work Plan that a pipe ran beneath the Area I Road that may have conveyed storm water runoff from the northern portion of the Building 359 RFI site. The pipe is believed to have discharged at or near the toe of the Area I landfill into the headwaters of the Northern Drainage. It is possible then, that storm water that may have contained perchlorate from the northern portion of the Building 359 RFI site was discharged into the headwaters of the Northern Drainage.

2.2.4 Perchlorate Results from Sampling at the TTF

Preliminary perchlorate characterization data were also collected by DTSC in March 2003 at the TTF. Boeing collected split samples at each location sampled by DTSC. The preliminary analytical results for perchlorate in both surface water (four locations) and soil leachate samples (seven locations) showed only one detection in surface water at a value of 0.0043 mg/L, which is just slightly over the reporting limit of 0.004 mg/L. Perchlorate was not detected at the seven soil leachate or three other surface water sampling locations. These data confirm the general conclusion reached in the Perchlorate Report (MWH, 2003a) about perchlorate at the TTF, which was that any releases of perchlorate would likely be small.

2.2.5 Off-site Perchlorate Results from Agency Sampling

Both the DTSC and the RWQCB have collected additional samples of surface water, soil leachate and/or groundwater at off-site locations surrounding the SSFL since the Perchlorate Report (MWH, 2003a) was issued. With the possible exception of OS-9, sampling results report no detections of perchlorate to the best of Boeing's knowledge, although Boeing has not been provided and hence has not reviewed the laboratory reports.

2.2.5.1 Chronology of Sampling Events for Perchlorate At OS-9

The remaining piece of new perchlorate data that has been collected since the February 2003 Perchlorate Report is that associated with OS-9. A chronological summary of the sampling results for this location is provided below since these results are cited by the DTSC in its letter to Boeing as the basis for additional perchlorate characterization (DTSC, 2003, see Appendix A).

March 20, 2002 – OS-9 was sampled and analyzed for perchlorate by staff from the DTSC. Analytical laboratory results from the DTSC reported that perchlorate was not detected at a reporting limit of 0.003 mg/L.

February 21, 2003 – OS-9 was sampled and analyzed for perchlorate, along with 4 other wells on the Brandies-Bardin Institute property north of the SSFL. The sampling was performed at the request of the County of Ventura's Public Works Agency. Boeing was made aware of the sampling results via a facsimile from the Los Angeles RWQCB on May 28, 2003. A commercial laboratory (Weck Laboratories, Inc.) initially reported perchlorate in the sample at a concentration of 0.082 mg/L. The laboratory subsequently revised this reported result to ***not detected*** at a reporting limit of 0.004 mg/L in an email transmittal to the RWQCB on July 17, 2003. It was reported that the laboratory mistakenly identified a peak on the chromatogram as perchlorate when it was not perchlorate.

May 30, 2003 – Staff from DTSC sampled and analyzed groundwater from OS-9 for perchlorate. A commercial laboratory (American Scientific, who subsequently subcontracted the work to American Technology Laboratories) reported perchlorate concentrations of 0.14 mg/L from one sample and a concentration of 0.15 mg/L from a duplicate sample.

June 11, 2003 - Staff from DTSC re-sampled and analyzed groundwater from OS-9 for perchlorate. A commercial analytical laboratory (American Scientific, who subsequently subcontracted the work to American Technology Laboratories) reported perchlorate concentrations of 0.036 mg/L and a duplicate result of 0.039 mg/L. Split samples were also collected by DTSC staff on the same date and were sent to DTSC's Hazardous Materials Laboratory in Berkeley, CA. The HML reported that perchlorate was not present in the two

samples at a reporting limit of 0.004 mg/L. Additionally, DTSC staff collected three samples of saturated soil adjacent to the bathtub into which the well discharges. Perchlorate was not detected in these three soil samples above a reporting limit of 0.04 milligrams per kilogram (mg/kg).

Boeing initiated a weekly sampling program for OS-9 on July 2, 2003 because of the inconsistent sampling results described above. The weekly sampling has been performed consistent with that described in a work plan that was submitted to DTSC on July 16, 2003, a copy of which is provided in Appendix B. In accordance with the work plan, samples were collected by Boeing's contractor on the 2nd, 10th, 17th, 24th and 31st of July, and the 7th and 12th of August, 2003 and were analyzed for perchlorate. Perchlorate was not detected in samples collected from OS-9 during these sampling events. A full summary of the sampling events conducted at OS-9 since the beginning of July 2003 is provided in Appendix C.

Furthermore, chemists commissioned by Boeing have reviewed available analytical laboratory data from the May and June 2003 sampling events where perchlorate was reportedly detected in samples from OS-9. This review has cast doubt as to whether perchlorate was actually present in the samples collected during the May and June sampling events. The chemists evaluation of the analytical laboratory results from these sampling events is provided in Appendix D. This analysis, coupled with the weekly sampling results from OS-9 conducted over the last seven weeks call in to question whether perchlorate is or has ever been truly present in samples collected from OS-9.

2.3 SUMMARY OF SSFL BACKGROUND INFORMATION ON PERCHLORATE

In summary, additional samples of various environmental media have been collected and analyzed for perchlorate both on- and off-site of the SSFL since the sampling described in the Perchlorate Report (MWH, 2003a). Media that have been sampled to characterize the occurrence and concentration of perchlorate associated with the potential transport pathways include:

- Stormwater for NPDES sampling and monitoring requirements and for source characterization to evaluate the surface water transport pathway,
- Groundwater for plume identification and monitoring to evaluate the groundwater transport and surface water-to-groundwater transport pathways, and
- Soil, soil leachate and drainage sediment leachate for source and transport characterization.

These data, as described previously in this section, indicate that additional characterization is required in the Happy Valley drainage and in the Northern Drainage. Characterization of the Happy Valley drainage has already been proposed in the Interim Measures Work Plan (MWH, 2003c). The objective of this work plan will be to:

1. Confirm that perchlorate is absent in OS-9, and

2. Characterize the potential impacts of perchlorate, if any, along the Northern Drainage of the SSFL potentially associated with historic operations at the Building 359 RFI site. The rationale for focusing the scope of this work plan to the Northern Drainage is based on historic and recent characterization results and the SSFL's on-going monitoring results for perchlorate.

3.0 BACKGROUND INFORMATION AND PERCHLORATE SAMPLING RESULTS ALONG THE NORTHERN DRAINAGE

Available background information and perchlorate sampling results were compiled to assist in the development of a scope of work to characterize the nature and extent of potential perchlorate impacts to the Northern Drainage from the Building 359 RFI site. This section of the work plan discusses the background information and the available perchlorate sampling results.

3.1 CATCHMENT AREA AND SLOPE OF DRAINAGE

The Northern Drainage of the SSFL collects storm water runoff from a catchment area of approximately 780 acres. The drainage and catchment area are shown on Figure 2. Plate 1 depicts the drainage from its headwaters at the SSFL to the location of OS-9 and has been stationed for ease of reference. A profile of the drainage is also shown on Plate 1. As can be seen on the profile, the drainage exhibits five general changes in slope from the Area I Landfill at the SSFL to OS-9. The slope of the drainage between stations 10+00 and 18+00 is about 0.12 feet per foot (ft/ft). Between stations 18+00 and 83+00, the drainage flattens to a slope of about 0.04 ft/ft. The drainage then steepens to a slope of 0.3 ft/ft from station 83+00 to station 95+00 and the drainage becomes less steep with a slope of 0.075 ft/ft to station 105+00. From station 105+00 to 148+00, the slope of the drainage flattens to 0.03 ft/ft.

3.2 RFI SITES WITHIN CATCHMENT AREA

SSFL RFI sites that lie within the catchment area of this drainage include the following:

- The former B-1 Test Area (Solid Waste Management Unit (SWMU) 4.1),
- The Instrument and Equipment Laboratories (SWMUs 4.3 and 4.4),
- The former Liquid Oxygen Plant (owned by the National Aeronautics and Space Administration, SWMU 4.5),
- The Area I and Area II Landfills (SWMUs 4.2 and 5.1, respectively),
- The former Incinerator Ash Pile (SWMU 5.6),

- The eastern portion of the Expendable Launch Vehicle site (SWMU 5.2), and
- The Area II sewage treatment plant (Area II Area of Concern).

Also, as mentioned in Section 2.2.3, storm water runoff from the northern portion of the Building 359 Area likely drained via a pipe beneath the Area I Road and discharged to the Northern Drainage even though the Building 359 Area lies wholly in a different surface water catchment area. The catchment of the Northern Drainage also includes the southern portions of the Santa Monica Mountains Conservancy property that lies to the north of the SSFL property boundary as shown on Plate 1.

Available perchlorate sampling data from the characterization of the various facilities identified above was previously reported (MWH, 2003a). The Area I and II landfills have not yet been characterized but are proposed for characterization according to the work plan submitted to the DTSC (MWH, 2003d). Hence, the potential for these two landfills to act as perchlorate sources to the Northern Drainage will be evaluated once the work plan is approved by the DTSC. However, it is expected that if the landfills are perchlorate sources at all, that they would be small because the existing data as presented in Sections 2.2 above and 3.1 below do not show perchlorate to be present in the environmental media that have historically been sampled at locations proximal to the landfills.

3.3 GEOLOGIC FEATURES ALONG NORTHERN DRAINAGE

The Northern Drainage runs either along or across a number of geologic features that have been identified at the SSFL. From the pipe that ran beneath the Area I Road (station 11+00), a southern reach of the Northern Drainage ran across the Area I Landfill and crossed over the Shear Zone at station 13+00. This southern tributary tied into the primary reach of the Northern Drainage along the North Fault at station 18+00. The Northern Drainage then basically flows westward along strike of the North Fault for about 5,600 feet from station 18+00 to approximately station 74+00. Two finer-grained stratigraphic members intersect the North Fault along this reach of the drainage. Shale 2, one of the finer-grained members, intersects the North Fault between stations 43+00 and 54+00. It should be noted that the North Fault off-sets Shale 2

between the north and south sides of the fault. The SPA Member, which is the second finer-grained member, intersects the North Fault approximately between stations 56+00 and 57+00. At station 74+00, the Northern Drainage flows northward with slight jogs to the west between stations 90+00 and 100+00 and between stations 130+00 and 150+00. Along this reach of the drainage, the finer-grained ELV Member intersects the drainage between stations 80+00 and 82+00. Further to the north, Shale 3 intersects the drainage just below station 115+00. The geologic contact between Chatsworth formation and the Simi Conglomerate formation intersects the drainage at station 115+00.

3.4 OTHER PHYSICAL FEATURES

Other physical features along the drainage include:

- Two dams have been constructed along the Northern Drainage on the Brandeis-Bardin Institute property. One dam was constructed in about 1965 at station 106+00. The other dam was constructed sometime after 1952 at about station 113+00.
- A section of the drainage between stations 84+00 and 122+00 appears to be an area of groundwater discharge (i.e., the drainage appears to be a gaining stream) as evidenced by a number of groundwater seeps, springs and surface pools.

3.5 EASTERN DRAINAGE TRIBUTARY

Another tributary contributes storm water runoff to the Northern Drainage at station 130+00. This tributary lies north of the SSFL property boundary and its headwaters are sourced to the east of Black Canyon Road. This tributary to the Northern Drainage (labeled East Drainage on Plate 1) collects and conveys storm water runoff from residential properties located east of Black Canyon Road, from portions of the Santa Monica Mountains Conservancy property and from portions of the Brandies-Bardin Institute.

3.6 PERCHLORATE SAMPLING RESULTS ALONG THE NORTHERN DRAINAGE

Surface water, groundwater and spring/seep samples have been collected and analyzed for the occurrence and concentration of perchlorate since 1999. Three surface water samples have been

collected at three distinct locations along the Northern Drainage. Sample locations and results are shown on Plate 1. One of the surface water samples was collected near the Area I landfill in February of 2001 (station 13+00). Perchlorate was not detected in this sample at a reporting limit of 0.003 mg/L. A second surface water sample was also collected in February of 2003 north and down stream of the Area II landfill (station 71+00). Perchlorate was not detected in this sample at a reporting limit of 0.004 mg/L. The third surface water sample was collected further down the drainage in 1999 as part of the NPDES sampling program (station 82+00). Perchlorate was not detected in this sample at a reporting limit of 0.004 mg/L.

Groundwater samples have been collected and analyzed for perchlorate from four wells located along and near the Northern Drainage. Well WS-4A was sampled on five different occasions between November 1997 and November 2000 (station 37+00). Perchlorate was not detected in the samples collected from this well, at reporting limits ranging from 0.001 mg/L to 0.004 mg/L. Well RD-52B was sampled on five different occasions between February 1999 and February 2003 (station 54+00). Perchlorate was not detected in the samples collected from this well, at reporting limits ranging from 0.00043 mg/L to 0.004 mg/L. Well RD-52C was sampled on four different occasions between November 1997 and November 2000 (station 53+00). Perchlorate was not detected in the samples collected from this well, at reporting limits ranging from 0.001 mg/L to 0.004 mg/L. OS-9 (station 147+00) sampling results were previously presented in Section 2.2.5.1.

Prior to July 2003, samples have been collected and analyzed for perchlorate at two different springs/seeps. A sample was collected from spring/seep location S-17 in June of 2002 (station 94+00) and perchlorate was not detected at a reporting limit of 0.001 mg/L. Four samples have been collected from OS-8 (station 100+00) between February of 1999 and January of 2003. Perchlorate was not detected in the four samples collected from this spring/seep, at reporting limits ranging from 0.00043 mg/L to 0.004 mg/L.

Staff from the DTSC also reportedly collected a soil sample and produced a field leachate at a location noted as East Canyon-1 (station 122+00) in May of 2002 and perchlorate was not detected at a reporting limit of 0.003 mg/L.

3.7 OTHER WATER CHEMISTRY RESULTS

Samples from groundwater and springs/seeps have also been collected at locations along the Northern Drainage and analyzed for background water quality parameters. Samples have been analyzed for general minerals and total dissolved solids (TDS) from eight groundwater wells and two springs/seeps. Stiff diagrams depicting the cation and anion results for these locations are shown on Plate 1. As noted by the shape of the stiff diagrams, wells and springs that are positioned in the Chatsworth formation are a calcium-bicarbonate type groundwater. Wells and springs positioned in the Simi Conglomerate formation or near the contact with the Chatsworth formation are a sodium-bicarbonate type groundwater. These data indicate that groundwater within these two formations are hydraulically distinct.

3.8 SUMMARY OF DATA ANALYSIS

In summary, samples of surface water, groundwater, spring/seep and soil leachate that have been collected along the Northern Drainage and analyzed for perchlorate showed none to be present. Additionally, general minerals data show that Chatsworth Formation groundwater underlying the SSFL is different from groundwater in the Simi Conglomerate formation.

4.0 DATA NEEDS AND POTENTIAL TRANSPORT PATHWAY ANALYSIS

An independent assessment of the data needed to characterize the potential for a historical perchlorate release from the Building 359 RFI site to the Northern Drainage was made. This assessment indicated that the following data were needed to complete this characterization:

1. Occurrence and concentration of perchlorate and background water quality indicators in groundwater and at seeps/springs and surface water pools along the Northern Drainage.
2. Occurrence and concentration of perchlorate in drainage sediments in the Northern Drainage and its tributaries that are located within the SSFL property boundary.
3. Occurrence and concentration of perchlorate in soils and materials in the Area I and II landfills.
4. Occurrence and concentration of perchlorate in weathered bedrock within the Northern Drainage.
5. Geologic and hydrogeologic conditions along the Northern Drainage of the SSFL.
6. Surface water hydrology along the Northern Drainage.
7. Direction of groundwater flow from the Building 359 RFI site.

