DRAFT - Under Review by DTSC

HAPPY VALLEY INTERIM MEASURES WORK PLAN ADDENDUM AND AMENDMENT
HAPPY VALLEY AND BUILDING 359 AREAS OF CONCERN
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

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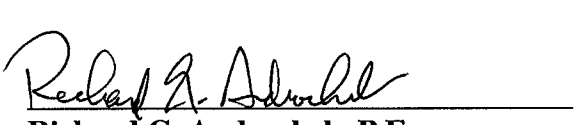

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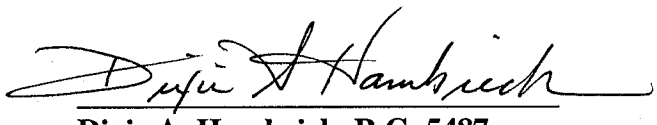

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This document includes both the Happy Valley Interim Measures Work Plan Addendum, prepared in June 2003, and the Happy Valley Interim Measures Work Plan Addendum Amendment, prepared in August 2003. These work plans describe the proposed mitigative actions to control the release of perchlorate to surface water at the Happy Valley and Building 359 areas at the Santa Susana Laboratory, located in Ventura County, California.

The Happy Valley Interim Measures Work Plan Addendum describes sites histories, sampling data, and presents the overall proposed approach for the interim measures at these sites. The Amendment was prepared to address regulatory agency comments regarding the June 2003 work plan, provide new, additional sampling data, and provide detail regarding the implementation of the interim measures.

Both documents are provided in this one report for ease of use. First, the June 2003 Happy Valley Work Plan Addendum is presented in its entirety, followed by the August 2003 Amendment.

HAPPY VALLEY INTERIM MEASURES WORK PLAN ADDENDUM
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SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

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LIST OF ABBREVIATIONS

Boeing	The Boeing Company
bgs	below ground surface
CAL-EPA	California Environmental Protection Agency
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
DTSC	Department of Toxic Substances Control
IM	Interim Measures
LOX	liquid oxygen
µg/L	micrograms per liter
µg/kg	micrograms per kilogram
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NAKA	North American Kindleberger Atwood
NPDES	National Pollution Discharge Elimination System
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RWQCB	Los Angeles Regional Water Quality Control Board
SAIC	Science Applications International Corporation
SSFL	Santa Susana Field Laboratory
SWMU	Solid Waste Management Unit
TCE	trichloroethene
VCEHD	Ventura County Environmental Health Division

1.0 INTRODUCTION

This Happy Valley Interim Measures (IM) Work Plan Addendum presents mitigative actions to control the release of perchlorate to surface water at the Happy Valley and Building 359 areas at the Santa Susana Field Laboratory (SSFL). It was 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 May 21, 2003 (DTSC, 2003) (Appendix A). In this letter, DTSC has requested the submittal of an IM work plan describing immediate and long-term measures to address perchlorate releases to surface water from the Happy Valley and Building 359 areas.

Perchlorate occurrence at the SSFL is described in a detailed, comprehensive report entitled *Perchlorate Source Evaluation and Technical Report, Santa Susana Field Laboratory, Ventura County, California* (MWH, 2003a). This IM work plan presents a summary of the information regarding the Happy Valley and Building 359 sites presented in the above-referenced report, and provides additional perchlorate sampling data collected between February and May 2003 to help define the scope of the proposed IM.

This IM Work Plan has been prepared as an Addendum to a previous Happy Valley IM work plan that described the actions required to identify and remove suspect ordnance from the Happy Valley site (UXB, 1998). The Happy Valley IM Work Plan was approved by DTSC and the work was conducted in 1999. As part of the IM, approximately 1,800 cubic yards of perchlorate-containing soil/debris were removed (UXB, 2002). The scope of the 1999 IM extended into the areas surrounding Happy Valley, and included the Building 359 site. This document has been prepared as an addendum to the previous Happy Valley IM Work Plan because some of the proposed actions presented herein are similar in scope to the 1999 activities, and because previous plans developed for the 1999 IM will be used for the work proposed here.

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 rocket engine 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 two environmental programs at the SSFL pertinent to the perchlorate IM at the Happy Valley and Building 359 sites are the Resource Conservation and Recovery Act (RCRA) and National Pollutant Discharge Elimination System (NPDES) Programs. The RCRA-related activities at the SSFL are regulated by the DTSC. RCRA Corrective Action

includes the RCRA facility assessment (RFA), the RCRA facility investigation (RFI), corrective measures study (CMS), and corrective measures implementation (CMI) phases. The RCRA program at the SSFL is currently in the RFI phase. This program also includes the authority to implement interim measures cleanup actions when and where appropriate.

