

**FINAL
OPERABLE UNIT 1
2007 SECOND FIVE-YEAR REVIEW REPORT
Former Naval Air Station, Moffett Field
Moffett Field, California**

**ENVIRONMENTAL MULTIPLE AWARD CONTRACT (EMAC)
Contract Number N68711-01-D-6005
Contract Task Order 0004**

Prepared for:



**Base Realignment and Closure
Program Management Office West
1455 Frazee Road, Suite 900
San Diego, California 92108-4310**

Prepared by:

TN **T N & Associates, Inc.**
&A Engineering and Science

**3150 Hilltop Mall Road #55
Richmond, CA 94806**

September 2007

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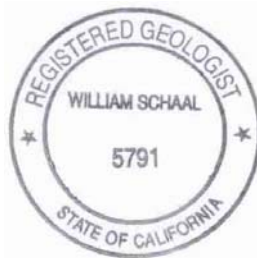
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ABBREVIATIONS AND ACRONYMS

µg/L	micrograms per liter
ARAR	applicable or relevant and appropriate requirement
AWQC	ambient water quality criteria
bgs	below ground surface
CAMU	corrective action management unit
CCL	calculated concentration limit
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm/s	centimeter per second
COC	constituent of concern
DEH	Department of Environmental Health
DoD	Department of Defense
DTSC	Department of Toxic Substances Control
EATS	East-Side Aquifer Treatment System
EE/CA	Engineering Evaluation and Cost Analysis
EPA	U.S. Environmental Protection Agency
EO	Executive Order
FWENC	Foster Wheeler Environmental Corporation
HAWP	Habitat Alteration Work Plan
HLA	Harding Lawson Associates
HRC [®]	Hydrogen Release Compound [®]
IR	Installation Restoration
IT	International Technology Corporation
LFL	lower foundation layer
LGMW	landfill gas monitoring well
LPCL	low-permeability clay layer
MOA	Memorandum of Agreement
msl	mean sea level
NAS	Naval Air Station

ABBREVIATIONS AND ACRONYMS

(Continued)

NASA	National Aeronautics and Space Administration
Navy	Department of the Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NFA	No Further Action
O&M	operation and maintenance
O.D.	outer diameter
OU	Operable Unit
PCB	polychlorinated biphenyl
PRG	Preliminary Remediation Goal
RAB	Restoration Advisory Board
RI	Remedial Investigation
ROD	Record of Decision
Site 1	Site 1 Landfill
Site 2	Site 2 Former Landfill
SVOC	semivolatile organic compound
SWAT	solid waste assessment test
TDS	total dissolved solids
TtEMI	Tetra Tech EM, Inc.
TtFW	Tetra Tech Foster Wheeler
TtECI	Tetra Tech EC, Inc.
TN&A	T N & Associates, Inc.
UFL	upper foundation layer
USC	United States Code
USFWS	United States Fish and Wildlife Service
VOC	volatile organic compound

**DECLARATION OF ACCEPTANCE
FOR
OPERABLE UNIT 1 2007 SECOND FIVE-YEAR REVIEW REPORT,
FORMER NAVAL AIR STATION, MOFFETT FIELD,
MOFFETT FIELD, CALIFORNIA**

Pursuant to the delegations of authority in Sections 2(d) and 11(g) of Executive Order 12580, and Department of Defense (DoD) Instruction 4715.7 of 22 April 1996, the Department of the Navy (Navy) is the approval authority for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) five-year reviews performed at sites under its jurisdiction, custody, or control.



DARREN NEWTON
Base Realignment and Closure Environmental Coordinator
Program Management Office West, by direction of the Director

27-SEPT-2007

Date

EXECUTIVE SUMMARY

This report presents the second five-year review of the remedy implemented at Operable Unit (OU) 1 (Site 1 Landfill and Site 2 Former Landfill) at Former Naval Air Station Moffett Field, near Mountain View, California. This review was performed by the Department of the Navy (Navy) in accordance with Executive Order (EO) 12580, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Section 121, and National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Section 9621c.