Currently available data from items 1, 5 and 7 were reviewed to establish the appropriate focus for this work plan. These data indicate that the primary potential transport mechanism for perchlorate to have possibly been transported from the Building 359 RFI site to the Northern Drainage is by surface water flow. For this transport mechanism to be valid, it is expected that such discharges from surface water to the subsurface would occur along the drainage with the highest concentrations closest to the Building 359 RFI site. This concept is the fundamental design premise for this work plan and is conceptually depicted in Figure 3. Additionally, the potential transport of perchlorate from either the Area I or Area II landfills is another possibility that will be explored upon implementation of the work plan for these two locations (MWH, 2003d, pending review and approval from the DTSC). The conceptual transport mechanism from the landfills would be via leachate production and surface water flow to the Northern Drainage.

The groundwater transport pathway from the source areas in groundwater at the Building 359 Area and from Happy Valley, the other primary perchlorate use area at the SSFL, was considered during this analysis. This transport pathway is considered incomplete for the following reasons:

- Extraction wells WS-5, WS-6 and RD-1, which are located near the two primary use areas for perchlorate at the SSFL (i.e., the Building 359 and Happy Valley RFI sites), induce local hydraulic gradients that would capture Chatsworth formation groundwater impacted by perchlorate at these locations. The general effect of groundwater extraction at WS-5 and WS-6 was presented in the Perchlorate Report (MWH, 2003a).

- Results of one-dimensional single-fracture and two-dimensional fracture-network transport simulations illustrate that, although the rates of groundwater flow in the fractured Chatsworth formation may be very high, the transport rate of perchlorate in the Chatsworth formation is orders of magnitude slower. The slower transport rate is the result of retardation caused by molecular diffusion into the rock matrix.

- Available groundwater sampling results presented in the Perchlorate Report (MWH, 2003a) and the locations of the primary perchlorate use areas at the SSFL (i.e., Building 359 and Happy Valley) show that the site monitoring data are consistent with the slow transport of perchlorate in Chatsworth formation groundwater. Perchlorate is detected in wells proximal to the release locations and bounded by wells with samples showing no detections of perchlorate. These results show the transport distances to be only 100s to a few 1000s of feet from where it was released.

However, work will be proposed as requested by DTSC to confirm that this pathway is incomplete and is described in Section 5.0.

The potential for the transport of perchlorate by possible perchlorate releases to the atmosphere followed by deposition by rain-out was also considered. However, the distribution pattern of wells where perchlorate has been detected is inconsistent with this potential release mechanism (see Plate 4-11 of the Perchlorate Report). Hence, no specific scope of work will be proposed in Section 5.0 to evaluate this potential transport pathway.

5.0 SCOPE OF WORK

The scope of work proposed in this work plan considers:

- The data, information and approaches presented in the previous sections,
- The specific requirements in DTSC's June 23, 2003 letter requesting additional characterization of perchlorate at the SSFL (see Appendix A), and
- Existing work plans that have previously been prepared for conducting similar work at the SSFL.

Table 3 summarizes requested elements for perchlorate characterization as outlined by DTSC in the June 23, 2003 letter, the work that is proposed to be performed to comply with the request and a listing of existing applicable work plans.

Perchlorate characterization along the Northern Drainage from the Building 359 RFI site will include the following tasks:

1 – Sample and analyze drainage sediments
2 – Sample and analyze groundwater
3 – Sample and analyze surface water
4 – Install additional groundwater monitoring wells
5 – Test the aquifer(s)
6 - Evaluate geology, hydrogeology and surface water hydrology
7 - Perform a groundwater corrective measures study

Additional descriptions of the work to be performed for these tasks are outlined below.

5.1 SAMPLE AND ANALYZE DRAINAGE SEDIMENTS

Sediment samples have been collected from surficial and deeper sediments within the active channel of the Northern Drainage. Boeing obtained permission from off-site property owners prior to collecting any off-site samples. The objective of this sampling program was to evaluate

the potential surface water transport of perchlorate from the Building 359 RFI site and the Area I and II landfills. Sediment samples were collected using the guidelines presented below. Sample locations are shown on Plate 2.

The lateral spacing along the drainage at or near RFI sites generally ranged from 50 to 125 feet. Sediment samples were collected near the Area I and Area II landfills at the locations presented in the landfills investigation work plan that was recently submitted to DTSC (MWH, 2003d). The lateral spacing of sediment samples within the drainage increased with distance from the RFI sites. A lateral spacing ranging from 250 feet to 500 feet was used within the SSFL. Off-site to the north of the SSFL, the lateral spacing of sediment samples increased and ranged from 500 feet to 1000 feet. The maximum lateral distance between sample locations did not exceed 1000 feet.

Samples were collected at various depths and across the width of the drainage as outlined below and diagrammatically depicted in Plate 2. Samples were collected at depths between the surface and ½ inch below the surface (designated as sample S01) and at six inches above the bedrock (designated as sample S03). At approximately 10 percent of the sample locations, an additional sediment sample was collected between ½ inch and 4 inches below the surface (designated as sample S02). Additional samples of this type were collected in areas with thin sediment deposits that precluded collecting S03 samples.

Additional sample locations were added along the drainage if salt deposits were noted. Similarly, if salt deposits were observed in the bank(s) of the drainage, additional samples were also collected (designated as sample S04). These samples were in addition to the sample intervals discussed in the previous paragraphs and targeted the salt-bearing unit only.

At representative locations within the drainage where thicker sediment deposits were present, over-bank samples (designated as sample S05) and deeper samples were collected at approximately 6” depth intervals to just above bedrock (designated as samples S06, S07, etc.).

Leachates were produced from the majority of the samples collected using an enhanced leachate protocol as described below. EPA Method 314.0 was used to analyze the leachates for perchlorate. Recently, a enhanced leachate procedure was developed based on information that indicates very near-surface sediments concentrate perchlorate in areas with continuing sources. The enhanced leachate procedure was recently used to sample in previously identified areas with perchlorate impacts at the Happy Valley and Building 359 RFI sites. Side-by-side comparison samples were collected to allow for a comparison to be made between the 'original' and 'enhanced' methodologies. The enhanced procedure uses standardized sample and water amounts, and targets the uppermost sediments at a location (1/2- and 4-inches of sediment) or sediments near salt incrustations. The original leachate method does not standardize sample or water amounts (except in the most general sense of using 4 to 6 sampling sleeves), and targets the upper 6-inches of sediment from the locations being sampled. At these side-by-side comparison locations, the enhanced leachate procedure detected higher concentrations of perchlorate in the uppermost ½-inch of sediment than the 'original' method detected in sediments collected between 0 and 6 inches. It is believed this result occurred because perchlorate is a salt that wicks to the sediment surface as water evaporates. Additional leachate samples were also produced from samples collected at regular intervals using the original methodology developed between MWH and DTSC to compare results between the two methods. The additional leachates (S99 sample identification) were created from sediment samples collected from the surface to 6 inches below the surface at a maximum lateral distance of 1000 feet. In areas of thicker sediment deposits, vertical composites (S99) were also prepared using the original methodology. Leachates from these samples were prepared using the 'original' leachate sampling procedures (see below).

The following guidelines were used to prepare leachates from the sediment samples collected:

- Leachate samples were prepared from all surface and salt deposit samples (S01 and S04).
- Leachate samples were prepared from all upper channel sediments (S02), assuming 10 percent of the locations are sampled in this manner.
- Leachate samples were prepared from above-bedrock samples (S03) at a spacing of no more than 1000 feet. This spacing was decreased near RFI sites or in areas of thick sediment accumulation.

- Leachate samples were prepared from overbank, above bedrock, and at 2-foot intervals in the deeper sediment accumulation areas within the drainage (S05, and S06, etc.). The sediment samples collected from the intervening 6-inch intervals were retained for further analysis if necessary.

- Finally, if water was encountered in any sampling location in the drainage, or in the bottom of the auger boring, then water samples were also collected using a disposable bailer or syringe device.

Sediment or soil samples consisting of sediment or soil matrix were also collected at leachate sampling locations. Locations of these samples depended on the leachate sampling results. At a minimum, at least one sediment sample was collected downstream of every RFI site (typically the one closest to the RFI site). However, two sediment/soil matrix samples were collected downstream of the Area I and Area II landfills.

5.2 SAMPLE AND ANALYZE GROUNDWATER

Groundwater samples will be collected and analyzed for perchlorate and general minerals from both existing wells and springs/seeps and from new wells to be installed as outlined in Section 5.4. The objective of this sampling program is to evaluate the potential groundwater transport of perchlorate from the Building 359 RFI site across geologic features and to evaluate the potential surface water transport pathway along the Northern Drainage. Certain wells located within the SSFL and all off-site wells currently within the site-wide groundwater monitoring program will be sampled and analyzed for perchlorate and general minerals quarterly. Boeing will obtain permission from any necessary off-site property owners prior to collecting off-site samples.

On-site wells to be sampled are identified in the table below and their locations are shown on Plate 2.

Location and Well Type		Wells to be Sampled for Perchlorate and General Minerals	Frequency
On-site	Near-surface groundwater	PZ-062 and four new piezometers to be installed as outlined in Section 5.4	Whenever saturated or quarterly if continually saturated for first year, annually thereafter
	Chatsworth monitoring	RD-37, RD-45A, RD-45B, RD-45C, RD-51A, RD-51B, RD-51C, RD-52A, RD-52B, RD-52C, and RD-70	Quarterly for the first year, annually thereafter
	Former water supply	WS-4A, WS-9B, WS-12, WS-13 and WS-14	Quarterly for one year[1]

Where applicable, existing work plans as shown on Table 3 that contain details about sampling and analysis procedures including the appropriate quality control and quality assurance requirements will be used during the sampling events.

Samples from former water supply wells WS-12, WS-13 and WS-14 will be collected from discrete locations that will be chosen based on the results of hydrophysical logs. The objective of this task is to determine of perchlorate and other COCs are present in these water supply wells and, if so, to obtain an understanding of their vertical distribution. These data will also be useful in evaluating both the potential surface water transport pathway along the Northern Drainage and the potential groundwater transport pathway from the source in groundwater at the Building 359 RFI site. If available, the United States Geologic Survey (USGS) will collaborate with the University of Waterloo and MWH to collect fluid temperature, fluid resistivity and either or both electromagnetic and heat-pulse flow meter logs. Similar measurements were previously made by the USGS in three boreholes at the SSFL (USGS, 2002). Descriptions of the methods to be used for hydrophysical logging are as follows:

- Fluid-resistivity logging will record the electrical resistivity of the water in the former water supply wells. The electrical resistivity of the water is related to its dissolved-solids concentration. Fluid-resistivity logs will be collected under ambient and pumped

[1] The frequency and location of samples to be collected from former water supply wells WS-12, WS-13 and WS-14 will be dependent upon the results of hydrophysical logging.

conditions. The fluid-resistivity logs will be combined with the temperature and flowmeter logs to identify flow zones and to determine the relative dissolved-solids concentration of their contained water.

- Temperature logging will record the temperature of the water in the water supply wells. In wells with no vertical flow, the temperature of the water within the well generally increases with depth as a function of the geothermal gradient in the surrounding rocks. Temperature gradients less than the geothermal gradient may indicate intervals with vertical flow. Temperature logs will be used with the fluid-resistivity and electromagnetic or heat-pulse flowmeter logs to identify flow zones under ambient and pumped conditions.

- Electromagnetic flowmeter logging will record the direction and rate of vertical flow in the water supply wells. The flow of water (an electrical conductor) through an induced magnetic field generates a voltage gradient that according to Faraday's Law, is proportional to its velocity. Stationary flow measurements will be made under ambient conditions and both trolling and stationary measurements will be made under pumped conditions. The electromagnetic-flowmeter logs will be used in conjunction with the fluid-resistivity and temperature logs to identify flow zones, commonly composed of multiple fractures and their relative hydraulic head, flow contribution and dissolved-solids concentration.

Staff from the USGS will interpret the hydrophysical logs and recommend discrete intervals for water quality sampling from the water supply wells. The data produced from these logs at these water supply wells is expected to provide information useful to the site-wide characterization of the Chatsworth formation. Sampling of these wells will be performed using a canister sampling device to collect discrete samples that will be submitted for perchlorate analysis, general minerals, volatile organic compounds (VOCs) and other constituents as appropriate. Certain elements of the canister sampler will be decontaminated between sampling events according to the procedures identified in the Site-Wide Sampling and Analysis Plan (GRC, 1995a).

Samples from springs/seeps located along the Northern Drainage will be collected and analyzed for perchlorate twice annually for the first year and will follow the procedures outlined in the Spring and Seep Sampling Work Plan (MWH, 2002a). The objective of the spring/seep sampling program is to confirm that perchlorate releases to groundwater remain local to their respective release location. Sampling locations are shown on Plate 2. Additionally, other springs and seeps currently in the site-wide groundwater monitoring program will also be sampled and analyzed for perchlorate. Twice per year sampling is proposed for springs/seeps

because of their transient occurrence. Spring/seep sampling events will be conducted once during the late spring and again in the early fall (assuming spring/seep discharges are still occurring). Spring/seep samples will not be collected during winter and early spring because surface water flows along the drainage dilute and/or submerge the springs/seeps during these periods. Samples will be analyzed for perchlorate, general minerals, including total dissolved solids and stable oxygen and hydrogen isotopes. Should perchlorate be detected in a spring/seep sample, a sample of the alluvium/colluvium and or bedrock adjacent to the spring/seep will also be collected and submitted for perchlorate analysis.

5.2.1 OS-9 Sampling and Analysis

Groundwater samples will be collected from OS-9 weekly for two months starting in July 2003, monthly for 10 months and quarterly thereafter. All samples will be analyzed for perchlorate. Samples will be analyzed for general minerals and stable oxygen and hydrogen isotopes monthly for the first year and quarterly thereafter. The sampling program is described in further detail in Appendix B. The objective of this sampling program is to confirm that perchlorate is absent in groundwater flowing from OS-9.

5.3 SAMPLE AND ANALYZE SURFACE WATER

Both one-time and periodic surface water samples will be collected from the Northern Drainage and analyzed for perchlorate. The objective of these samples is to evaluate potential surface water transport of perchlorate from the Building 359 RFI site and the Area I and II landfills. The one-time sampling event occurred in July 2003 from surface water pools that were identified during an inspection of the drainage. Locations that were sampled are shown on Plate 2. Samples were analyzed for general minerals, including total dissolved solids, and stable oxygen and hydrogen isotopes to determine if the pooled water was surface water or groundwater.

Periodic surface water samples will also be collected and analyzed for perchlorate during the rainy season in accordance with the requirements specified by the Los Angeles RWQCB.