Surface water discharge from the SSFL has been regulated by the Los Angeles Regional Water Quality Control Board (RWQCB) since 1958, and subject to a NPDES Permit issued by this agency beginning in 1984. Surface water discharges from the site are routinely monitored at eight outfall locations shown on Figure 1. As described in the perchlorate summary report (MWH, 2003a), more than 250 surface water samples have been collected and analyzed for perchlorate in support of the NPDES program since 1998. Perchlorate has been detected in NPDES surface water samples collected at the Happy Valley monitoring location at an average concentration of about 0.008 milligrams per liter (mg/L) since 2000. Perchlorate has not been detected in surface water samples from NPDES Outfalls 1, 2, 3, 4, 5, and 7 (Figure 1). At Outfall 6 all of the surface water samples (28) have not detected perchlorate, with the exception of one sample. Perchlorate was reportedly detected in this one sample at Outfall 6 in 1998 at a concentration of 0.00426 mg/L, just slightly above the laboratory reporting limit of 0.004 mg/L. It is possible that this result was a false positive. In addition to these routine monitoring locations, one surface water sample was collected in 1999 at the confluence of two northern drainages in Area II (Figure 1). This sample location was selected by the RWQCB staff while conducting a site visit. Perchlorate was not detected in this sample (MWH, 2003a).

1.2 OBJECTIVE AND SCOPE OF HAPPY VALLEY IM

The objective of this IM is to control perchlorate releases to surface water at the Happy Valley and Building 359 sites. The overall goal of the IM is remove sources contributing to perchlorate detected in surface water. This work plan describes the proposed measures that will be implemented in an attempt to achieve this objective before the 2003/2004 winter rainy season.

2.0 HAPPY VALLEY AND BUILDING 359 FACILITY INFORMATION

Both the Happy Valley and Building 359 Areas are located in the northeastern portion of the SSFL (Figure 1), and are included in the RCRA Program as an Area I AOC (SAIC, 1994). Site plan information and the physical relationship between the two sites is presented in Figure 2. A summary of site operational history regarding the use of perchlorate at the Happy Valley and Building 359 sites is described in the following sections, and further site information is provided in the perchlorate summary report (MWH, 2003a).

2.1 HAPPY VALLEY AREA

The Happy Valley RFI site is approximately 9 acres in size, and is divided into two areas based on location (Figure 2). The northern portion of the site is an approximately 1-acre area surrounding the Tunnel Facility and is located south, and uphill of, the Building 359 RFI site. The southern portion of the site is an approximately 8-acre area, located further south and separated from the northern portion of the site by a ridge that forms a surface water divide.

The Happy Valley site was used for solid propellant research and testing, and gun propellant testing between the 1950s and 1993 (Ogden, 1996). Perchlorate used at the Happy Valley site was stored at the Building 359 RFI site. The primary use of perchlorate at the Happy Valley RFI site occurred during the 1960s in support of flare research, development, and production for the military. This work was conducted in the southern portion of Happy Valley at Building 372 (Figure 2). Perchlorate was also used in this portion of the site for rocket propellant research and testing activities during the 1970s through 1993. Additional perchlorate use occurred in the northern portion of Happy Valley at the Tunnel Facility where turbine spinners were tested in the 1950s. Building 316 was used for static propellant tests (UXB, 2002).

A surface water divide south of the Tunnel Facility splits surface water runoff at the Happy Valley site. The area north of this surface water divide drains toward the concrete-lined channel along the Area I Road that discharges to the R-1 Pond (Solid Waste Management Unit [SWMU] 4.16). The R-1 Pond is shown on Figure 1. Surface water discharge from the R-1 Pond drains to

Perimeter Pond (SWMU 4.1). Discharge from Perimeter Pond is regularly monitored at the NPDES Outfall 1, located in the undeveloped land in the southern portion of the SSFL (Figure 1). Surface water runoff south of the surface water divide is to the south, into the drainage leading to Dayton Canyon (Figures 1 and 2). Discharge in this drainage has been regularly monitored since 1998 at the NPDES Happy Valley surface water monitoring location HV-1 (Figure 2). During late 2002, a second surface water monitoring point was established further down the Happy Valley drainage, near the SSFL property boundary. This monitoring point, HV-2, has only been sampled during the spring of 2003.

Vegetation habitats in the southern Happy Valley site include mulefat scrub, Venturan coastal sage scrub, chaparral, non-native grasslands, and coast live oak woodland, with interspersed bedrock outcrops (AMEC, 2003). Much of the area near former Building 372 is considered disturbed habitat. The upper reach of the southern drainage at the site is mapped as mulefat scrub, and the majority of the lower reach of the drainage is mapped as chaparral (AMEC, 2003). Recent biological survey visits to the site in early May 2003 noted Santa Susana Tar Plant on the rock outcrops within the upper reach of the drainage south of former Building 372 (Hovore, 2003).

2.2 BUILDING 359 AREA

The Building 359 Area is located northeast of the Happy Valley North RFI site in Area I of the SSFL, and is approximately 3 acres in size (Figures 1 and 2). The Building 359 RFI site, also known as the North American Kindleberger Atwood (NAKA) area, was used for energetic research using solid propellants between the 1950s and early 1990s (Ogden, 1996; Lockheed, 1997). Building 359 was used as the primary energetic material testing area at the site, and contained four test cells.

The primary use of perchlorate at the Building 359 RFI site was in preparation and assembly of turbine spinners and igniters during the 1950s and 1960s. During the 1970s through the early 1990s, perchlorate was milled and mixed with other compounds for solid rocket propellant development. The mixing and milling operations primarily took place in Building 325. In

addition, the area near Building 376 was the primary perchlorate storage area for the operations in Happy Valley (MWH, 2003a).