Five-year review activities were performed from January 2002 through May 2007. This report includes a summary of analytical data collected between January 2002 and April 2007.

The purpose of this five-year review is to evaluate the implementation and performance of the selected remedy at Operable Unit 1, including whether the selected remedy remains protective of human health and the environment. The methods, findings, conclusions, and recommendations identified during the review are presented in this OU 1 2007 Second Five-Year Review Report. The first five-year report was completed in year 2002. The five-year review is required because hazardous substances, pollutants, or contaminants remain at the Site 1 Landfill above levels that allow for unlimited use and unrestricted exposure.

In 1997, the Navy and the Regulatory Agencies signed a Record of Decision (ROD), which selected remedial action for OU 1, which consists of two landfills (Sites 1 and 2), at Moffett Field (*Moffett Federal Airfield Final Operable Unit 1 Record of Decision, Moffett Federal Airfield, California* [Navy, 1997]). The remedial action was chosen in accordance with CERCLA, as amended by the Superfund Amendments and Reauthorization Act, and with the NCP. The U.S. Environmental Protection Agency (EPA) and the State of California Environmental Protection Agency concurred with the selected remedy.

The Site 2 Former Landfill was excavated in year 1997 and is no longer a landfill. Approximately 23,000 cubic yards of refuse were transferred and consolidated within the Site 1 Landfill. The excavation was backfilled with overburden soil removed during the clearing and grubbing of the landfill surface. Clean imported soil was graded and hydroseeded following the excavation activities (Tetra Tech EM, Inc., 2001).

The remedy for OU 1, as described by the ROD (Navy, 1997) included the following:

- Consolidating wastes from Site 2 to the Site 1 Landfill; backfilling and restoring the Site 2 Former Landfill; and designating the Site 1 Landfill as a corrective action management unit (CAMU)
- Capping the Site 1 Landfill
- Conducting groundwater monitoring at the Site 1 Landfill
- Conducting groundwater monitoring at the Site 2 Former Landfill for a minimum period of 3 years after the Site 2 Former Landfill waste is consolidated at the Site 1 Landfill (1997) to ensure groundwater at the Site 2 Former Landfill is not adversely affected

- Conducting landfill gas monitoring at the Site 1 Landfill
- Installing a subsurface groundwater collection trench along the northern border of the Site 1 Landfill to intercept potential future leachate migration before it reaches surface water, if necessary
- Conducting post-closure maintenance activities at the Site 1 Landfill
- Installing a passive gas-venting trench along the western boundary of the Site 1 Landfill to prevent potential off-site, subsurface migration of landfill gases
- Institutional Controls – Fencing; signs; operation and maintenance (O&M) of the Building 191 pump station and drain/sub-drain system; and restrictions on cover disturbances

The first five-year review report recommendations and follow-up actions included monitoring of squirrel activities at Site 1; completion and implementation of the Habitat Alteration Work Plan for Site 1 Landfill; setting calculated concentration limits (CCL) according to 1997 ROD requirements; and evaluation of groundwater data from Sites 1 and 2. All follow-up actions from the first five-year review report were completed, except for mitigating surface animal burrows made in the vegetative cover. This deficiency requires routine mitigation that consists of collapsing and backfilling the burrows.

This five-year review found that the remedy was completed in accordance with the requirements of the ROD (Navy, 1997). The remedy included a multi-layer cover at the Site 1 Landfill following consolidation of wastes from the Site 2 Former Landfill, groundwater and landfill gas monitoring, a subsurface groundwater collection trench, a passive gas venting trench, and institutional controls.

The landfill cover, in conjunction with in-place engineering and institutional controls, prevents surface exposure of humans and animals to site contaminants, is functioning as designed and is protective of human health and the environment. The monitoring program is appropriate to determine the protectiveness and effectiveness of the remedy.