5.4 INSTALL ADDITIONAL GROUNDWATER MONITORING WELLS

Four additional near-surface groundwater monitoring wells will be installed along the Northern Drainage. The objective of these wells is to determine if near-surface groundwater is present near the Northern Drainage down-slope from the Area I and II landfills and, if so, to determine if it has been impacted by perchlorate. The wells will be installed north of the Area I and Area II landfills at the locations proposed in the Landfills Investigation Work Plan (MWH, 2003d). The proposed locations for these wells are shown on Plate 2. The wells will be drilled and installed according to the procedures specified in the Shallow Zone Groundwater Investigation Work Plan (Ogden, 2000c), which has been approved by the DTSC.

One enhancement will be made to the drilling and sample collection procedures specified in the Shallow Zone Groundwater Investigation Work Plan. The enhancement will consist of sampling the weathered bedrock at the western most well to be installed north of the Area II landfill (near station 70+00 on Plate 2). The objective of sampling the weathered bedrock is to evaluate potential surface water transport of perchlorate along the Northern Drainage. A continuous core of the weathered bedrock will be collected using a wireline coring device. Weathered bedrock samples will be collected from the core at approximately one-foot intervals from its first occurrence in the borehole to the unweathered bedrock contact. The rock samples will be collected and crushed according to the procedures outlined in the Chatsworth Formation Work Plan (Montgomery Watson, 2000b). The crushed rock samples will be placed into glass jars containing appropriate amounts of de-ionized water. The samples will be shaken for a defined period to dissolve any residual perchlorate that may be present in the crushed rock and aliquots of the water will be extracted from the sample container and analyzed for perchlorate.

Additional Chatsworth formation monitoring wells are not being proposed at this time. The current understanding of the groundwater flow system from the source areas impacted by perchlorate at the SSFL indicates that perchlorate is effectively contained due to faults and fine-grained stratigraphic members that are aquitards that inhibit groundwater flow. Additional work will be performed as outlined in Section 5.5 to confirm the aquitard characteristics of the Shear Zone. The Shear Zone is the primary geologic feature that substantially isolates the potential

northwesterly transport of perchlorate impacted groundwater at the Building 359 and Happy Valley RFI sites. Additionally, the data obtained from the hydrophysical logging and subsequent discrete-interval sampling of water supply wells WS-12, WS-13 and WS-14 will provide data to confirm or refute the lack of northwesterly transport of perchlorate-impacted groundwater from the east side of the Shear Zone to the west side. However, additional Chatsworth formation wells will be considered if sampling results from the water supply wells are inconclusive or if results indicate the presence of perchlorate. The locations to be selected for the installation of additional Chatsworth formation wells will be dependent upon completing a three-dimensional groundwater flow model.

5.5 TEST THE AQUIFER(S)

An aquifer test will be performed to evaluate the potential transport of perchlorate in groundwater from the Building 359 RFI site toward the northwest. The aquifer test will be performed by extracting groundwater from corehole C-1 and monitoring pressure responses in a number of surrounding monitoring wells. Details of the proposed aquifer test were previously described in a transmittal to the DTSC (Boeing, 2003). However, in addition to monitoring water level responses in the wells proposed in the aquifer test work plan, a pressure transducer will be installed in well WS-14 to monitor for potential water level changes in this well. WS-14 is located on the opposite side of the Shear Zone (i.e., on the west side) from the selected extraction well C-1.

If necessary, an aquifer test can also be performed by using WS-14 as the extraction well. However, the use of WS-14 as an extraction well will be reserved as a contingency. The results from the C-1 aquifer test along with the USGS hydrophysical logging and subsequent discrete-interval sampling of WS-12, WS-13 and WS-14 will be reviewed and considered prior to determining the need for an additional aquifer test using WS-14 as an extraction well. The need for the aquifer test will be determined in consultation with the DTSC.

5.6 EVALUATE GEOLOGY, HYDROGEOLOGY AND SURFACE WATER HYDROLOGY

The geology, hydrogeology and surface water hydrology along the Northern Drainage from the SSFL to the vicinity of OS-9 will be evaluated. The geology will be evaluated by field mapping and the inspection of aerial photos. Photographs of notable geologic features identified during the field mapping will also be taken and incorporated as part of the geologic characterization. Where possible, correlations of the lithology at depth will be constructed from borehole geophysical logs that will be obtained as part of the Chatsworth Formation Work Plan (Montgomery Watson, 2000b). Advanced borehole geophysical logs have been obtained from WS-14 and will be collected from WS-12 in the near future (see MWH, 2002b for a description of the borehole geophysical logs that are produced for this work). The objective of the geologic characterization will be to verify the existing geologic framework and to determine the stratigraphy of the Simi Conglomerate and its potential effect on groundwater occurrence and flow.

A summary of the hydrogeology will also be prepared for the groundwater along the Northern Drainage. Hydrogeologic data presented in Appendix B of the Conceptual Site Model Technical Memorandum (Montgomery Watson, 2000a) will be summarized and coupled with the hydrogeologic data that will be collected as described in this work plan. Data on depth to groundwater, groundwater elevations, well responses to pumping, hydraulic conductivity, groundwater flow rates and directions and intra-well flow zones, where applicable, will be presented and discussed.

Surface water flows along the Northern Drainage will also be characterized from the head waters at the SSFL. Surface water flows along a tributary drainage that lies to the north of the SSFL (i.e., the Eastern Drainage, see Plate 1) will also be characterized as this drainage connects with the Northern Drainage north of the SSFL. Surface water flow rates will be estimated using appropriate methods and or models for various precipitation events. The objective of this analysis is to obtain a general assessment of the surface water flows along the Northern Drainage to assist in assessing potential surface water transport of perchlorate.

5.7 PERFORM A GROUNDWATER CORRECTIVE MEASURES STUDY

A corrective measures study on the groundwater underlying the SSFL will be initiated by preparing a corrective measures study work plan as specified in the Post-Closure Permit (DTSC, 1995). The corrective measures study work plan will specify how the CMS report will be prepared and will be used to identify and evaluate potential remedial alternatives to address the groundwater impacted by COCs that underlies the SSFL. The corrective measures study work plan will be performed consistent with Attachment E of the Post-Closure Permit and the requirements specified in Section 66264.101 of Title 22 of the California Code of Regulations. The corrective measures study work plan will be submitted within 90 days of DTSC's approval of this work plan.

Although a request has been made by DTSC to assess potential interim measures to reduce or contain perchlorate with the objective of controlling further migration from identified source areas, such actions are unlikely to be useful for the following reasons.

1. Currently available treatment technologies to remove perchlorate from extracted groundwater are well-known and readily implementable if appropriate.

2. Perchlorate is only one of the known constituents dissolved in groundwater at the identified source areas, hence any evaluation of technologies needs to consider all of the COCs.

3. The current understanding of perchlorate occurrence and transport in SSFL groundwater indicates that there is no immediate threat requiring an interim action. Existing interim measures associated with groundwater extraction at WS-5, WS-6 and RD-1 are effective at capturing perchlorate impacted groundwater at the Building 359 and Happy Valley RFI sites as discussed in Section 4.0. Furthermore, molecular diffusion of dissolved perchlorate in groundwater into the sandstone bedrock that comprises the Chatsworth formation is effective in the short term at containing perchlorate-impacted groundwater and in controlling further transport.

4. The time and effort associated with modifying the post-closure permit (DTSC, 1995) to incorporate a unit operation into the existing treatment system(s) to treat perchlorate-impacted groundwater are long and extensive. Consideration of such modifications is inappropriate prior to completing the corrective measures study.

6.0 SCHEDULE AND DELIVERABLES

Portions of the scope of work have been initiated by Boeing because the presence of certain environmental media are transient and subject to variations in the climate. Samples from surface water pools discussed in Section 5.3 were collected in the early and middle portions of July 2003 as these pools evaporate as summer progresses. Similarly, the spring/seep samples that are discussed in Section 5.2 were also collected in July 2003 because their discharge either becomes too small to collect a representative sample or ceases altogether as summer progresses. The sampling program for OS-9 proposed by Boeing in the July 12, 2003 letter (see Appendix B) was also initiated in July and continues as of the date of this work plan. Available results were presented in Section 2.2.5.1 and Appendix C. Finally, sampling of the drainage sediments as outlined in Section 5.1 was also initiated in July to assess whether perchlorate is present in drainage sediments at the locations shown on Plate 2. Analytical results from samples noted above are still pending.

Sampling of the Chatsworth formation, 2 of the 5 water supply and the off-site wells will be initiated within 60 days of DTSC's approval of this work plan. The near-surface piezometers will be sampled within 45 days of installation if saturated and whenever PZ-062 becomes saturated (multiple gauging events conducted at PZ-062 over the last few years have not encountered groundwater). Installation of the four proposed near-surface piezometers will commence within 45 days of DTSC's approval of the Area I and II Landfills Investigation Work Plan (MWH, 2003d). Hydrophysical logging and discrete sampling of water supply wells WS-12, WS-13 and WS-14 will be initiated within 90 days of DTSC's approval of this work plan, assuming the USGS logging and sampling equipment is available for shipment to the SSFL.

The periodic sampling of surface water from the Northern Drainage will be initiated during the rainy season whenever sufficient runoff is generated and at the frequency specified by the Los Angeles RWQCB.

The pumping test at corehole C-1 is expected to be started on August 25, 2003.

Work has been initiated to evaluate the geology and surface water hydrology along the Northern Drainage. It is expected that this work will be substantially complete within 60 days of DTSC's approval of this work plan.

6.1 DELIVERABLES

An RFI site report describing the work performed, analytical laboratory results and other data and interpretations as discussed in Section 5.0 will be prepared and submitted within 180 days of DTSC's approval of this work plan. This report will also identify any additional gaps in the data that might exist and a plan will be prepared that identifies the work that would need to be performed to fill the data gaps.

Available sampling data will be summarized and presented in a perchlorate update report that will be submitted to the DTSC by November 15, 2003. This report will include results of Northern Drainage sampling data and other perchlorate sampling data collected both within the SSFL property boundary and in off-site areas. If made available, the report will also include perchlorate results from samples collected by DTSC, the RWQCB and other agencies as appropriate. Supplemental perchlorate report amendments can also be produced in the future if significant additional data are collected.

Periodic monitoring results from wells and springs/seeps to be sampled as described in this work plan will be included in the quarterly or annual groundwater monitoring reports that are submitted to DTSC on the last day of February, May, August and November of each year.

Finally, as noted in Section 5.7, a corrective measures study work plan for groundwater will be submitted within 90 days of DTSC's approval of this perchlorate characterization work plan.

7.0 SUMMARY

This RFI work plan presents characterization activities to evaluate the potential for off-site migration of perchlorate from the SSFL in response to a DTSC letter dated June 23, 2003 (Appendix A). DTSC has requested the submittal of a work plan describing measures to be taken to investigate the potential migration of perchlorate contamination from the SSFL to off-site areas such as the Brandeis-Bardin Institute property. This RFI work plan presents characterization activities necessary to (1) confirm that perchlorate is absent in OS-9 (Bathtub Well #1), and (2) evaluate the potential migration of perchlorate from the SSFL to off-site areas.

A comprehensive report on the occurrence of perchlorate at and near the SSFL was issued in February 2003 (MWH, 2003a). This report documented the usage of perchlorate at the SSFL, identified source areas, evaluated migration pathways and perchlorate transport and evaluated potential off-site migration of perchlorate from the SSFL. The report also contained conclusions about the occurrence of perchlorate at the SSFL and discussed areas requiring further characterization. Three areas were identified in the report as requiring additional work to evaluate the nature and extent of perchlorate in soil, surface water and/or groundwater: Happy Valley, Building 359 and the TTF.

Two of the areas, the Happy Valley and Building 359 RFI sites, have been the focus of additional characterization work to define areas for treatment under interim measures. Characterization of these two areas continues as outlined in the Interim Measures Work Plan (MWH, 2003c). Preliminary characterization work has also been performed at the third area, the TTF. The data produced from the samples collected at the TTF show negligible impact as only one of the eleven samples contained perchlorate and the concentration detected was slightly above the reporting limit (0.0043 mg/L). This recent data collected from the TTF supports the conclusion presented in the Perchlorate Report. The report concluded that any perchlorate releases at the TTF would likely be small as monitoring results from wells located adjacent to the TTF and from surface water sampling from designated NPDES outfalls did not show perchlorate to be present. Additional perchlorate monitoring data from surface water samples collected since

January 2003 from designated outfalls around the SSFL and from groundwater monitoring well samples also confirm the conclusions presented in the Perchlorate Report.

The initial work completed under the Interim Measures Work Plan for the B359 RFI site discovered a potential migration pathway requiring additional characterization (MWH, 2003c). The potential pathway is surface water transport via a former drainage pipeline leading to the Northern Drainage. As presented in Section 3.0 of the work plan herein, a significant amount of data exists regarding various potential migration pathways from this drainage. Data collected to date within the SSFL and along the Northern Drainage do not currently indicate that off-site migration of perchlorate is occurring north of the SSFL. The data supporting this statement include samples from groundwater monitoring and water supply wells, from springs/seeps and from surface water. Furthermore, as discussed in Section 2.2.5.1 of this work plan, additional groundwater samples collected at OS-9 in July and August 2003 show that perchlorate is absent. An evaluation of OS-9 perchlorate data collected on May 30 and June 11, 2003 indicate results are inconsistent and that additional validation is necessary before these data can be used.

The scope of work presented in the work plan herein is summarized on Figure 4 and includes the following:

- Collecting groundwater samples from OS-9 weekly for two weeks, monthly for 10 months and quarterly thereafter. All samples will be analyzed for perchlorate. Samples will be analyzed for general minerals and stable oxygen and hydrogen isotopes monthly for the first year and quarterly thereafter.

- Collecting sediment samples from more than 60 locations within and along the Northern Drainage and laboratory analysis of leachates from approximately 100 samples collected at these locations for the occurrence and concentration of perchlorate.

- Collecting groundwater samples from five near-surface, 11 Chatsworth formation, five former water supply and those off-site wells currently in the site-wide groundwater monitoring program and analyzing the samples for perchlorate and general minerals. Groundwater will be collected from the near-surface, Chatsworth formation, off-site and two of the five water supply wells quarterly for one year and analyzed for perchlorate and general minerals. After the first year of sampling, the sample frequency will become annual. Three of the water supply wells will be hydrophysically logged by the USGS and discrete-interval samples will be collected and submitted for perchlorate and VOC analysis based on the results of the hydrophysical logs.

- Collecting spring/seep samples from six locations along the Northern Drainage and analyzing the samples for perchlorate twice annually. Samples will be collected once during the late spring and again in the late fall. These samples will also be analyzed for general minerals, including total dissolved solids and stable oxygen and hydrogen isotopes. Samples will also be collected from seeps/springs currently in the site-wide groundwater monitoring program and analyzed for perchlorate and general minerals.

- Collecting one-time surface water samples from nine pools that have been identified along the Northern Drainage and analyzing the samples for perchlorate, general minerals and stable oxygen and hydrogen isotopes. When flowing, surface water samples will also be collected along the Northern Drainage as required by the RWQCB and analyzed for perchlorate.

- Installing four additional near-surface groundwater monitoring wells along the Northern Drainage consistent with what has been proposed in the Landfills Investigation Work Plan (MWH, 2003d) and according to the procedures specified in previously submitted and DTSC-approved Shallow Groundwater Investigation Work Plan (Ogden, 2000c). Samples of weathered bedrock will be collected at one-foot intervals during the installation of one well and processed and analyzed for the occurrence and concentration of perchlorate. No Chatsworth formation wells are proposed for installation as part of this work plan because the existing data do not indicate that they are needed.