The overall site drainage in the Building 359 Area is to the north, toward the concrete-lined drainage ditch along the Area I Road. This drainage ditch leads to the R-1 Pond (SWMU 4.16), and then to the Perimeter Pond (SWMU 4.17), located southwest of the Building 359 RFI site (Figure 1). Surface water discharge from the Perimeter Pond is monitored as required in the NPDES permit at Outfall 1, located in the undeveloped land to south (Figure 1).

Drainage from the Building 359 test cells flowed into a covered, concrete sump and then into a subsurface pipeline which in turn discharged to the concrete-lined ditch along the Area I Road. Other asphalt-lined ditches surrounding Building 359 also led to the concrete-lined ditch along the Area I Road. At Building 325, drainage was directed into concrete-lined ditches that also led to the primary drainage ditch along the Area I road.

Drainage from the former Building 376 storage area is toward the north, and flows to either a subsurface pipeline or storm water culvert that discharges to a natural depression on the site. Based on observations made during the rainy seasons since 1997, it appears that most surface water in this area infiltrates into the subsurface, but some discharge may periodically reach the drainage ditch along the Area I road. Historically, a storm water culvert located within the Area I Road drainage ditch on the northeastern edge of the Building 359 Area likely diverted runoff from this portion of the site northwards. Geophysical surveys in this area indicate that the culvert pipeline extends to beneath the Area I Landfill (SWMU 4.2) (Figure 2). Discharge from the Area I Landfill is toward the north, to a drainage that flows west near the northern boundary of the SSFL (Figure 1). This drainage culvert was sealed during 2001/2002 at the request of Ventura County Environmental Health Division (VCEHD) because the discharge pipeline may have been creating depressions within the Area I Landfill (VCEHD, 2001). Further investigation of this storm water culvert is proposed in this IM (see Section 4.3). Investigation of the Area I Landfill is also planned for the summer/fall of 2003 after DTSC approves the work plan (AMEC, 2001 and MWH, 2003b).

Vegetation habitats at the Building 359 site include non-native grasslands and other species typically occurring in a disturbed environment (ruderal habitat). The southernmost portion of the Building 359 area and the northern Happy Valley site is mapped as coast live oak woodland with outcropping bedrock (AMEC, 2003). Recent biological survey visits to the site in early May 2003 noted Santa Susana Tar Plant in the vicinity of former Building 376, and a nesting killdeer in the central portion of the Building 359 site (Hovore, 2003).

2.3 PREVIOUS INTERIM MEASURES

An IM soil removal action was conducted at the Happy Valley and Building 359 sites during 1999 as part of the RCRA Corrective Action program at the SSFL. All work for this IM was conducted following DTSC-approved work plans (UXB, 1998). The primary purpose of the IM was to identify and remove suspect energetic and/or ordnance items, and originally targeted the entire Happy Valley site. Based on field findings and with the approval of DTSC, the scope of the Happy Valley IM was expanded to include investigating a 29-acre area, including the Building 359 RFI site and areas beyond. The IM included screening the subsurface for metallic anomalies, and then excavating and sifting soil where metallic debris was present. The primary soil/debris removal area was south of Building 372, within the upper reach of the drainage (Figure 2). Approximately 1,800 cubic yards of soil/debris were removed during the IM. A report on the IM activities was issued (UXB, 2002) and subsequently approved by DTSC (DTSC, 2002) (Appendix A).

Although the primary purpose of the IM was identification and removal of suspect energetic and/or ordnance items, sampling results indicated the presence of perchlorate in the excavated soils. As described in the perchlorate summary report (MWH, 2003a), a total of 20 soil samples were collected and analyzed in the soils designated for offsite disposal. Perchlorate was detected in nine of these samples, with concentrations ranging from 0.02 milligrams per kilogram (mg/kg) to 0.16 mg/kg (MWH, 2003a). Toward the end of the IM activities, six confirmation soil samples for perchlorate characterization were collected in the soil removal area. Perchlorate was not detected in these samples (UXB, 2002).

3.0 HAPPY VALLEY AND BUILDING 359 PERCHLORATE SAMPLING RESULTS

Numerous samples have been collected from surface water, soil leachate, and soils in the Happy Valley and the Building 359 RFI sites since 1998. Data collected prior to February 2003 are depicted in the perchlorate report described above (MWH, 2003a). Subsequent to that submittal, a total of 75 additional perchlorate surface water and soil leachate samples were collected during the spring 2003 rainy season (February through April) to aid in perchlorate source characterization at both sites. These new sampling results, along with previous data, are depicted on Figures 3 through 8. Laboratory analytical results and data validation reports for these recent characterization samples are included in Appendix B.