Groundwater sample testing results from Sites 1 and 2 were compared with the CCLs identified in the Final Technical Memorandum, Site 1 Groundwater Evaluation (Tetra Tech Foster Wheeler, 2004). None of the monitoring parameters were detected above their respective CCLs. Volatile organic compounds, semivolatile organic compounds, polychlorinated biphenyls, and pesticides at Sites 1 and 2 do not appear to be affecting the shallow aquifer based on the infrequent, low and trace concentrations detected.

No significant issues have been identified regarding the integrity of the remedial actions implemented at Site 1.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION

Site name (from WasteLAN) *NAS Moffett Field, Operable Unit 1*

EPA ID (from WasteLAN) *CA2-1-70090078*

Region: 09

State: CA

City/County: Moffett Field/Santa Clara County

SITE STATUS

NPL status: Final Deleted Other (specify) _____

Remediation status (choose all that apply): Under Construction Operating Complete

Multiple OUs? YES NO

Construction completion date: 11 / 16 / 98

Has site been put into reuse? YES NO

REVIEW STATUS

Reviewing agency: EPA State Tribe Other Federal Agency US Navy

Author name: Darren Newton

Author Title: BRAC Environmental Coordinator

Author affiliation: BRAC PMO West

Review period: 1 / 1 / 2002 to 5 / 31 / 2007

Date(s) of inspection: 9 / 27 / 2007 , ongoing quarterly inspections

Type of review: Statutory

Policy

Post-SARA Pre-SARA NPL-Removal only

Non-NPL Remedial Action Site NPL State/Tribe-lead

Regional Discretion)

Review number: 1 (first) 2 (second) 3 (third) Other (specify) _____

Triggering action:

Actual RA Onsite Construction at OU 1 Actual RA Start at OU #__

Construction Completion

First OU 1 2002 Five-Year Review

Report

Other (specify) _____

Triggering action date (from WasteLAN): 9 / 30 / 2002

Due date (five years after triggering action date): 9 / 30 / 2007

FIVE-YEAR REVIEW SUMMARY FORM

Deficiencies:

Site 1 Landfill:

- Burrowing ground squirrels active on landfill slopes and area surrounding landfill
- Miscellaneous maintenance including paint, fence signage, vegetation control, and cracked gas-vent slabs

Recommendations and Follow-up Actions:

Site 1 Landfill:

- Continue to monitor ground squirrel activity and fill holes with soil, as necessary
- Repair gas-vent slabs

Protectiveness Statement:

The remedy at Operable Unit 1 is protective of human health and the environment. The final remedy included a multi-layer landfill cover following consolidation of wastes from the Site 2 Former Landfill; groundwater and landfill gas monitoring; a subsurface groundwater collection trench; a passive gas venting trench; and institutional controls.

The landfill cover, in conjunction with in-place engineering and institutional controls, prevents surface exposure of humans and animals to site contaminants. The ongoing monitoring program is appropriate to determine and ensure the long-term protectiveness and effectiveness of the remedy.

1.0 INTRODUCTION

The Department of the Navy (Navy) has performed a five-year review of the remedy implemented at Operable Unit (OU) 1, Site 1 Landfill (Site 1) and Site 2 Former Landfill (Site 2), at Former Naval Air Station (NAS), Moffett Field (Moffett Field), near Mountain View, California (Figure 1-1, Regional Location Map). The five-year review was performed in accordance with U.S. Environmental Protection Agency (EPA) guidance document (*Comprehensive Five-Year Review Guidance, EPA 540-R-01-007* [EPA, 2001]).

1.1 PURPOSE

The purpose of this five-year review is to evaluate the implementation and performance of the selected remedy at OU 1 (Sites 1 and 2) (Figure 1-2, Sites 1 & 2 Location Map), and to confirm whether the selected remedy remains protective of human health and the environment. The methods, findings, conclusions, and recommendations identified during the review are presented in this OU 1 2007 Second Five-Year Review Report. The five-year review of the remedy was implemented according to the Record of Decision (ROD) issued for OU 1 (*Moffett Federal Airfield Final Operable Unit I Record of Decision, Moffett Federal Airfield, California* [Navy, 1997]).