- Testing the aquifer by performing a pumping test at corehole C-1. As a contingency, an additional aquifer test can be performed using WS-14 as an extraction well. The objective of these aquifer tests is to evaluate the groundwater flow system near the perchlorate source areas at the SSFL and to evaluate the effectiveness of geologic features in the vicinity of extraction wells as aquitards. If the data collected as specified in this work plan indicate a need for a Chatsworth formation well(s), such a well(s) will be installed following the completion of a three-dimensional groundwater flow model.

- Evaluating the geology, hydrogeology and surface water hydrology along the Northern Drainage within the SSFL to the vicinity of OS-9. The geology will be evaluated through field mapping, inspection of aerial photos and correlation of borehole geophysical logs. Existing hydrogeologic data will be combined with the hydrogeology data to be collected as described in this work plan. Surface water flows from various precipitation events will be characterized.

- Performing a groundwater corrective measures study to evaluate possible measures to reduce and/or contain perchlorate and other COCs in impacted groundwater that underlies the SSFL. The corrective measure study will identify and screen potential treatment technologies for perchlorate and other COCs in groundwater and will include both *in situ* and aboveground treatment technologies. The technologies will then be developed into specific alternatives and evaluated with respect to their effectiveness, compliance with applicable laws and regulations, implementability and cost.

A report will be prepared and submitted within 180 days of DTSC's approval of this work plan herein. The report will describe the data collected and an interpretation of results. Plans for collecting any additional data will also be included.

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MWH, 2003a. *Perchlorate Source Evaluation and Technical Report,* Santa Susana Field Laboratory, Ventura County, California. Volumes I, II, III. February.

MWH, 2003b. *Health and Safety Plan, RCRA Corrective Action Program Activities,* Santa Susana Field Laboratory, Ventura County, California, Revision 1, April 2003 Update.

MWH, 2003c. *Happy Valley Interim Measures Work Plan Addendum, Happy Valley and Building 359 Areas of Concern,* Santa Susana Field Laboratory, Ventura County, California. June.

MWH, 2003d. *Area I and Area II Landfill Investigation Work Plan, RCRA Facility Investigation Addendum Amendment,* Santa Susana Field Laboratory, Ventura County, California. June.

Ogden, 2000a. *RCRA Facility Investigation Work Plan Addendum Amendment*, Santa Susana Field Laboratory, Ventura County, California. June.

Ogden, 2000b. *Final RCRA Facility Investigation Work Plan Amendment Addendum*, Santa Susana Field Laboratory, Ventura County, California, Appendix A. October.

Ogden, 2000c. *Final RCRA Facility Investigation Shallow Zone Groundwater Investigation Work Plan*, Santa Susana Field Laboratory, Ventura County, California. December.

SAIC, 1994. *Final RCRA Facility Assessment Report for Rockwell International Corporation, Rocketdyne Division,* Santa Susana Field Laboratory, Ventura County, California. May.

USGS, 2002. *Application of Advanced Geophysical Logging Methods in the Characterization of a Fractured-Sedimentary Bedrock Aquifer, Ventura County, California.* WRIR 00-4083. March.

TABLE 1
SUMMARY OF SSFL PERCHLORATE ANALYSES
Santa Susana Field Laboratory
January through May 2003

Sampling Program and Sample Type	Location of Sampling Program	Number of Samples	Number of Detections
RFI Soil	Onsite	0	0
RFI Soil Leachate	Onsite	17	3
Total Soil		**17**	**3**
RFI Surface Water	Onsite	139	98
NPDES Surface Water	Onsite	37	4
Total Surface Water		**176**	**102**
RFI Spring and Seep	Offsite	1	0
Near-Surface Groundwater Wells	Onsite	61	17
Onsite Chatsworth Formation Wells	Onsite	56	3
Offsite Chatsworth Formation Wells	Offsite	27	0
Chatsworth Formation - FLUTe	Onsite	84	32
Groundwater Treatment System	Onsite	6	0
Total Groundwater		**235**	**52**
TOTAL SAMPLES		**428**	**157**
Total Onsite Samples		**400**	**157**
Total Offsite Samples		**28**	**0**

Onsite = Sampling program conducted within SSFL boundary.
Offsite = Sampling program conducted outside of SSFL boundary.

NPDES = National Pollutant Discharge Elimination System
FLUTe = Flexible Liner Underground Technology

TABLE 2
PERCHLORATE RESULTS FROM SURFACE WATER SAMPLES
Santa Susana Field Laborabory
January through May 2003

NPDES Outfalls 001 through 007, and Happy Valley (HV)

Date	Outfall								
	001	**002**	**003**	**004**	**005**	**006**	**007**	**HV-1**	**HV-2**
2/11/2003	--	--	--	--	< 4.0	--	--	--	--
2/12/2003	< 4.0	< 4.0	< 4.0	< 4.0	--	< 4.0	< 4.0	**4.7**	< 4.0
2/25/2003	--	--	--	--	--	--	--	**12**	< 4.0
2/27/2003	--	< 4.0	--	< 4.0	< 4.0	< 4.0	--	--	--
3/15/2003	--	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	**5.3**	< 4.0
3/16/2003	< 4.0	--	--	--	--	--	--	--	--
4/14/2003	--	< 4.0	--	< 4.0	< 4.0	< 4.0	--	--	--
5/3/2003	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	**4.6**

All data in micrograms per liter (ug/L)
-- Not sampled/analyzed

Bold indicates detected concen
NPDES: National Pollutant Discharge Elimination

Source: Published in Boeing NPDES monitoring reports.

TABLE 3
SUMMARY OF DTSC'S WORK PLAN REQUIREMENTS AND PROPOSED SCOPE OF WORK
Santa Susana Field Laboratory, Perchlorate Characterization Work Plan

DTSC'S REQUIREMENTS FOR WORK PLAN	OBJECTIVE OF PROPOSED SCOPE OF WORK	APPLICABLE EXISTING WORK PLANS	PROPOSED SCOPE OF WORK	RFI OPERABLE UNIT PROGRAM
1. Install additional groundwater monitoring wells, position to best intercept potential perchlorate or other contaminant migration pathways	Evaluate potential perchlorate impacts from surface water transport along Northern Drainage from Building 359 site and potential impacts from landfills	5, 6, 9, 12	1. Install four near-surface groundwater monitoring wells, one north of Area I landfill, three north of Area II landfill. 2. Complete hydrophysical logs and discrete sampling of WS-12, WS-13 and WS-14 and 3-D groundwater flow model prior to determining need and/or location of any additional Chatsworth Formation wells.	1. Surficial media 2. Chatsworth formation
2. Test the aquifer	Evaluate potential groundwater transport of perchlorate across the Shear Zone and other faults and fine-grained stratigraphic members	1, 7	1. Perform pumping test at C-1. 2. Perform pumping test at WS-14 as a contingency depending upon results of C-1 pumping test, hydrophysical logs and discrete sampling of WS-12, WS-13 and WS-14.	1. and 2.: Chatsworth formation
3. Evaluate water quality and assess data from existing wells to characterize contaminant movement	Confirm that perchlorate is absent in OS-9. Determine if perchlorate and other chemicals are present in water supply wells and evaluate vertical concentration profiles. Evaluate potential surface water transport of perchlorate along Northern Drainage	Appendix B of this Work Plan	1. Collect weekly water samples from OS-9 for two months, monthly for 10 months and quarterly thereafter. Analyze all samples for perchlorate. Analyze for general minerals and for 18O and 2H monthly for 1st year and quarterly thereafter. 2. Characterize vertical flow regimes in WS-12, WS-13 and WS-14 using borehole hydrophysics and sample discrete intervals based on results and analyze for perchlorate, general minerals, volatile organic compounds and other constituents as appropriate.	1. Surficial media 2. Chatsworth formation
4. Map geology and review aerial photographs, review all existing hydrology data	Determine nature of stratigraphy in Simi Conglomerate and its lateral extent and effects of stratigraphy on groundwater occurrence and flow. Evaluate hydrogeology along Northern Drainage. Assess nature of potential surface water flows.	7	1. Geology along Northern Drainage to be mapped in additional detail from northern SSFL property boundary. Includes inspection, analysis and interpretation of aerial photos and photo documentation of key geologic features. 2. All existing hydrogeologic data provided in 2000 technical memorandum to be reviewed and summarized. Additional hydrogeologic data collected as part of this work plan will also be incorporated. 3. Characterize surface water flows from Northern and Eastern Drainages.	1, and 2. Chatsworth formation 3. Surficial media
5. Assess available remediation technologies for interim measures to reduce or contain perchlorate	Identify and evaluate potential remedial technologies for perchlorate and other COCs in groundwater.	None.	1. Prepare and submit corrective measures study work plan consistent with 22 CCR 66264.101 and Attachment E of the Post-Closure Permit.	Surficial media and Chatsworth formation
6. Other characterization activities – Quarterly sampling of all off-site groundwater monitoring wells and springs currently in program for perchlorate and general minerals	Evaluate potential groundwater transport of perchlorate across the Shear Zone and other faults and fine-grained stratigraphic members. Evaluate potential surface water transport of perchlorate along Northern Drainage.	2, 3, 4, 8	1. Collect groundwater samples quarterly from WS-4A, WS-9B, RD-37, RD-45A, RD-45B, RD-45C, RD-51A, RD-51B, RD-51C, RD-52A, RD-52B, RD-52C, RD-70, and PZ-62 and four new wells to be installed at landfills. Analyze all samples for perchlorate and general minerals. Collect samples quarterly from all off-site wells currently in the site-side groundwater monitoring program and analyze for perchlorate and general minerals. 2. Collect samples from six springs and seeps along the Northern Drainage twice annually, once in the late spring and again in the early fall. Analyze samples for perchlorate, general minerals and 18O and 2H. If perchlorate is detected in spring/seep, collect samples of alluvium/colluvium and/or rock and submit for perchlorate analysis. Collect samples twice annually from all off-site springs/seeps currently in the site-side groundwater monitoring program and analyze for perchlorate and general minerals.	Surficial media and Chatsworth formation
7. Other characterization activities – Characterize soil and groundwater conditions in surface drainage beginning at SSFL and leading to Bathtub Well #1. Collect samples at minimum intervals of 1,000 feet at surface, alluvium/colluvium-bedrock interface and collect water samples if water encountered in boring.	Evaluate potential surface water transport of perchlorate along Northern Drainage	9, 10, 11	1. Collect sediment leachate samples from surficial and deeper sediments from more than 60 locations within the active channel of the Northern Drainage mostly using an enhanced field leaching procedure. Lateral spacing near RFI sites to range from 50 to 125 feet. Spacing to increase with distance from RFI sites. Spacing ranging from 250 to 500 feet to be used on SSFL property, and ranging from 500 to 1,000 feet off-site, with no distance exceeding 1,000 feet. Samples to be collected from all locations at 0-1/2" and at 6" above bedrock. Collect sample from 0.5-4" at ~10 percent of locations. Collect additional samples at locations where salt deposits are noted from channel and bank. At locations where sediment deposits are thick, collect overbank samples and samples at 6" intervals to bedrock. Collect sample of water if encountered in boring. 2. Collect one-time surface water samples from approximately 9 pools identified during inspections of the Northern Drainage. Analyze samples for perchlorate, general minerals and ^{18}O and ^{2}H. 3. Collect periodic surface water samples from one location within the Northern Drainage near the SSFL property boundary during the rainy season in accordance with the requirements specified by the RWQCB. Analyze samples for perchlorate.	1., 2., and 3.: Surficial media

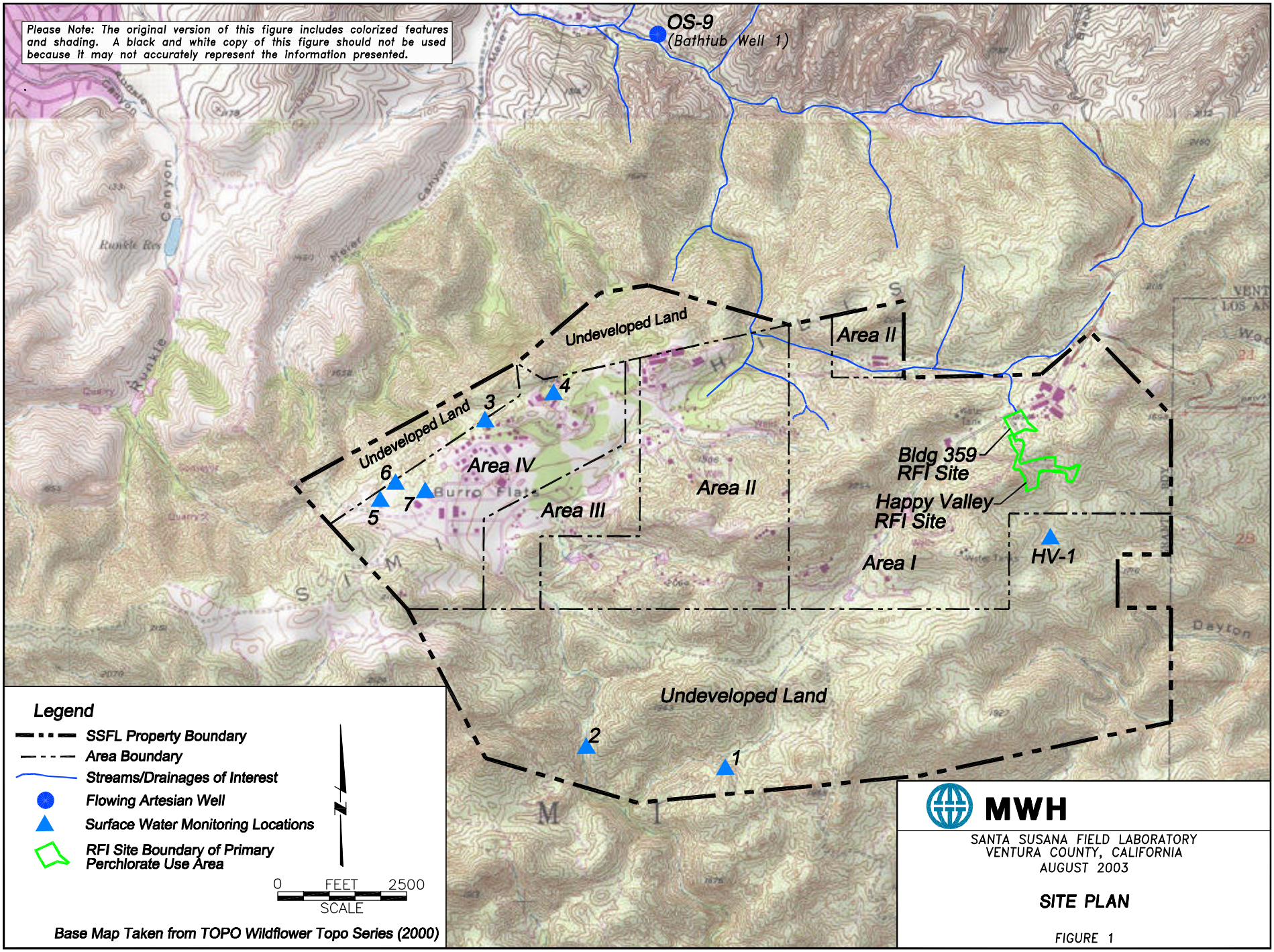
Notes:

TABLE 3
SUMMARY OF DTSC'S WORK PLAN REQUIREMENTS AND PROPOSED SCOPE OF WORK
Santa Susana Field Laboratory, Perchlorate Characterization Work Plan

Existing Work Plans.