DTSC was present for many of the recent 2003 surface water sampling events and collected split samples for analysis at the DTSC laboratory. The DTSC split sample results were not available at the time this work plan was prepared, hence results are not shown on the figures. Split sample locations are shown as squares. Also, it may be noted on these figures that multiple analytical results may be shown for a sample on the same sampling date. These data represent field duplicate samples or multiple aliquots of a single sample analyzed using slightly different laboratory procedures to check laboratory reproducibility. In general, the reported perchlorate values for these samples are very similar (generally varying within 10 percent).

Routine surface water sampling was also performed as part of the NPDES program at HV-1 and HV-2 monitoring points in the southern Happy Valley drainage. Table 1 provides a summary of the perchlorate detected in surface water samples collected from the Happy Valley drainage NPDES monitoring points. Since February 2003, nine additional samples have been collected at the Happy Valley drainage monitoring locations. These data are reported in regular monitoring reports to the RWQCB and are not appended to this document.

The following sections summarize the analytical results of various environmental media that have been sampled as part of the perchlorate source identification activities in the Happy Valley and Building 359 RFI sites.

3.1 SOUTHERN HAPPY VALLEY

Perchlorate has been analyzed in surface water, soil leachate, and soil samples collected from the southern portion of the Happy Valley site. Perchlorate sampling results for southern Happy Valley are presented in Figures 3 and 4 (surface water), and in Figures 5 and 6 (soil data). Detected concentrations are highlighted in yellow. Please note that the surface water data depicted on Figures 3 and 4 represent data collected from multiple storm events between 2000 and 2003. As such, variation of sample results for a given location is expected given the temporal variability of storms and the corresponding runoff.

3.1.1 Analytical Results of Surface Water Samples

As shown on Figure 3, the highest perchlorate concentrations detected in surface water samples collected from the Happy Valley drainage were in HVSW12 and HVSW13 (up to 630 micrograms per liter [µg/L]). These samples were collected in the upper reach of the drainage, near the head of a rocky exposure and immediately downstream of sediment deposits (up to about 4 feet thick). Perchlorate concentrations in surface water decrease down drainage from this location, ranging from near 100 µg/L in HVSW14 to about 40 µg/L in HVSW01, south of piezometer PZ-117 (Figures 3 and 4). These higher surface water concentrations generally occur within the boundaries of the previous IM soil removal extent, between the rocky outcrop and the topographically level area near PZ-117.

To evaluate the occurrence of perchlorate in storm water in the lower reach of the drainage, additional surface water samples were collected below the southern extent of the previous IM boundary to the SSFL facility boundary as shown on Figure 4. Similar to above, perchlorate concentrations decrease with distance down drainage. In general, perchlorate concentrations decrease to about 10 µg/L near the Happy Valley NPDES monitoring point HV-1 (Figure 4).

3.1.2 NPDES Monitoring Results

Surface water perchlorate sample results at the Happy Valley drainage monitoring locations for the NPDES program at the SSFL are presented in Table 1. The monitoring locations are shown

on Figures 2 and 4. Perchlorate sampling results at HV-1 during Spring 2003 range up to 12 µg/L, and are similar to those detected at this location since 2000. In general, there is a decrease in the average perchlorate concentrations detected in surface water at the HV-1 monitoring location with time. Prior to the spring of 2003, the HV-2 sampling location was not established. Perchlorate was detected at a concentration up to 6.6 µg/L in one sample collected from this location in May 2003.

3.1.3 Analytical Results of Soil Samples

In addition to surface water runoff, soils were analyzed for perchlorate occurrence. Soils were evaluated using two methodologies: direct soil matrix analysis (soil matrix samples with identifiers "HVBS", "HVSS", and "HVTS"), and analysis of water mixed with soil and decanted prior to analysis (soil leachate samples with the identifier "HVLS"). Figures 5 and 6 show soil and soil leachate perchlorate sample locations and analytical results in the building and drainage portions of the southern Happy Valley site. Also shown on these figures are perchlorate water sampling results where fire-hose water was used to wet areas of soil (artificial water samples with the identifier "HVAW").

It should be noted that the Building 372 concrete foundation was removed during 2002 and backfilled with clean soil from an onsite, DTSC-approved borrow source (MWH, 2003a). Therefore, soil, concrete, or artificial water samples collected from the foundation are not shown on Figure 5.

The highest concentrations of perchlorate detected in soil, soil leachate, or artificial water samples collected in the southern portion of the Happy Valley site occur in the vicinity of Building 745 (up to 81 µg/L) and in the topographic low south of former Building 372 (up to 103 µg/L). These locations are shown on Figure 5.

Perchlorate was not detected in the four soil matrix samples collected from drainage sediments south of PZ-117 at a laboratory reporting limit of 50 micrograms per kilogram (µg/kg)

(Figure 6). Perchlorate was also not detected in the soil leachate samples near PZ-117 and PZ-074.

3.2 BUILDING 359 AND NORTHERN HAPPY VALLEY AREAS

Perchlorate has been analyzed in surface water, soil leachate, and soil samples collected from the Building 359 and northern Happy Valley sites. Perchlorate sampling results for these areas are presented in Figures 7 and 8 for surface water and soil, respectively. Detected concentrations are highlighted in yellow.