Consistent with Executive Order (EO) 12580, the Secretary of Defense is responsible for ensuring that five-year reviews are performed at all qualifying Department of Defense (DoD) cleanup sites. According to the November 2001 Navy/Marine Corps *Policy for Conducting Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Statutory Five-Year Reviews* (Navy, 2001), a statutory five-year review is required when both of the following conditions are met:

- Upon completion of the remedial actions at a site, hazardous substances, pollutants, or contaminants will remain above levels that allow for unlimited use and unrestricted exposure
- The ROD or Decision Document for the site was signed on or after October 17, 1986

The Navy has prepared this OU 1 2007 Second Five-Year Review Report pursuant to CERCLA, Section 121, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA, Section 121 states:

If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with Sections [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.

The NCP, 42 United States Code (USC), Section 9621(c), Implementing Regulations, and 40 Code of Federal Regulations (CFR), Part 300.430(f)(4)(ii) provide:

If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after initiation of the selected remedial action.

The Navy is responsible for the five-year review of the remedy implemented at Moffett Field, Operable Unit 1, near Mountain View, California. The triggering action for this statutory review is the first five-year report: *Final Operable Unit (OU) 1 2002 Five-Year Report* (Navy, 2002). The five-year review is required because hazardous substances, pollutants, or contaminants remain at Site 1 above levels that allow for unlimited use and unrestricted exposure. Appendix A, Document Review List, provides the list of documents reviewed in support of preparing this report.

The Navy fulfilled the OU 1 ROD requirement to perform quarterly groundwater monitoring at Site 2 for a minimum period of three years following consolidation of the Site 2 landfill waste within the Site 1 landfill. Groundwater monitoring at Site 2 was performed from August 1999 through October 2002. Groundwater sampling analytical data from July 1999 to October 2001 was included in the OU 1 2002 First Five-Year Review Report. This report includes groundwater sampling analytical data from January 2002 to October 2002 for Site 2. Groundwater sample test results were compared to calculated concentration limits (CCLs) established in the *Technical Memorandum, Site 1 Groundwater Evaluation Process* (Tetra Tech Foster Wheeler [TtFW], 2004). During the three-year sampling period, no constituents of concern (COCs) were consistently detected in groundwater samples from Site 2 at concentrations that could be of concern to the environment. Therefore, the Navy, the Regional Water Quality Control Board, San Francisco Bay Region (Water Board), and the EPA concurred to discontinue groundwater monitoring at Site 2 after October 2002 (EPA Region 9 Letter January 31, 2003, and Water Board, Letter February 25, 2003).

Groundwater sampling was performed on a quarterly basis at Site 1 from January 2002 to November 2004 according to Appendix E of the *Site 1 Landfill Final Closure Plan and Post-Closure Maintenance Plan* until 2005 (Tetra Tech EMI, Inc. [TtEMI], 1998a). Beginning in January 2005, the groundwater monitoring schedule was revised to semi-annual monitoring according to the *Site 1 Landfill Post-Closure Long-Term Monitoring Plan* (TtFW, 2005b). Groundwater sample test results were compared to CCLs established in the *Technical Memorandum* (TtFW, 2004).

To verify and ensure long-term protectiveness, analyzed groundwater sample results are compared with the CCLs identified in the *Final Technical Memorandum, Site 1 Groundwater Evaluation* (TtFW, 2004). The monitoring program currently implemented is appropriate to determine the protectiveness and effectiveness of the remedy.

The status of all operable units and sites at Former NAS Moffett Field are provided below. Site locations, by Installation Restoration (IR) Site number, are provided in Figure 1-3, Navy IR Sites.