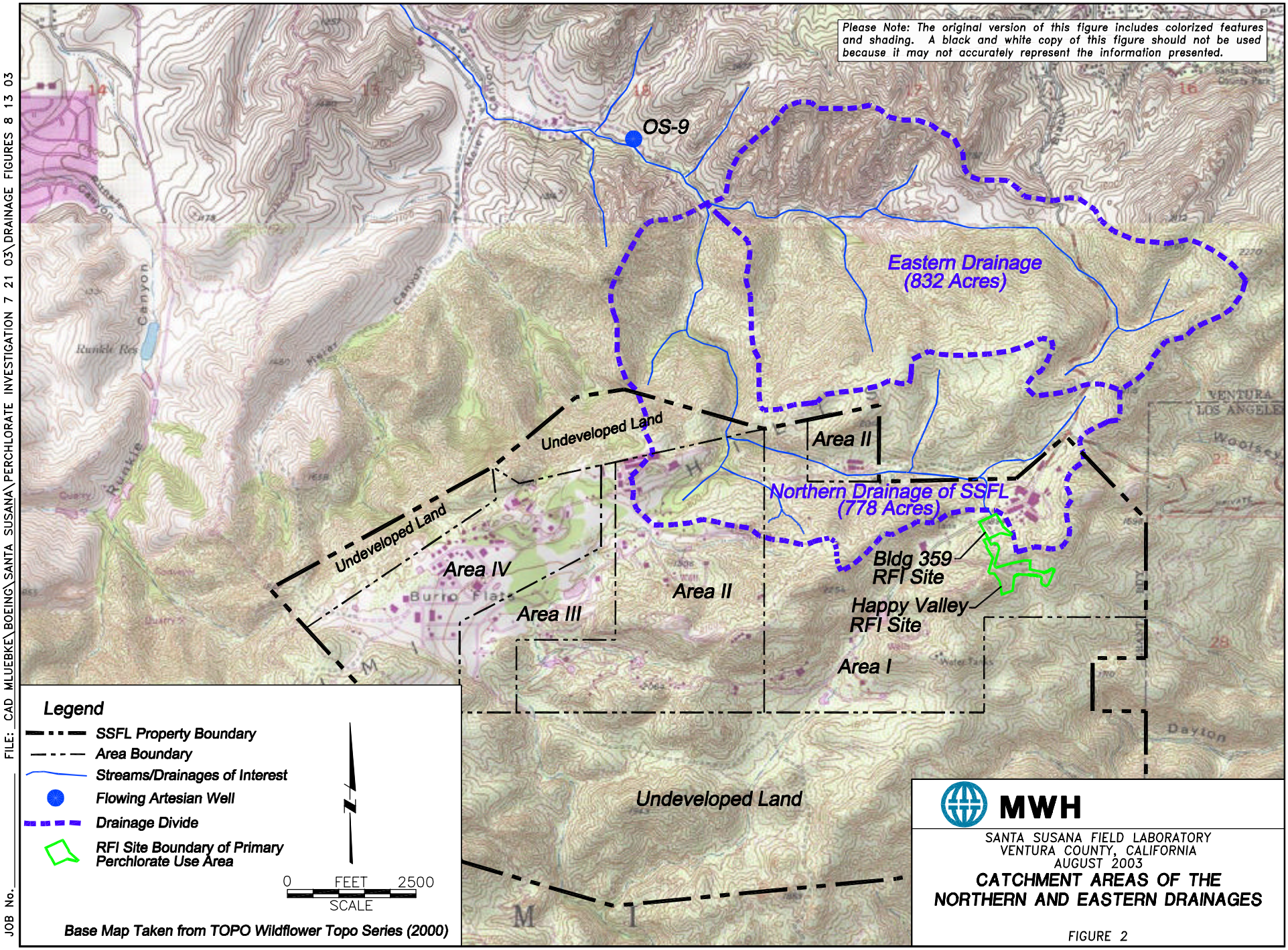
1. CFOU Work Plan Supplemental for Corehole C-1 Pumping Test, Santa Susana Field Laboratory, Ventura County, California. May 2003, The Boeing Company.
2. Site-Wide Sampling and Analysis Plan, Santa Susana Field Laboratory, Rockwell International Corporation, Rocketdyne Division. May 3, 1995, GRC
3. Sampling and Analysis Plan, Hazardous Waste Facility Post-Closure Permit PC-94/95-3-02, Area II, Santa Susana Field Laboratory, Rockwell International Corporation, Rocketdyne Division. June 5, 1995, GRC.
4. Sampling and Analysis Plan, Hazardous Waste Facility Post-Closure Permit PC-94/95-3-03, Areas I and III, Santa Susana Field Laboratory, Rockwell International Corporation, Rocketdyne Division. June 5, 1995, GRC.
5. Proposed Designs for Drilling, Construction and Testing of Additional Monitor Wells at the Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California. June 28, 1995, GRC.
6. Modifications to Monitor Well Drilling and Construction Plan Titled: Proposed Designs for the Drilling, Construction and Testing of Additional Monitor Wells at the Santa Susana Field Laboratory. November 6, 1996, GRC.
7. Work Plan for Additional Field Investigations, Chatsworth Formation Operable Unit. Revision 1. October 2000, Montgomery Watson.
8. Spring and Seep Sampling Work Plan. Santa Susana Field Laboratory, Ventura County, California. March 2002, MWH.
9. RCRA Facility Investigation, Work Plan Addendum Amendment, Area 1 and Area II Landfills Investigation Work Plan, SWMU 4.2 and SWMU 51., Santa Susana Field Laboratory, Ventura County, California. June 2003, MWH.
10. RCRA Facility Investigation Work Plan Addendum Amendment, Santa Susana Field Laboratory, Ventura County, California. June 2000, Ogden.
11. Final RCRA Facility Investigation Work Plan Amendment Addendum, Santa Susana Field Laboratory, Ventura County, California, Appendix A. October 2000, Ogden
12. Final RCRA Facility Investigation Shallow Zone Groundwater Investigation Work Plan, Santa Susana Field Laboratory, Ventura County, California. December 2000, Ogden.

CCR	California Code of Regulations
^{2}H	deuterium
^{18}O	oxygen-18
RFI	Resource Conservation and Recovery Act (RCRA) Facility Investigation
RWQCB	Regional Water Quality Control Board
SSFL	Santa Susana Field Laboratory



FILE: CAD MLUEBKE\BOEING\SANTA SUSANA\PERCHLORATE INVESTIGATION 7 21 03\DRAINAGE FIGURES 8 13 03

JOB No.



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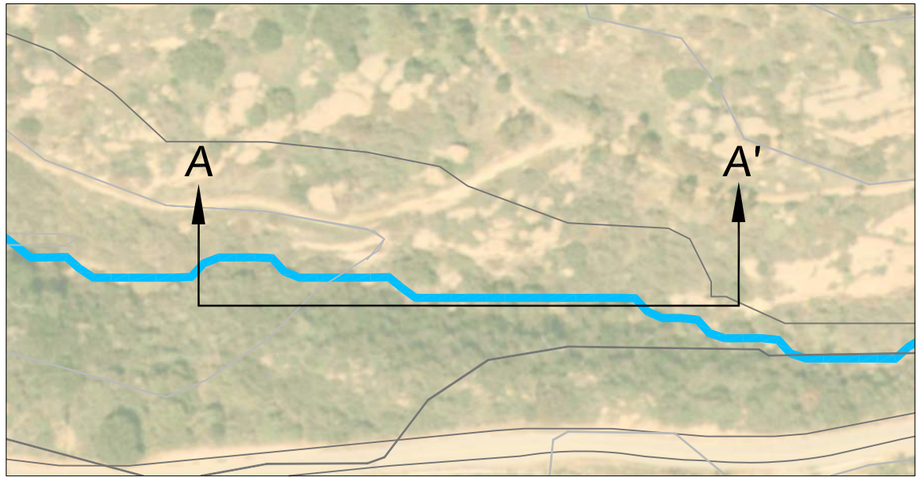
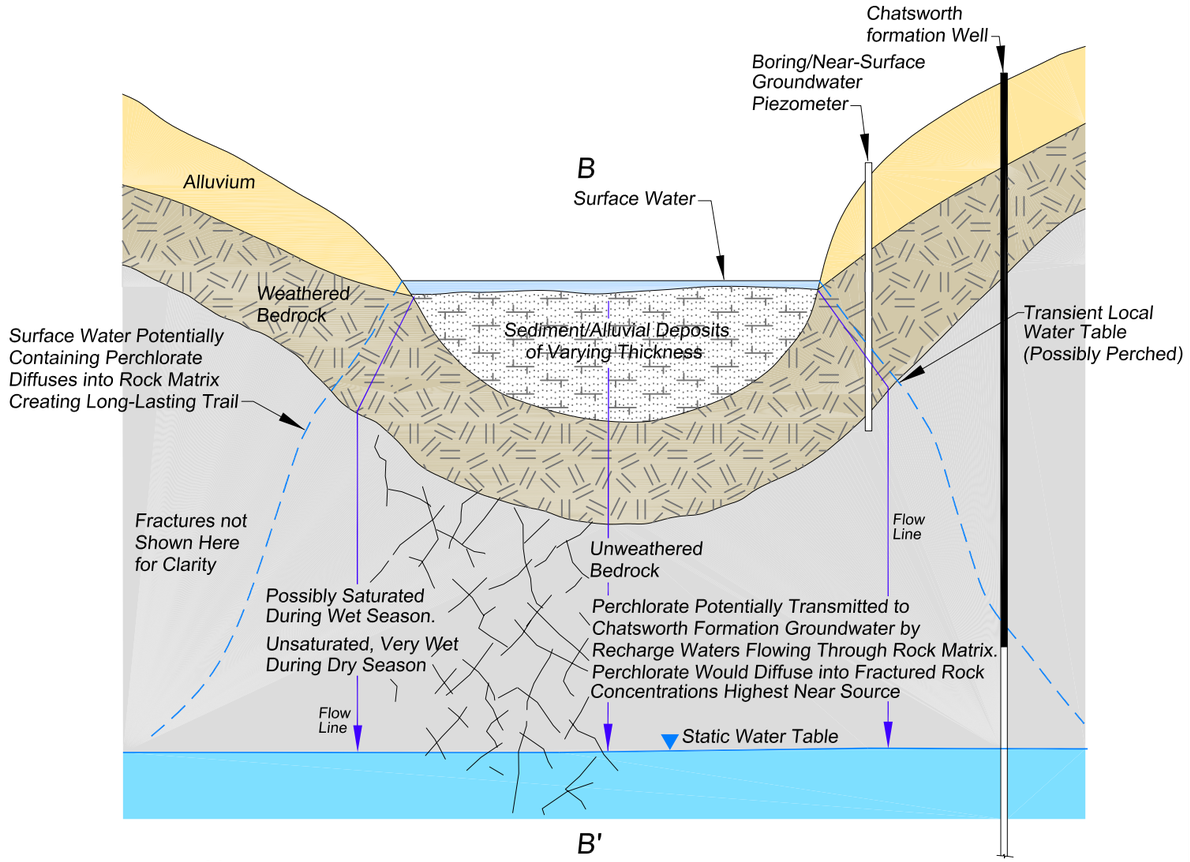
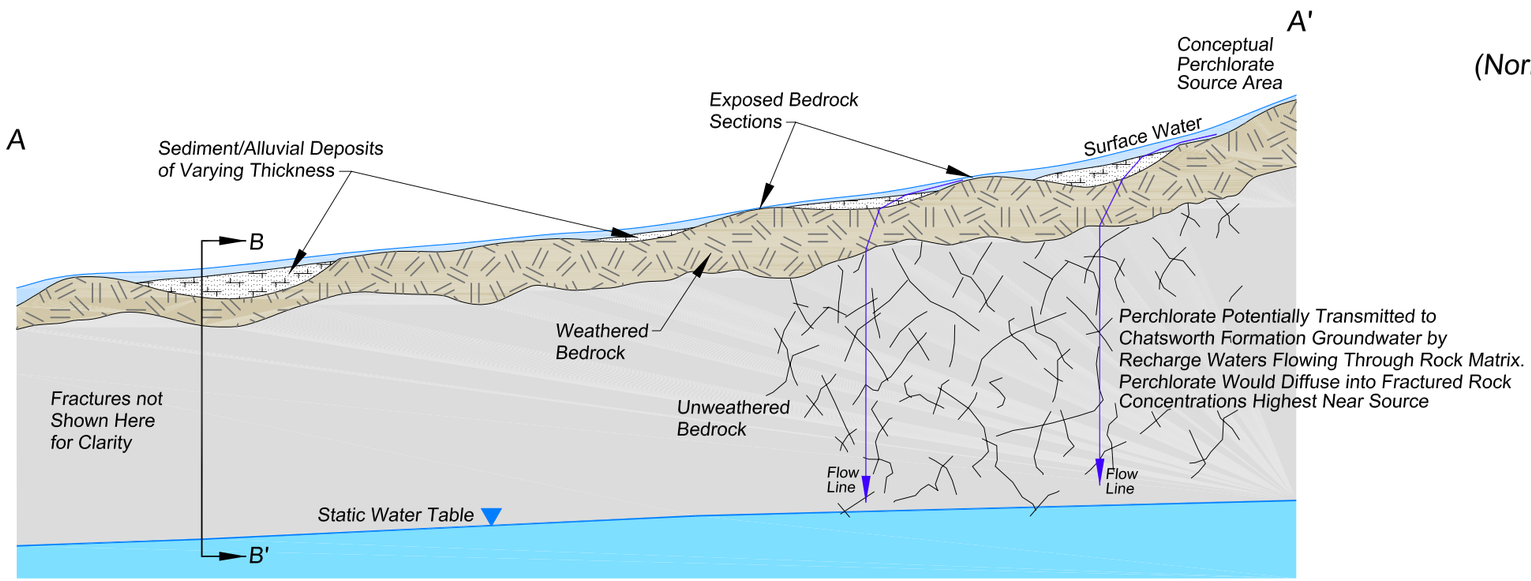


Conceptual Plan View



Section B-B'
(Normal to Drainage, Not to Scale)



Section A-A'
(Longitudinal Section, Not to Scale)