3.2.1 Analytical Results of Surface Water Samples

As shown on Figure 7, the highest perchlorate concentration detected in surface water samples from the Building 359 Area was in BSSW18 (up to 570 µg/L). It should be noted that this sample was collected following a rain event from a puddle on top of the Building 325 concrete foundation, not from flowing water. Surface water samples (BSSW26 and BSSW27) collected from the concrete ditch that collects runoff from this portion of the site contained up to 97 µg/L perchlorate during earlier spring rain events. Perchlorate concentrations decrease with distance down this concrete-lined drainage as additional surface water flows into the channel along the Area I Road. In the southeastern portion of the Building 359 site, surface water samples collected downstream of the former perchlorate storage area at Building 376 contained up to 170 µg/L perchlorate. Perchlorate was also detected in one surface water sample collected from the runoff from the northern Happy Valley area. This sample contained 11 µg/L perchlorate (Figure 7).

As described above, surface water runoff from the Building 359 site is generally to the north toward the Area I Road drainage ditch, which flows into the R-1 Pond, and then into the Perimeter Pond. Surface water discharge from the Perimeter Pond is monitored in the NPDES program at Outfall 1 (Figure 1). Perchlorate has not been detected in any surface water samples collected at this outfall location (MWH, 2003a). Prior to 2001 when the culvert was sealed, surface water from the Building 376 area that reached the Area I Road, would likely have been diverted northwards beneath the Area I Landfill (Figure 7). As part of the RFI program in 2001,

one surface water sample was also collected downstream of the Area I Landfill. Perchlorate was not detected in this sample (MWH, 2003a).

3.2.2 Analytical Results of Soil Samples

Similar to Happy Valley, the Building 359 and northern Happy Valley soils were also evaluated for perchlorate by analyzing both soil and soil leachate samples. Artificial runoff water samples (generated using a fire hose) were not collected at these sites. Figure 8 shows soil and soil leachate perchlorate sample locations and analytical results at the Building 359 and northern Happy Valley sites. Similar to the surface water results, the highest concentrations of perchlorate occur in the vicinity of the former perchlorate storage area at Building 376 and near Building 359. Perchlorate was detected at concentrations up to 10 mg/L in soil leachate and 71.3 mg/kg in soil in the former storage area at Building 376, and up to 4.8 mg/kg in soil south of Building 359. Soil and soil leachate samples collected near Building 316 in the northern Happy Valley area also contained perchlorate at concentrations of 100 µg/kg and 15 µg/L, respectively (see Figure 8).

3.3 SUMMARY OF PERCHLORATE SAMPLING RESULTS

Based on the perchlorate sampling results described above and depicted on Figures 3 through 8, six perchlorate source areas have been identified in the Happy Valley and Building 359 sites. These six areas are the initial sources that will be the target for the interim measures. The areas and associated maximum sampling results are shown on Figure 9 and described briefly below:

Southern Happy Valley Drainage. This area is located in the valley south of former Building 372, above the bedrock outcrop that forms the upper reach of the drainage in this part of the site. Although high concentrations of perchlorate have not been detected in soil or soil leachate samples in this area, consistently high surface water results have been detected (100 µg/L in 2000, and up to 630 µg/L in 2003). Based on these results, it is believed that a source of perchlorate exists in the soils immediately upstream from the location of HVSW12 and HVSW13. Soils are generally between 2 and 6 feet thick upstream of the bedrock outcrop.

Vegetation in this area is relatively dense and comprised of mule fat scrub and grass. A few oak trees are also present.

Building 745. This area includes the soils in the vicinity of and beneath the foundation of Building 745. Perchlorate is detected at low levels in most of the samples collected in this area, with soil leachate results ranging up to 81 µg/L. This area is developed (concrete pad beneath awning).

Building 359/325 Area. This area includes the soils in the vicinity of and beneath the foundations of Building 359 and Building 325. Perchlorate concentrations south of Building 359 range up to 4.8 mg/kg in surface soils, and up to 570 µg/L in surface water above the Building 325 concrete foundation. Subsurface soils immediately beneath Building 325 foundation have not yet been sampled, but adjacent to the foundation perchlorate has been detected up to 200 µg/kg. Soils in this part of the site extend up to 17 feet below ground surface (bgs). Minimal vegetation (primarily grass) exists in this portion of the site because it is developed.

Building 376 Area. This area includes the soils in the vicinity of the former perchlorate storage area at Building 376. Perchlorate concentrations in this area range up to 71.3 mg/kg in surface soils, and up to 10 mg/L in soil leachate. Soils in this part of the site are thin, generally less than 3 feet, and bedrock is commonly exposed even within the level portions of the area. Minimal vegetation (primarily grass and Santa Susana Tar Plant) exists in this portion of the site because of the thin soils and exposed bedrock.

North of Building 376 Area. This area includes the soils in the surface water discharge area from former Building 376. Perchlorate concentrations in this area range up to 120 µg/L in surface water. Soils in this part of the site are between 7 and 15 feet thick. Minimal vegetation (primarily grass) exists in this portion of the site.

Building 316 Area. This area includes the soils in the vicinity of and beneath the foundation of Building 316. Perchlorate concentrations in this area range up 100 µg/kg in surface soils, and up

to 15 µg/L in soil leachate. Soils in this part of the site are thin, generally less than 5 feet. This area is developed.

4.0 PROPOSED INTERIM MEASURES

Interim measures that were considered for controlling perchlorate releases to the surface water at the southern Happy Valley and Building 359/northern Happy Valley areas have two functions. First, a preference was given to implementing interim measures that would treat perchlorate at the currently identified sources. Perchlorate has been demonstrated to be readily destroyed by microbial degradation (GeoSyntec Consultants, 2002). In this interim measure, *in situ* and *ex situ* anaerobic bioremediation of soil and sediments that contain perchlorate is proposed as a method for ultimately transforming perchlorate to the chloride ion. Second, when *in situ* treatment is not or may not be feasible, measures for isolating perchlorate present in solid media (soil, rock, and sediment) from contacting surface water runoff were considered. Perchlorate isolation technologies proposed in this work plan include spatial separation of the impacted environmental media from contact with surface water runoff (e.g., excavate, relocate and treat, or dispose) and implementation of physical barriers to prevent storm water from contacting the media that contains perchlorate (e.g., tarping).

Other interim measures may be implemented as a result of the additional characterization program discussed in Section 4.4. Contingent interim measures that may be appropriate include re-routing of storm water drainage(s) away from, or around, areas determined to contain perchlorate in soil and/or sediment, and/or sealing of rock surfaces that are determined to contain perchlorate. These interim measures will be proposed once the additional characterization has been completed and the data have been reviewed.

The specific interim measures proposed for both the southern Happy Valley and Building 359/northern Happy Valley areas are summarized on Table 2 and shown on Figure 10. Interim measure activities to be performed include the following:

- Excavation of drainage sediments containing perchlorate and onsite treatment via *ex situ* composting
- *In situ* treatment of perchlorate-impacted soils
- Additional characterization of soils, drainage sediment, and bedrock, investigation of the storm water culvert at Building 359, and performing topographic surveys at each site

Additional detail on the scope and location of each of these interim measures is provided in the following sections.

4.1 EXCAVATION OF SEDIMENTS FROM ABOVE THE UPPER REACH OF THE HAPPY VALLEY DRAINAGE

The most effective method to prevent the perchlorate present in sediments above the upper reach of the Happy Valley drainage from contacting surface water runoff is to excavate and transport the sediments to the Building 359 Area for subsequent treatment. Based on the data collected to date, the expected excavation area is shown on Figures 9 and 10, in the valley south of Building 372 above the rocky outcrops. The anticipated volume of soil to be excavated from this area is less than 250 cubic yards. As recommended in the previous Happy Valley IM report, a professional experienced at the identification and management of unexploded ordnance will be present during excavation activities (UXB, 2002). Sediments excavated from this area will be treated via *ex situ* anaerobic composting as described below in Section 4.2, or alternatively disposed of offsite.

Excavated sediments from the valley south of Building 372 (above the rocky outcrops) will be transported to the Building 359 Area and placed on the ground at the former location of the Building 325 and 359 foundations. The sediment will be stockpiled directly on the ground and mixed with a carbon-based electron donor, such as composted cow manure, corn syrup, or calcium magnesium acetate. The amended soils will be saturated with water, and the compost pile will be covered with a plastic tarp. The soils pile will be sampled periodically and tested for perchlorate. Treatment will be deemed complete when perchlorate concentrations are reduced so that surface water discharge requirements are met.

After excavation of the drainage sediments, physical barriers will be used to temporarily control and pond runoff from a simulated rainfall event applied to the sediments upstream, within, and adjacent to the excavation area. The sediments/soils surrounding the excavated area will be deliberately flooded with water to evaluate the effectiveness of the action to reduce and control perchlorate release into surface water at the site. Simulated rainwater that drains from the excavation will be collected for perchlorate analysis. If the runoff does not contain perchlorate, it will provide an indication of what to expect from an actual storm event. If perchlorate is detected in the runoff, additional sediment sampling and excavation may be warranted.

4.2 *IN SITU* TREATMENT OF SOIL

Perchlorate present in soil has been successfully bioremediated by *in situ* anaerobic composting using two different methods as described by GeoSyntec Consultants (2002). One method involves the mixing of treatment materials (comprised of cow manure or other suitable electron donors) into shallow soils that contain perchlorate. A second method involves the application of a 6- to 12-inch layer of composted treatment material over the top of the shallow soils that contain perchlorate, saturating the treatment material with water, and allowing time for the microbial population to degrade the perchlorate. The method that involved mixing treatment material with shallow soils was applied to areas where the perchlorate concentration was relatively high (>50 mg/kg). In areas with lower perchlorate concentrations in soil, simple application of a layer of composted treatment material over the targeted soil along with increasing soil moisture by adding water was performed. Both methods were effective, although a year or more of time was required to reduce the concentrations to the target levels.

In situ treatment of perchlorate in soils is proposed at five known source areas. One of these areas is in the southern portion of Happy Valley at Building 745. The other four sources are within the Building 359/northern Happy Valley areas at Buildings 316, 376 (two locations), and 325/359. Except for soils at Building 376, the soils targeted for *in situ* treatment characteristically contain much lower perchlorate concentrations than those soils treated in the aforementioned study (see Section 3).