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

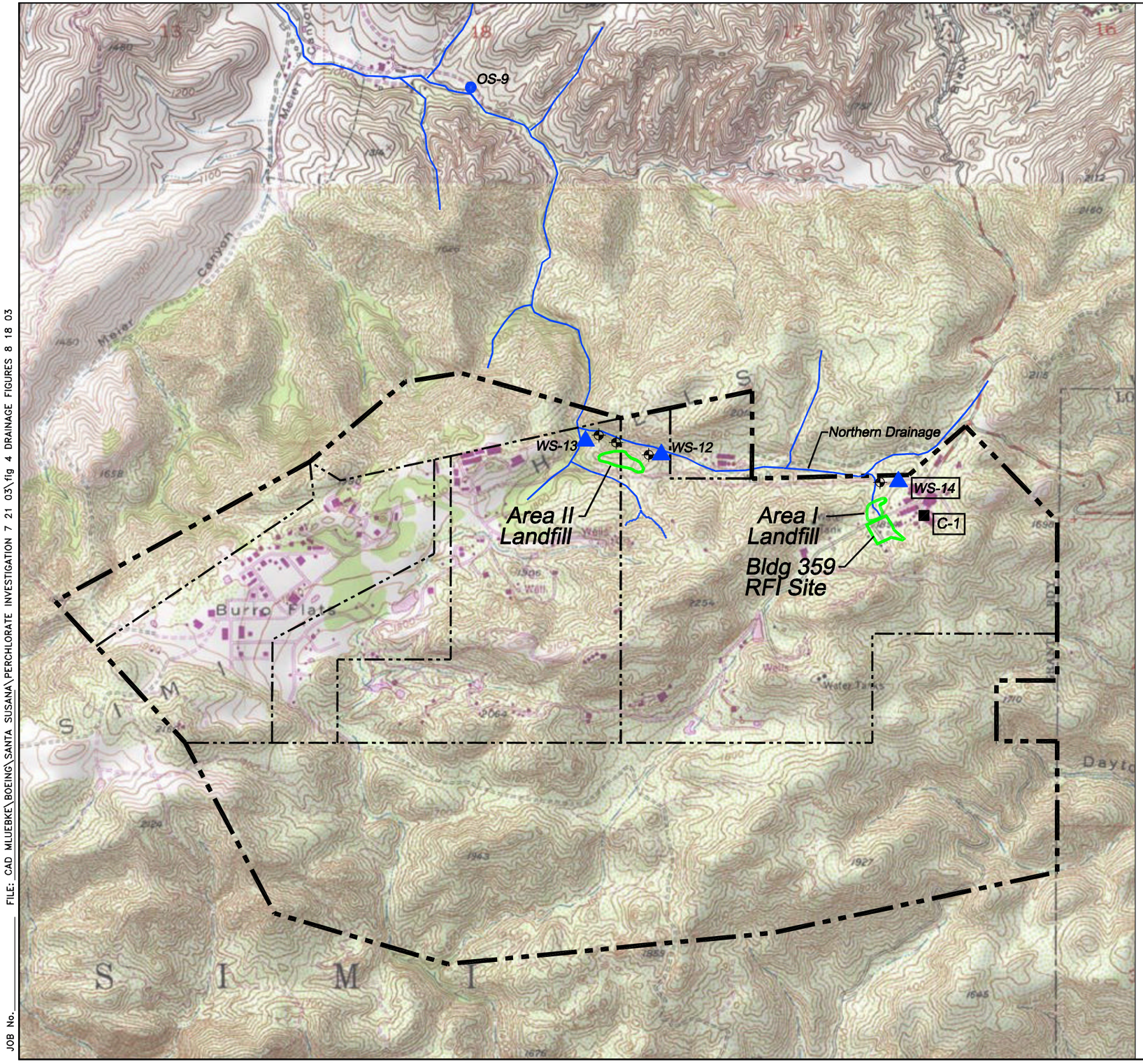
MWH

SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
AUGUST 2003

CONCEPTUAL DIAGRAM OF POTENTIAL PERCHLORATE TRANSPORT AT THE NORTHERN DRAINAGE

FIGURE 3

JOB No. -- FILE No. INDSVR\INDUSTRIAL\CAD MLUEBKE\BOEING\SANTA SUSANA\BRANDEIS\OS-9\NORTH DRAINAGE CSM 8 03



Perchlorate Characterization Work Plan Summary

- *Sample Northern Drainage Sediments from 60 Locations & Analyze for Perchlorate*
- *Sample Surface Water Periodically at 1 On-site Location on Northern Drainage as Required by RWQCB. Analyze for Perchlorate. Collect One-time Samples Along Northern Drainage Analyze for Perchlorate, General Minerals and ^{18}O & ^{2}H*
- *Sample Springs/Seeps Twice Annually. Six Locations Along Northern Drainage, and Other Current Off-Site Locations. Analyze for Perchlorate, General Minerals, ^{18}O & ^{2}H*
- *Sample OS-9 Weekly for 2 Months, Monthly for 10 Months and Quarterly Thereafter. Analyze All Samples for Perchlorate, Monthly and Quarterly Samples for General Minerals, ^{18}O & ^{2}H*
- *Sample 5 Near-Surface, 11 Chatsworth, & 2 Water Supply Wells & Current Off-Site Locations Quarterly. Analyze for Perchlorate & General Minerals*
- *Hydrophysically Log & Sample 3 Water Supply Wells. Analyze for Perchlorate & VOCs*
- *Install 4 Near-Surface Groundwater Monitoring Wells*
- *Perform Pumping Test at C-1 and Possibly WS-14*
- *Characterize Geology, Hydrogeology & Hydrology*
- *Submit Corrective Measures Study Workplan*

Legend

- *SSFL Property Boundary*
- *Area Boundary*
- *Streams/Drainages of Interest*
- *Flowing Artesian Well*
- *Water Supply Well to be Hydrophysically Logged*
- *Proposed Near-Surface Groundwater Monitoring Wells*
- *Corehole Location*
- *C-1 Proposed Pumping Test location*
- *RFI Site Boundary of Interest*

0 FEET 1800
SCALE

Base Map Taken from TOPO Wildflower Topo Series (2000)

MWH

SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA
AUGUST 2003

SUMMARY OF PROPOSED SCOPE OF WORK

FIGURE 4

Department of Toxic Substances Control

Winston H. Hickox
Agency Secretary
California Environmental
Protection Agency

Edwin F. Lowry, Director
8800 Cal Center Drive
Sacramento, California 95826-3200

Gray Davis
Governor

June 23, 2003

Mr. Steve Lafflam
The Boeing Company
Rocketdyne Propulsion & Power
6633 Canoga Avenue
Post Office Box 7922
Canoga Park, California 91309-7922

SUBMITTAL OF WORKPLAN TO CHARACTERIZE POTENTIAL MIGRATION OF PERCHLORATE CONTAMINATION TO OFFSITE AREAS, SANTA SUSANA FIELD LABORATORY, VENTURA COUNTY, CALIFORNIA

Dear Mr. Lafflam:

The purpose of this letter is to require submittal of a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Workplan (Workplan) pursuant to the November 12, 1992 Stipulated Enforcement Order (Health and Safety Code section 25187). The Workplan shall describe measures to be taken to investigate the potential migration of perchlorate contamination from the Santa Susana Field Laboratory (SSFL) to offsite areas, such as Brandeis-Bardin Institute property.

Perchlorate has been detected in Bathtub Well 1 at the Brandeis-Bardin Institute property. Bathtub Well 1, located approximately 4,700 feet north of the SSFL, consists of a pipe with flowing water at a livestock-drinking trough. The pipe is fed by a flowing artesian well adjacent to the trough. On May 28, 2003, the Department of Toxic Substances Control (DTSC) was first made aware of the presence of perchlorate at Bathtub Well 1, at a concentration of 82 micrograms per liter (µg/L), in a water sample collected by Ventura County on February 21, 2003. On May 30, 2003, DTSC staff collected two samples from Bathtub Well 1 (one duplicate for Quality Assurance/Quality Control). Laboratory analyses of the samples reported 140 and 150 µg/L. Prior to the sampling events in February by Ventura County and in May by DTSC, a sample collected from the same well by DTSC staff on March 20, 2002 did not contain detectable concentrations of perchlorate

(less than 3 ug/L). DTSC collected additional samples from four wells on the Brandels-Bardin property on June 11, 2003; the results for Bathtub Well 1 show perchlorate at 39 and 36 µg/L. Results from the other three wells (Bathtub Well 2, OS-1, and OS-2) sampled June 11, 2003, were less than 3 ug/L.

Previous Perchlorate Investigations - Simi Valley

Perchlorate was detected in the shallow groundwater at Simi Valley in 1999. At that time, DTSC initiated an extensive effort to collect and analyze a large volume of offsite samples to determine if the perchlorate detections in Simi Valley were associated with the known perchlorate impacts at the site. The actions taken by DTSC included: collecting spring/seep samples from known locations around the site; collecting split groundwater samples from SSFL onsite and offsite wells; coordinating with the Regional Water Quality Control Board – Los Angeles Region (RWQCB-LAR) in collecting and analyzing groundwater samples from existing gasoline service station wells in Simi Valley for perchlorate; collecting soil samples from the surface water drainages; and collecting surface water runoff samples. To date, DTSC and RWQCB-LAR have collected over 210 samples as part of this effort. Based on this extensive offsite sampling effort along with the additional historical onsite perchlorate data, DTSC could not clearly establish a link between the onsite releases and the perchlorate detections in Simi Valley. It should be noted, the "hits" of perchlorate in Simi Valley are located approximately 3 to 5 miles from the northernmost SSFL facility boundary.

Additional Perchlorate Investigations –Onsite/Offsite

The recent confirmed detection of perchlorate in Bathtub Well 1 suggests that the perchlorate contamination from SSFL may have migrated offsite to the Brandels-Bardin property based on the following rationale:

1. Perchlorate has been detected onsite at SSFL with the highest reported concentration found in groundwater at Happy Valley Area at a concentration of 1,600 ug/L. Happy Valley is located approximately two miles from the Bathtub Well 1 location.

2. Bathtub Well 1 is within 1 mile geologically down-dip and topographically down slope of the facility.

3. The area between SSFL and Bathtub Well 1 is relatively pristine land with minimal anthropogenic impacts; therefore, the presence of other or contributing sources of perchlorate, beyond those identified at SSFL is unlikely.

4. The well feeding Bathtub Well 1 is under artesian conditions. The recharge zone for groundwater at this well would therefore be located further up-slope closer to SSFL.

A connection between the perchlorate releases at SSFL and the detections in Simi Valley still remains indeterminate, even with the new data. However, based on the perchlorate detections at Bathtub Well 1 and the rationale provided above, DTSC hereby requires The Boeing Company (Boeing) to submit the Workplan to investigate the potential of offsite migration of perchlorate contamination from the facility. The Workplan should also address additional onsite investigation of groundwater and must address all potential surface water and groundwater pathways originating from SSFL.

At a minimum, the scope of work should include:

- Additional DTSC-approved groundwater monitoring wells positioned and constructed in a manner to best intercept potential perchlorate or other contaminant migration pathway(s). Since contaminant migration may have occurred at the site via both surface and groundwater pathways (or a combination of both). The additional investigation should not be based on the premise that contaminant migration would be prevented by geologic features such as faults and finer-grained stratigraphic units. However, the effects of faults and finer-grained units, specifically the Shear Zone and North Fault, should be evaluated through the installation of additional groundwater monitoring wells, aquifer testing, and the evaluation of water quality data to assess the nature of any effects on contaminant migration. Due to the complexities and inherent uncertainties associated with the groundwater flow at the site, several groundwater monitoring wells may be required. Wells may need to be installed in an iterative process. Data from the existing groundwater monitoring wells should be assessed in the areas between the known sources and Bathtub Well 1 to determine their value in characterizing the movement of contaminants. These wells may be altered or retrofitted as appropriate to provide more useful information. Multiple depth wells will be necessary to assess the effects of vertical gradients on the migration of perchlorate.

- Characterization of the hydrogeologic conditions present between known source areas at SSFL to the area of Bathtub well 1. In addition to installing new wells and retrofitting existing wells as discussed above, activities should include detailed geologic mapping, aerial photograph review, and the review of all existing hydrology data.

- Assessment of available remediation technologies, to be used as Interim Measures, to reduce and/or contain perchlorate contamination with the objective of controlling further migration of perchlorate from identified source areas. Enhancement of the existing groundwater treatment system should also be evaluated.

- Quarterly sampling of all offsite groundwater monitoring wells, seeps, and springs currently in the Boeing groundwater monitoring program for perchlorate and general chemistry parameters. Characterization of the soil and groundwater conditions in the surface drainage beginning at SSFL and leading to Bathtub Well 1 must be included. Characterization activities must include, but not be limited to, collecting soil samples in the natural drainages leading to the area of Bathtub Well 1, at a minimum of 1,000-feet intervals, at the surface and at the alluvium/colluvium and bedrock interface. If encountered, water samples must be collected from the soil borings. All samples shall be analyzed for perchlorate.

The Workplan shall be submitted to DTSC by August 18, 2003 for review, comment and subsequent approval. Upon completion of the Workplan activities, a report summarizing all soil, surface water, and/or groundwater sampling data collected during the investigation resulting from implementation of the Workplan and any prior soil and groundwater investigations shall also be submitted to DTSC. The report shall include the conclusions from this investigation, recommendations for additional investigations as necessary, and plans for actions to be taken for site remediation and/or source control as needed. These actions should be in addition to those outlined in the Happy Valley Interim Measures (HVIM) Workplan Addendum dated June 16, 2003, submitted pursuant to DTSC's May 21, 2003 letter. DTSC is currently reviewing the HVIM workplan and will be forwarding comments, which may include additional HVIM activities to those proposed by Boeing in the Workplan.

If you have any questions, please do not hesitate to contact me at (916) 255-3574.

Sincerely,

James M. Pappas

James M. Pappas, P.E., Chief
Northern California Permits and Corrective Action Branch

cc: Mr. Dave Bacharowski
California Regional Water
Quality Control Board
Los Angeles Region
320 W. 4th Street, Suite 200
Los Angeles, CA 90013

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Brandeis-Bardin Institute
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Mr. Watson Gin, P.E.
Deputy Director
Hazardous Waste Management Program
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Mr. Stephen Baxter, P.E.
Senior Hazardous Substances Engineer
Southern California Permits and
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Mr. Steve Cain
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Ms. Laura Magelnicki
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Simi Valley, CA 93063-2199

The Boeing Company
6633 Canoga Avenue
P.O. Box 7922
Canoga Park, CA 91309-7922

Faxed July 16, 2003

July 16, 2003
In reply refer to 2003RC02569

BOEING

James M. Pappas, P.E., Chief
Northern California Permits and Corrective Action Branch
California Environmental Protection Agency
Department of Toxic Substances Control
8800 Cal Center Drive
Sacramento, CA 91309-7922

Subject: Off-site Perchlorate Sampling at Brandeis-Bardin Institute
Santa Susana Field Laboratory
Ventura County, California

RE: Well OS-09

Dear Mr. Pappas:

The Boeing Company, Rocketdyne (Rocketdyne) hereby submits the proposed activities and methodologies for the sampling and analysis of perchlorate in groundwater from a well off-site of the Boeing Santa Susana Field Laboratory (SSFL). The period of work will be July and August 2003. The site to be sampled is well OS-9 on Brandeis-Bardin Institute (BBI) property in Ventura, California. BBI is located north and northwest of SSFL.

The water quality samples will be collected on a weekly basis through August 2003 by Haley & Aldrich, Inc.

Water samples will be submitted each week for the analysis of perchlorate using EPA method 314. Water samples will also be submitted weekly for the analysis of general mineral constituents. General mineral constituents will include major anions (carbonate, bicarbonate, chloride, and sulfate), major cations (calcium, magnesium, sodium, and potassium), nitrate, electrical conductivity, total dissolved solids, and pH. Twice during the project period, water samples will be submitted for analysis of deuterium and oxygen-18.