The proposed approach to bioremediating perchlorate at the Building 316, 376 (two areas), and 745 areas is *in situ* anaerobic composting using a simple overlay of 6 to 12 inches of composted treatment material. This methodology relies on deliberately applied water and rainfall to leach nutrients and organic substrate from the treatment material into the subsurface to cultivate anaerobic conditions conducive to the degradation of perchlorate. Periodic sampling of soil for perchlorate will be conducted to assess the progress of treatment. The soils at the Building 325/359 area will be similarly treated except that the sediment excavated from above the upper reach of the Happy Valley drainage will first be placed within this area prior to the 6- to 12-inch overlay of treatment material.

4.3 ADDITIONAL SOURCE CHARACTERIZATION ACTIVITIES AND CONTINGENT MEASURES

The interim measures will require five types of additional characterization activities. Sampling and analysis activities will be performed consistent with DTSC-approved RFI sampling protocols. The additional characterization activities include:

1. Soil leachate samples will be collected beneath buildings and other constructed surfaces that are currently being demolished. The objective of this sampling activity is to determine if sources of perchlorate are present in soils beneath the building foundations that could leach perchlorate to surface water runoff.

2. Soil leachate samples will be collected from the southern Happy Valley drainage sediments. Also, surface water samples will be collected from the Happy Valley drainage using simulated "surface water runoff" events. Both soil leachate and simulated surface water runoff samples will be collected along the drainage to the SSFL property line. The objective of this sampling activity is to determine if perchlorate is present within the drainage sediments and are leaching into surface water as it flows along the drainage.

3. Bedrock samples will be collected from exposed bedrock from within the upper reach of the southern Happy Valley drainage. The objective of this sampling activity is to assess whether perchlorate is leaching from the bedrock into surface water as it flows along the drainage.

4. The storm water culvert located along the northeastern edge of the Building 359 site will be investigated. The objective of this task is to determine the discharge location for this feature, and evaluate the condition of the subsurface pipeline. As part of this IM, the investigation effort may include geophysical surveying, mechanical probes, and/or soil sampling. An extensive subsurface investigation near this feature will be performed during the Area I Landfill investigation (also planned prior to the 2003/2004 rainy season).

5. Topographic surveys of the Happy Valley and Building 359 sites will be performed to allow additional definition of surface water flow characteristics. The objective of this task is to provide sufficient site layout detail for additional sampling location control (e.g., stationing and staking the southern Happy Valley drainage) and for design of the contingent interim measures described below.

Contingent interim measures that may be taken as a result of these characterization activities are described below.

4.3.1 Contingent Interim Measures

As indicated above, supplemental soil, sediment, and rock sampling and analysis of the Building 359 Area and Happy Valley sites will be performed. If other perchlorate sources are identified, additional interim measures may be warranted. In addition to the interim measures described in Sections 4.1 and 4.2, contingent interim measures may also be implemented. The contingent interim measures that may be considered and their potential applicability are described below.

In situ degradation of perchlorate could be employed within the Happy Valley drainage if sampling results indicate perchlorate is leaching into surface water from drainage sediments. This contingent measure would be consistent with what was described in Section 4.2. Alternately, drainage sediments could be excavated and either treated at a suitable location onsite or transported offsite for disposal according to applicable laws and regulations.

If sampling of bedrock shows perchlorate to be present at concentrations that could diffuse into storm water, sealing the rock surface with an engineered sealant (e.g., epoxy or shot-crete) may be considered as an interim measure. This measure will effectively prevent contact of the surface water runoff from the impacted bedrock. Alternatively, re-routing drainage channels away from, or around, areas determined to contain perchlorate may also be considered as a contingent interim measure. An additional contingent interim measure that may be considered would be to place an impermeable cover or cap over the impacted rock to prevent contact with surface water runoff. Furthermore, any one or a combination of the above alternatives may prove effective at helping to achieve the interim measure goal.

A last contingent interim measure that may be implemented would be to place an impermeable cover (e.g., tarping) over the six sources identified on Figure 10, that will be treated through composting. This interim measure would be implemented only during the rainy season to prevent contact with surface water runoff. This method might also be deployed along the Happy Valley drainage if impacted sediments are found and require treatment by composting.

4.4 INTERIM MEASURE IMPLEMENTATION SCHEDULE AND REPORTING

Implementation of the interim measures described herein will be performed following DTSC approval of this work plan and once necessary permits are obtained. Implementation of the interim measures will follow the existing DTSC-approved plans (e.g., health and safety plan, transportation plan) included in the previous Happy Valley interim measures work plan (UXB, 1998). As described in Section 1, implementation of the interim measures described herein will be implemented prior to the 2003/2004 rainy season. Additional characterization sampling and topographic survey efforts described above are in progress. Following completion the interim measures, a report will be prepared that documents the actions taken and the results of sampling to confirm effectiveness of the IM. Risks posed by remaining environmental media onsite will be evaluated following DTSC-approved methodologies in RFI site reports.