Water samples collected for perchlorate and general mineral constituents will be submitted to:

Del Mar Analytical
2852 Alton Avenue
Irvine, CA 92606

BOEING

Each water sample collected for analysis of perchlorate will also be submitted (split) to:

Ceimic Corporation
10 Dean Knauss Drive
Narragansett, RI 02882

Samples collected for deuterium and oxygen-18 will be submitted to the **University of Ottawa** for analysis:

G. G. Hatch Isotope Laboratories
University of Ottawa (Earth Sciences)
140 Louis Pasteur
Ottawa, Ontario Canada K1N 6N5

LOCATION IDENTIFIER	SOURCE TYPE	ANALYSIS FREQUENCY			
		Deuterium & Oxygen-18 (U of Ottawa)	**Perchlorate** (Del Mar & Ceimic)	**General Minerals** (Del Mar)	**Flow Rate, Field Parameters**
OS-9	Groundwater	Twice	Weekly	Weekly	Weekly

During sample collection, a second duplicate set of water samples for analysis of perchlorate will be collected for submittal to Del Mar and Ceimic. The laboratories will be instructed to "hold" these samples pending instruction based on the results of analysis of the initial samples. A blind duplicate set of water samples for analysis of perchlorate will also be collected for submittal to both Del Mar and Ceimic. In the event perchlorate is detected in an initial sample or blind duplicate, both laboratories will be instructed to analyze the duplicate "held" samples. All analyses will be conducted pursuant to EPA protocols (Test Methods for Evaluating Solid Waste (SW-846).

A blind field blank will be prepared and submitted to Del Mar and Ceimic during sample collection. The field blank sample will consist of de-ionized water provided by Del Mar Analytical and will be prepared by the sampling crew under normal sampling conditions at the same time the regular water quality samples are collected. QA/QC procedures as described in SW-846 will be implemented.

Both Del Mar Analytical and Ceimic will be requested to conduct a "matrix specific method detection limit study" using groundwater from well OS-9. The matrix specific method detection limit studies will be conducted following the procedures identified in Code of Federal Regulations, 40 CFR, Appendix B, Part 136 -- Definition and Procedure for the Determination of the Method Detection Limit -- Revision 1.11. It will consist of analyzing seven (7) representative samples of the groundwater from well OS-9 with perchlorate spiked at the concentration equivalent to the lowest calibration standard used in the quantification of the results.

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Perchlorate blind-spike samples will be submitted to each laboratory once during the project period. The samples will consist of both de-ionized water samples and groundwater samples from well OS-9 spiked with perchlorate at a concentration of 5 micrograms per liter. The spikes will be prepared by Environmental Resource Associates (ERA) of Arvada, Colorado. ERA's DI water has been analytically verified to be free of perchlorate at a detection limit of 0.5 µg/L by an independent laboratory. ERA will combine the groundwater from well OS-9 into a pre-rinsed poly carboy. A perchlorate spiking concentrate (1.00 mg/L) has been prepared and analytically verified by ERA. This concentrate will be used to spike the project samples at a concentration of 5 micrograms per liter. Class A volumetric glassware and NIST traceable calibrated balances will be used in the manufacture of these samples. Samples will be packaged by ERA in pre-rinsed bottles which will be the same as those used for the groundwater samples.

All activities will be conducted pursuant to current, approved sampling and analysis plans prepared by Groundwater Resources Consultants, Inc. for monitoring activities at SSFL: *"Sampling and Analysis Plan, Hazardous Waste Facility Post-Closure Permit PC-94/95-3-02, Area II, Santa Susana Field Laboratory, Rockwell International Corporation, Rocketdyne Division"* and *"Sampling and Analysis Plan, Hazardous Waste Facility Post-Closure Permit PC-94/95-3-03, Areas I and III, Santa Susana Field Laboratory, Rockwell International Corporation, Rocketdyne Division,"* both dated June 5, 1995.

Data will be provided to your office as validated results are made available to Boeing. Following the completion of the two month sampling program, a summary report will be presented to DTSC including all analytical results.

The California Department of Toxic Substances Control (DTSC) will be notified of the schedule for sampling to allow for a representative to be present to collect samples for independent analysis during the sampling period.

If you have any questions, please call me at (818) 586-5695.

Sincerely,

BOEING

Art Lenox
Environmental Remediation

AJL:DHC:bjc

cc: Gerard Abrams, DTSC, Sacramento
PaulineBatarseh, DTSC, Sacramento
Barbara Coler, DTSC, Sacramento
Dave Bacharowski, CRWQCB, LA
Karen Baker, DTSC, Cypress
John Varble, Brandeis Bardin Institute

(SHEA-097857)

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HALEY & ALDRICH

15 August 2003
File No. 26473M-435

The Boeing Company
Rocketdyne Propulsion & Power
6633 Canoga Avenue D/393 T/487
P.O. Box 7930
Canoga Park, California 91303

Attention: Art Lenox

Subject: Well OS-09 (Bathtub Well No. 1) Sampling Summary
Ventura County, California

Dear Mr. Lenox:

OFFICES

Boston
Massachusetts

Cleveland
Ohio

Dayton
Ohio

Detroit
Michigan

Hartford
Connecticut

Kansas City
Kansas

Los Angeles
California

Manchester
New Hampshire

Newark
New Jersey

Portland
Maine

Rochester
New York

San Diego
California

Santa Barbara
California

Washington
District of Columbia

This document summarizes the results of groundwater sampling and analysis activities conducted for The Boeing Company, Rocketdyne (Rocketdyne) at well OS-09 during the period July 2 through August 12, 2003.

Well OS-09 is located off-site of the Boeing Santa Susana Field Laboratory (SSFL) on Brandeis-Bardin Institute (BBI) property in Ventura County, California. BBI is located north and northwest of SSFL. Well OS-09 has also been referred to as Brandeis-Bardine Institute "bathtub well no. 1".

Well OS-09 is a flowing, artesian well and was producing approximately 0.3 liters per minute continuously during the sampling period.

WELL OS-09 SAMPLING ACTIVITIES

Haley & Aldrich, Inc. conducted weekly sampling and analysis of groundwater from well OS-09 beginning July 2, 2003. Sample collection was performed on July 2, July 10, July 17, July 24, July 31, August 7, and August 12. During the July 24 and 31, and August 12 sampling events, sampling was also conducted by Mr. Peter Bailey of the California Department of Toxic Substances Control.

Water samples were submitted each week for the analysis of perchlorate using EPA method 314.0 *Determination of Perchlorate in Drinking Water Using Ion Chromatography* (Table I). Water samples were also submitted weekly for the analysis of general mineral constituents. General mineral constituents include major anions (carbonate, bicarbonate, chloride, and

sulfate), major cations (calcium, magnesium, sodium, and potassium), nitrate, electrical conductivity, total dissolved solids, and pH (Table II). Twice during the project period (on July 2 and 17, 2003), water samples were submitted for analysis of deuterium and oxygen-18.

Weekly water samples collected for perchlorate and general mineral constituents were submitted to:

Del Mar Analytical
2852 Alton Avenue
Irvine, CA 92606, and

Water samples for analysis of perchlorate were also submitted to:

Ceimic Corporation
10 Dean Knauss Drive
Narragansett, RI 02882

A third sample set was collected on July 31 and submitted for analysis of perchlorate to:

American Analytics
9765 Eton Avenue
Chatsworth, CA 91311

Samples collected for deuterium and oxygen-18 were submitted to the **University of Ottawa** for analysis:

G. G. Hatch Isotope Laboratories
University of Ottawa (Earth Sciences)
140 Louis Pasteur
Ottawa, Ontario Canada K1N 6N5

Quality Control/Quality Assurance Samples

Control samples consisting of duplicates, blanks, and spikes were submitted for analyses with the primary groundwater samples from well OS-09 beginning with the samples collected July 10.

A duplicate water sample for analysis of perchlorate was collected and submitted to each laboratory.

A second duplicate water sample for analysis of perchlorate was also collected and submitted to each lab. The laboratories were instructed to “hold” these samples pending instruction based

on the results of analysis of the initial samples. In the event perchlorate was detected in an initial sample or blind duplicate, both laboratories would have been instructed to analyze the duplicate "held" samples.

A field blank was prepared during sample collection and submitted to each laboratory conducting perchlorate analyses. The field blank samples consisted of de-ionized water provided by Del Mar Analytical. Field blanks were prepared by the sampling crew under normal sampling conditions at the same time the regular perchlorate samples are collected from well OS-09.

A. Perchlorate Matrix Spike Samples

Perchlorate spike samples were submitted to Del Mar Analytical and Ceimic Corporation on July 17. The spike samples consisted of both de-ionized water samples and groundwater samples from well OS-09 spiked with perchlorate at a concentration of 5.0 micrograms per liter (µg/l). The spikes were prepared by Environmental Resource Associates (ERA) of Arvada, Colorado using de-ionized water and groundwater collected from well OS-09 on July 10.

A second set of perchlorate spike samples were submitted to Del Mar Analytical and Ceimic Corporation on August 12. Again the spike samples consisted of both de-ionized water samples and OS-09 groundwater samples. The August 12 matrix spikes were prepared in the field, by a Del Mar chemist, at the well OS-09 location. The matrix spikes were prepared using well OS-09 groundwater immediately after it was collected. The reagent de-ionized water spikes were prepared at the Del Mar Analytical laboratory. The August 12 spikes were prepared at three concentrations (5.0 µg/l, 50 µg/l, and 150 µg/l). Reagent de-ionized water blanks were also prepared by Del Mar Analytical.

B. Matrix Specific Method Detection Limit Study

Del Mar Analytical and Ceimic Corporation conducted "matrix specific method detection limit studies" using groundwater collected from well OS-09 on July 2, 2003. The matrix specific method detection limit studies were conducted following the procedures identified in: *Code of Federal Regulations, 40 CFR, Appendix B, Part 136 -- Definition and Procedure for the Determination of the Method Detection Limit -- Revision 1.11*.

The studies consisted of analyzing seven (7) representative samples of the groundwater from well OS-09 collected on July 10 with perchlorate spiked at the concentration equivalent to the lowest calibration standard used in the quantification of the results.

WELL OS-09 SAMPLING RESULTS

Groundwater samples collected from well OS-09 were analyzed for the determination of perchlorate, general mineral constituents, and deuterium and oxygen-18.

Perchlorate

Laboratory reports indicated that perchlorate was less than the detection limit in all primary groundwater samples and duplicate groundwater samples collected from well OS-09 by Haley & Aldrich. Perchlorate was also reported less than the detection limit in all field blanks prepared by Haley & Aldrich at well OS-09 (Table I). The detection limits were 0.8 micrograms per liter (µg/l) for the samples analyzed by Del Mar Analytical, 0.35 µg/l for samples analyzed by Ceimic Corporation, and 2 µg/l for the samples analyzed by American Analytics.

The second duplicate water samples submitted to the laboratories with instructions to hold pending notification were not analyzed. These samples were not analyzed because the primary and duplicate sample perchlorate concentrations were all reported to be less than the detection limit.

A. Perchlorate Matrix Spikes

1. July 17 Samples

The reported perchlorate concentration in the 5.0 µg/l groundwater matrix and reagent de-ionized water spike samples submitted with the July 17 groundwater samples ranged from 4.3 to 5.2 micrograms per liter (Table I). Perchlorate was less than the detection limit in all reagent de-ionized water blanks analyzed. The detection limits were 0.8 µg/l for Del Mar Analytical, and 0.35 µg/l for Ceimic Corporation.

2. August 12 Samples

The reported perchlorate concentration in the 5.0 µg/l field groundwater matrix and reagent de-ionized water spike samples submitted with the August 12 groundwater samples ranged from 4.2 to 4.6 µg/l (Table I).

The reported perchlorate concentration in the 50 µg/l field groundwater matrix and reagent de-ionized water spike samples submitted with the August 12 groundwater samples ranged from 49 to 49.9 µg/l.

The reported perchlorate concentration in the 150 µg/l field groundwater matrix and reagent de-ionized water spike samples submitted with the August 12 groundwater samples ranged

from 140 to 150 µg/l.

Perchlorate was less than the detection limit in all reagent de-ionized water blanks analyzed. The detection limits were 0.8 µg/l for Del Mar Analytical, and 0.35 µg/l for Ceimic Corporation.

B. Matrix Specific Method Detection Limit Studies

The well OS-09 groundwater, matrix specific method detection limit study performed by Del Mar Analytical supported the laboratory's method detection limit of 0.8 µg/l.

The matrix specific method detection limit study performed by Ceimic Corporation supported their method detection limit of 0.35 µg/l.

The laboratories did not report any significant matrix interferences for perchlorate analysis of well OS-09 groundwater.

General Mineral Constituents

Results of analyses by Del Mar Analytical for general mineral constituents in groundwater samples collected from well OS-09 indicate the groundwater is sodium-bicarbonate type water (Table II). Sodium is the predominant cation in solution and bicarbonate is the predominant anion. Total dissolved solids content of the groundwater ranged from 570 to 640 milligrams per liter and the pH ranged from 8.26 to 8.64.

Deuterium and Oxygen-18

Results of analyses by G. G. Hatch Isotope Laboratories for the groundwater samples collected from well OS-09 on July 2 indicated deuterium and oxygen-18 del values relative to standard mean ocean water were -49.9 and -9.7 permil, respectively.

Results of analyses for the groundwater samples collected July 17 indicate del values were -51.1 and -9.41 permil for deuterium and oxygen-18, respectively.

The OS-09 groundwater ratio of the del values for deuterium to oxygen-18 was greater than that of the global meteoric water line, and differed from measurements of other samples collected at SSFL including Chatsworth formation groundwater, rainfall, and Calleguas water. This suggests a different source for OS-09 water.

Copies of all laboratory reports for the analyses of groundwater and control samples associated with the well OS-09 sampling will be provided in a subsequent report following the completion of this program.

We appreciate the opportunity to provide environmental consulting services on this project.

Sincerely yours,
HALEY & ALDRICH, INC.