5.0 SUMMARY

DTSC has requested that Boeing submit a work plan describing proposed interim measures to be taken to control perchlorate releases to surface water at the Happy Valley and Building 359 areas at the SSFL. Significant characterization of the distribution and concentration of perchlorate in soils and in surface water has occurred at these two locations. Characterization data that were collected through January 2003 were previously reported (MWH, 2003a). Additional soil leachate and surface water data were collected from February through May 2003 to aid in further definition of the perchlorate sources at these sites (Section 3 and Appendix B). Analysis of the data shows six sources at the Happy Valley and Building 359 areas. These six sources are targeted for interim measures, as shown on Figure 10, using the following methods:

- Four sources in soil at the Building 359 Area (Building 316, Building 376 [two areas] and Buildings 325/359) are proposed for treatment by composting. Composting has shown to degrade perchlorate in soils to the chloride ion. A source in soil at the southern Happy Valley site (Building 745) is also proposed for treatment by composting.

- A source in sediment above the upper reach of the Happy Valley drainage is proposed for excavation. The excavated sediment will be transported to the Building 325/359 area and treated by composting, along with the existing in-place soils within the Building 325/359 area.

In addition to the above-proposed interim measures, topographic surveying of the Building 359 and Happy Valley sites will be performed to assist with additional characterization and the possible implementation of contingent interim measures. Additional characterization of sediments within the Happy Valley drainage is proposed to determine if perchlorate is present in drainage sediments that may be leaching into surface water as it flows along the drainage. Characterization of exposed bedrock is also proposed within the upper reach of the Happy Valley drainage to determine if bedrock is leaching perchlorate into the surface water where it flows over exposed portions. Finally, investigation of the northern storm water culvert at the Building 359 area is planned.

Contingent interim measures have been considered in addition to those proposed above. These measures may be implemented as a result of the additional sampling of soils beneath building foundations, sediments or bedrock within the Happy Valley, or soils near the northern storm water culvert at Building 359. Contingent interim measures proposed include the following:

- *In situ* bioremediation of soils beneath removed building foundations will be performed if concentrations of perchlorate are detected that could leach to surface water.

- Either *in situ* composting or excavation/transport/treatment or disposal of drainage sediments may be necessary pending the results of characterizing perchlorate in the Happy Valley drainage.

- If bedrock is determined to be leaching perchlorate, then the bedrock surface may be sealed with an inert sealant, or covered/capped with an impermeable cover. Alternately, it may be most effective to re-route the drainage around the exposed bedrock to prevent or minimize contact with storm water runoff.

- Finally, the sources that are being treated by composting can be covered with an impermeable cover during the rainy season to prevent contact with storm water runoff in these areas.

6.0 REFERENCES

AMEC, 2001. *Area I Landfill Investigation Work Plan, Ventura County, Environmental Health Division Facility File No. 56-CR-0051, Santa Susana Field Laboratory, Ventura County, California*. April.

AMEC, 2003. *Standardized Risk Assessment Methodology (SRAM) Work Plan, Revision 1, Santa Susana Field Laboratory, Ventura County.* In preparation.

DTSC, 2002. Letter from James Pappas, DTSC, to Arthur Lenox, Boeing, regarding Approval for Happy Valley Area of Concern (AOC), Subsurface Clearance, Geophysical Mapping, and Debris Removal Report (June 2002), Santa Susana Field Laboratory, Ventura County, California. September 12.

DTSC, 2003. Letter from James Pappas, DTSC, to Steve Lafflam, Boeing, regarding Submittal of an Interim Measures Work Plan to Address Ongoing Perchlorate Release to Surface Water from Building 359 and Happy Valley Areas at the Santa Susana Field Laboratory, Ventura County. May 21.

GeoSyntec Consultants, 2002. *Expanded Field Trial: Bioremediation of Soils with High Perchlorate Levels by Applying Composted Manure.* July.

Hovore, 2003. Personal communication between F. Hovore, FH&A, and D. Hambrick, MWH, regarding biological conditions at the Happy Valley and Building 359 sites. May 9.

Lockheed Environmental Systems and Technologies Company (Lockheed), 1997. *Aerial Photographic Analysis of Rockwell, Rocketdyne, Santa Susana Field Laboratory*, Ventura County, California. May.

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

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

Ogden Environmental and Energy Services Co., Inc. (Ogden), 1996. *RCRA Facility Investigation Work Plan Addendum*, Santa Susana Field Laboratory, Ventura County, California, Volumes I-II. September.

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

UXB, 1998. *Revised RCRA Facility Investigation Work Plan Addendum for Happy Valley-Area of Concern, Surface Clearance, Geophysical Mapping and Debris Removal*. November 4.

UXB, 2002. *Happy Valley Area of Concern, Subsurface Clearance, Geophysical Mapping and Debris Removal Report.* June 19.

Ventura County Environmental Health Division (VCEHD), 2001. Letter from Terrance Giladay, VCEHD, to Mr. Art Lenox, Boeing, regarding Work Plan Review for the Boeing Company Area I Landfill Investigation (dated April 2001). July 11.