Kurt J. Blust, R.G.
Sr. Hydrogeologist

Sheldon Clark
Vice President

Enclosures:
Table I: Summary of Preliminary Results for Perchlorate in Groundwater
Table II: Summary of Analyses for Inorganic Constituents in Groundwater

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TABLE I

SUMMARY OF PRELIMINARY RESULTS FOR PERCHLORATE IN GROUNDWATER FROM WELL OS-09
BOEING SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

SAMPLE IDENTIFIER	DATE	SAMPLE TYPE	LABORATORY	PERCHLORATE, micrograms per liter	ANALYTICAL METHOD	SAMPLERS	DATA VALIDATION
OS-09_070203_01	7/2/03	**OS-09 Groundwater**	Del Mar	<0.8	314.0	Haley & Aldrich	AMEC
OS-09_070203_03	7/2/03	**OS-09 Groundwater**	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC
OS-09_071003_01	7/10/03	**Groundwater**	Del Mar	<0.8	314.0	Haley & Aldrich	AMEC
OS-09_071003_02	7/10/03	**OS-09 Groundwater Duplicate**	Del Mar	<0.8	314.0	Haley & Aldrich	AMEC
OS-09_071003_04	7/10/03	Field Blank	Del Mar	<0.8	314.0	Haley & Aldrich	AMEC
OS-09_071003_03	7/10/03	**OS-09 Groundwater**	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC
OS-09_071003_03D	7/10/03	**OS-09 Groundwater Duplicate**	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC
OS-09_071003_03F	7/10/03	Field Blank	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC
OS-09_071703_01	7/17/03	**OS-09 Groundwater**	Del Mar	<0.8	314.0	Haley & Aldrich	AMEC
OS-09_071703_02	7/17/03	**OS-09 Groundwater Duplicate**	Del Mar	<0.8	314.0	Haley & Aldrich	AMEC
OS-09_071703_04	7/17/03	Field Blank	Del Mar	<0.8	314.0	Haley & Aldrich	AMEC
OS-09_071703_03	7/17/03	**OS-09 Groundwater**	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC
OS-09_071703_03D	7/17/03	**OS-09 Groundwater Duplicate**	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC
OS-09_071703_03F	7/17/03	Field Blank	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC
OS-09_071703_06M1	7/17/03	5.0 ug/l Matrix spike	Del Mar	4.8	314.0	Haley & Aldrich	AMEC
OS-09_071703_06R1	7/17/03	5.0 ug/l Reagent blank spike	Del Mar	5.0	314.0	Haley & Aldrich	AMEC
OS-09_071703_06N1	7/17/03	Reagent blank	Del Mar	<0.8	314.0	Haley & Aldrich	AMEC
OS-09_071703_06MD1	7/17/03	5.0 ug/l Matrix spike Duplicate	Del Mar	4.3	314.0	Haley & Aldrich	AMEC
OS-09_071703_06RD1	7/17/03	5.0 ug/l Reagent blank spike Duplicate	Del Mar	5.2	314.0	Haley & Aldrich	AMEC
OS-09_071703_06ND1	7/17/03	Reagent blank Duplicate	Del Mar	<0.8	314.0	Haley & Aldrich	AMEC
OS-09_071703_06M3	7/17/03	5.0 ug/l Matrix spike	Ceimic	4.9	314.0	Haley & Aldrich	AMEC
OS-09_071703_06R3	7/17/03	5.0 ug/l Reagent blank spike	Ceimic	5.0	314.0	Haley & Aldrich	AMEC
OS-09_071703_06N3	7/17/03	Reagent blank	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC
OS-09_071703_06MD3	7/17/03	5.0 ug/l Matrix spike Duplicate	Ceimic	4.98	314.0	Haley & Aldrich	AMEC
OS-09_071703_06RD3	7/17/03	5.0 ug/l Reagent blank spike Duplicate	Ceimic	4.96	314.0	Haley & Aldrich	AMEC
OS-09_071703_06ND3	7/17/03	Reagent blank Duplicate	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC

TABLE I

SUMMARY OF PRELIMINARY RESULTS FOR PERCHLORATE IN GROUNDWATER FROM WELL OS-09
BOEING SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

SAMPLE IDENTIFIER	DATE	SAMPLE TYPE	LABORATORY	PERCHLORATE, micrograms per liter	ANALYTICAL METHOD	SAMPLERS	DATA VALIDATION
OS-09_072403_01	7/24/03	**OS-09 Groundwater**	Del Mar	<0.8	314.0	Haley & Aldrich	AMEC
OS-09_072403_02	7/24/03	**OS-09 Groundwater Duplicate**	Del Mar	<0.8	314.0	Haley & Aldrich	AMEC
OS-09_072403_04	7/24/03	Field Blank	Del Mar	<0.8	314.0	Haley & Aldrich	AMEC
OS-09_072403_03	7/24/03	**OS-09 Groundwater**	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC
OS-09_072403_03D	7/24/03	**OS-09 Groundwater Duplicate**	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC
OS-09_072403_03F	7/24/03	Field Blank	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC
OS-09_073103_01	7/31/03	**OS-09 Groundwater**	Del Mar	<0.8	314.0	Haley & Aldrich	AMEC
OS-09_073103_02	7/31/03	**OS-09 Groundwater Duplicate**	Del Mar	<0.8	314.0	Haley & Aldrich	AMEC
OS-09_073103_04	7/31/03	Field Blank	Del Mar	<0.8	314.0	Haley & Aldrich	AMEC
OS-09_073103_03	7/31/03	**OS-09 Groundwater**	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC
OS-09_073103_03D	7/31/03	**OS-09 Groundwater Duplicate**	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC
OS-09_073103_03F	7/31/03	Field Blank	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC
OS-09_073103_08	7/31/03	**OS-09 Groundwater**	American Analytics	<2.00	314.0	Haley & Aldrich	AMEC
OS-09_073103_08D	7/31/03	**OS-09 Groundwater Duplicate**	American Analytics	<2.00	314.0	Haley & Aldrich	AMEC
OS-09_073103_08F	7/31/03	Field Blank	American Analytics	<2.00	314.0	Haley & Aldrich	AMEC
OS-09_080703_01	8/7/03	**OS-09 Groundwater**	Del Mar	<0.8	314.0	Haley & Aldrich	AMEC
OS-09_080703_02	8/7/03	**OS-09 Groundwater Duplicate**	Del Mar	<0.8	314.0	Haley & Aldrich	AMEC
OS-09_080703_04	8/7/03	Field Blank	Del Mar	<0.8	314.0	Haley & Aldrich	AMEC
OS-09_080703_03	8/7/03	**OS-09 Groundwater**	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC
OS-09_080703_03D	8/7/03	**OS-09 Groundwater Duplicate**	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC
OS-09_080703_03F	8/7/03	Field Blank	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC
OS-09_081203_01	8/12/03	**OS-09 Groundwater**	Del Mar	<0.8	314.0	Haley & Aldrich	Pending
OS-09_081203_02	8/12/03	**OS-09 Groundwater Duplicate**	Del Mar	<0.8	314.0	Haley & Aldrich	Pending
OS-09_081203_04	8/12/03	Field Blank	Del Mar	<0.8	314.0	Haley & Aldrich	Pending
OS-09_081203_03	8/12/03	**OS-09 Groundwater**	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC
OS-09_081203_03D	8/12/03	**OS-09 Groundwater Duplicate**	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC
OS-09_081203_03F	8/12/03	Field Blank	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC

TABLE I

SUMMARY OF PRELIMINARY RESULTS FOR PERCHLORATE IN GROUNDWATER FROM WELL OS-09
BOEING SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

SAMPLE IDENTIFIER	DATE	SAMPLE TYPE	LABORATORY	PERCHLORATE, micrograms per liter	ANALYTICAL METHOD	SAMPLERS	DATA VALIDATION
OS-09_081203_06M1	8/12/03	5.0 ug/l Field Matrix spike	Del Mar	4.2	314.0	Haley & Aldrich	Pending
OS-09_081203_06R1	8/12/03	5.0 ug/l Reagent blank spike	Del Mar	4.6	314.0	Haley & Aldrich	Pending
OS-09_081203_06MD1	8/12/03	5.0 ug/l Field Matrix spike duplicate	Del Mar	4.4	314.0	Haley & Aldrich	Pending
OS-09_081203_06M3	8/12/03	5.0 ug/l Field Matrix spike	Ceimic	4.508	314.0	Haley & Aldrich	AMEC
OS-09_081203_06R3	8/12/03	5.0 ug/l Reagent blank spike	Ceimic	4.621	314.0	Haley & Aldrich	AMEC
OS-09_081203_06MD3	8/12/03	5.0 ug/l Field Matrix spike duplicate	Ceimic	4.480	314.0	Haley & Aldrich	AMEC
OS-09_081203_06MB1	8/12/03	50 ug/l Field Matrix spike	Del Mar	49	314.0	Haley & Aldrich	Pending
OS-09_081203_06RB1	8/12/03	50 ug/l Reagent blank spike	Del Mar	49	314.0	Haley & Aldrich	Pending
OS-09_081203_06MBD1	8/12/03	50 ug/l Field Matrix spike duplicate	Del Mar	49	314.0	Haley & Aldrich	Pending
OS-09_081203_06MB3	8/12/03	50 ug/l Field Matrix spike	Ceimic	49.797	314.0	Haley & Aldrich	AMEC
OS-09_081203_06RB3	8/12/03	50 ug/l Reagent blank spike	Ceimic	49.525	314.0	Haley & Aldrich	AMEC
OS-09_081203_06MBD3	8/12/03	50 ug/l Field Matrix spike duplicate	Ceimic	49.912	314.0	Haley & Aldrich	AMEC
OS-09_081203_06MC1	8/12/03	150 ug/l Field Field Matrix spike	Del Mar	150	314.0	Haley & Aldrich	Pending
OS-09_081203_06RC1	8/12/03	150 ug/l Reagent blank spike	Del Mar	150	314.0	Haley & Aldrich	Pending
OS-09_081203_06MCD1	8/12/03	150 ug/l Field Matrix spike duplicate	Del Mar	150	314.0	Haley & Aldrich	Pending
OS-09_081203_06MC3	8/12/03	150 ug/l Field Matrix spike	Ceimic	141.433	314.0	Haley & Aldrich	AMEC
OS-09_081203_06RC3	8/12/03	150 ug/l Reagent blank spike	Ceimic	141.707	314.0	Haley & Aldrich	AMEC
OS-09_081203_06MCD3	8/12/03	150 ug/l Field Matrix spike duplicate	Ceimic	140.072	314.0	Haley & Aldrich	AMEC
OS-09_081203_06N1	8/12/03	Non-spiked reagent blank	Del Mar	<0.8	314.0	Haley & Aldrich	Pending
OS-09_081203_06N3	8/12/03	Non-spiked reagent blank	Ceimic	<0.35	314.0	Haley & Aldrich	AMEC

NOTE:

1) ALL RESULTS ARE PRELIMINARY PENDING DATA VALIDATION EXCEPT AS INDICATED.
2) < = Indicates Less Than, numerical value is the Method Detection Limit
3) All analyses performed using EPA METHOD 314 DETERMINATION OF PERCHLORATE IN DRINKING WATER USING ION CHROMATOGRAPHY.
4) AMEC = Indicates data validation performed by AMEC, no qualifications
5) **Bold indicates groundwater samples.**
6) Well OS-09 has been also referred to a Brandeis-Bardine Institute "bathtube well no. 1".

TABLE II

SUMMARY OF PRELIMINARY RESULTS FOR INORGANIC CONSTITUENTS IN GROUNDWATER FROM WELL OS-09
BOEING SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

Well Identifier			OS-09	OS-09	OS-09	OS-09	OS-09	OS-09	OS-09
Sampled Date			7/2/2003	7/10/2003	7/17/2003	7/24/2003	7/31/2003	8/7/2003	8/12/2003
Compound	Units	Method							
Calcium	mg/l	6010B	3.1	3.1	3.1	3 M2	2.9	3	3.3
Magnesium	mg/l	6010B	1.9	1.9	1.9	1.8	1.8	1.8	1.9
Potassium	mg/l	6010B	2	0.95	1.2	1.5	1.2	1.2	1.2
Sodium	mg/l	6010B	200 M-HA	190	190 M-HA	190 M-HA	190 M-HA	190 M-HA	190 M-HA
Bicarbonate	mg/l	SM2320B	317	317	305	268	329	pending	329
Carbonate	mg/l	SM2320B	3.8	7.2	14.4	21.6	0	pending	2.4
Chloride	mg/l	300.0	26	28	26	28	26	26	26
Nitrate-N	mg/l	300.0	<0.072	<0.072	0.083 J	<0.072	<0.072	<0.072	<0.072
Sulfate	mg/l	300.0	130	120	130	140	130	140	130
Total Dissolved Solids	mg/l	160.1	570	580	580	640	570	580	580
pH	pH	150.1	8.42	8.6	8.64	8.56	8.29	8.26	8.39
Specific Conductance	umhos/cm	120.1	870	890	890	880	880	900	890
Laboratory			DMA	DMA	DMA	DMA	DMA	DMA	DMA

NOTE:

1) M-HA = Due to high levels of analyte in the sample, the MS/MSD calculation does not provide useful spike recovery information.

2) M2 = The MS and /or MSD were below the acceptance limits due to sample matrix interference.

3) J = Estimated value. Analyte detected at a level less than the Reporting Limit (RL) and greater than or equal to the Method Detection Limit (MDL).
The user of this data should be aware that this data is of unknown quality.

4) DMA = Del Mar Analytical of Irvine, California.

5) mg/L = Milligrams per liter.

6) < = Not detected; numerical value represents the Method Detection Limit for that compound.

7) Well OS-09 has been also referred to a Brandeis-Bardine Institute "bathtube well no. 1".

AMEC chemists were requested to evaluate all available laboratory data from the sampling events associated with the OS-9 well (also known as Bathtub 1). These events included sampling on February 21, 2003 conducted by Ventura County, May 30, 2003 conducted by DTSC, June 11, 2003 conducted by DTSC, and weekly sampling by Haley & Aldrich beginning on July 2, 2003. The samples collected February 21st were analyzed by Weck Laboratories. The samples collected May 30th were analyzed by Advanced Technology Laboratories (ATL). The samples collected June 11th were analyzed by ATL and HML. The weekly samples that began on July 2nd were analyzed by Del Mar, the designated primary laboratory, and either Ceimic or American Analytics as the split lab.

Based upon a review of the available data, AMEC chemists have reason to question the validity of the detects reported by ATL in the May 30th and June 11th sampling events. Weck, in the February 21st sampling, and HML, in the June 11th sampling, each noted a peak in the sample chromatogram. HML spiked the sample with perchlorate to confirm that the unidentified peak was not perchlorate. Weck removed this perchlorate detect after a review of the data, requested by HML, as the peak was outside of the perchlorate retention time window. Subsequently, Del Mar, Ceimic, and American Analytics have also noted an unidentified peak (not perchlorate) in the OS-9 sample chromatograms. ATL also had a single peak in the OS-9 sample chromatograms. This peak fell within the perchlorate retention time window, but ATL did not perform matrix spikes to confirm the identification of perchlorate. As the samples from HML, Del Mar, Ceimic, and American Analytics have a single peak in the sample chromatograms that is not perchlorate, logic would question why two peaks, perchlorate and this unidentified peak, were not present in the ATL samples.

HML arranged to have both sets of samples from June 11th analyzed by ICMS. The ICMS analysis confirmed the nondetect results from HML and also confirmed the detects from ATL. Since these data contradict one another, one must look to other sources of error as the factor contributing to these inconsistencies. Such sources of error can include but are not limited to switching of the sample in the laboratory, inadvertent spiking of the sample in the laboratory, and the interval of time between the collection of the HML sample and the ATL sample. Other sampling events must also be considered in order to establish a bigger picture of the accuracy of the results.

In the weekly sampling of the OS-9 well, there have been no detects for perchlorate. There have been two separate, matrix-specific method detection limit studies that indicate that perchlorate is recoverable from the site water. There have been double-blind performance samples submitted to two of the three labs involved in the weekly sampling program which both laboratories passed. There have been duplicate field samples submitted to the laboratories with acceptable results. Lastly, both site water and deionized water samples were spiked with perchlorate at 5 ug/L, 50 ug/L, and 150 ug/L and submitted to Ceimic, Del Mar, and the DTSC split lab along with unspiked site and deionized water. The results for all spiked samples submitted to Ceimic and Del Mar meet the Method 314.0 QC acceptance criterion of a matrix spike recovery within 80-120%.