CERCLA OU	IR Site No.	Site Name	Status
1	1	Runway Landfill	Operations and maintenance ongoing. First Five-Year Review completed in 2002. Ongoing Annual Reporting.
	2	Golf Course Landfill	Groundwater monitoring completed. First Five-Year Review completed in 2002. Ongoing Annual Reporting.
2 West	8	Waste Oil Transfer Area	Pending evaluation regarding Site 25.
	16	PW Steam Rack Sump No. 60	Soils closed. Groundwater remediation is part of OU 4.
	17	Paint Shop Sump No. 61	Closed.
	18	Dry Cleaners Sump No. 66	Soils pending closure. Groundwater remediation is part of OU 4.
2 East	3	Marriage Road Ditch	Unsaturated soils closed. Groundwater remediation is part of OU 5.
	4	Former Industrial Wastewater Surface Impoundments	Soils closed. Groundwater remediation is part of OU 5.
	6	Runway Apron	Soils closed. Groundwater remediation is part of OU 5.
	7	Unpaved Areas Surrounding Hangars 2 and 3	Soils closed. Groundwater remediation is part of OU 5.
	10	Chase park Area and Runway	Soils closed. Groundwater remediation is part of OU 5.
	11	Engine Test Stand Area	Soils closed. Groundwater remediation is part of OU 5.
	13	Equipment Parking Area	Soils closed. Groundwater remediation is part of OU 5.
3	12	Firefighting Training Area	Closed.
	15	Nine Sumps and Oil/Water Separators	Pending closure.
4	28	West-Side Aquifers Treatment System (WATS) Area	Groundwater treatment system in continuous operation. Addressed under ROD for Middlefield-Ellis-Whisman Site. EPA First Five-Year Review in 2004. Navy First Five-Year Review in 2005. Focused Feasibility Study in progress. Ongoing Annual Reporting.
5	26	East-Side Aquifer Treatment System (EATS) Area	Groundwater treatment system turned off from July 2003 through present to allow for system evaluation, including pilot testing of Hydrogen Release Compound® (HRC®) injection at two groundwater hot spots. First Five-Year Review in September 2005. Ongoing Annual Reporting.
6	3	Marriage Road Ditch	Saturated soils removal completed during Site 27 channel dredging/soils removal. Groundwater remediation is part of OU 5.

CERCLA OU	IR Site No.	Site Name	Status
	25	Wetland Areas and No Further Action (NFA) Sites	Eastern Diked Marsh and Stormwater Retention Basin Feasibility Study completed in June 2007.
	27	Northern Channel	Channel dredging/soils removal began in 2006 and concluded in February 2007. Construction completion report in progress.
--	5	Fuel Farm French Drains	Petroleum impacted groundwater monitoring in progress.
--	9	Old Fuel Farm	Closed.
--	14	Tanks 19, 20, 67, and 68	Preparing work plan for groundwater monitoring and tank testing.
--	19	Tanks 2, 14, 43, and 53	Soils pending closure. Groundwater remediation is part of OU 5.
--	20	Zook Road Fuel Spill	Pending closure.
--	21	Patrol Road Ditch	Soils removal part of Site 27 channel dredging/soil removal. Groundwater remediation is part of OU 5.
--	22	Site 22 Landfill	Operation and maintenance ongoing. First Five-Year Review in 2008. Ongoing Annual Reporting.
--	23	Golf Course Fill Area	Soils response complete. Groundwater remediation is part of OU 5.
--	24	Active Petroleum Sites	Closed.
--	29	Hangar 1	Revising Engineering Evaluation/Cost Analysis (EE/CA).
--	--	Orion Park Housing Area	Groundwater Monitoring Well Installation and Sampling Report for Orion Park Housing Area distributed September 12, 2007.
--	--	Buildings 29 and 55 Pipelines	Pending closure.
--	--	Building 29 Additional Fuel System Components	Fieldwork in progress for petroleum characterization/soil removal.
--	--	Building 55 Sump	Preparing work plan for removal of petroleum sump.
--	--	Wash Rack	Petroleum groundwater monitoring in progress.

1.2 DOCUMENT ORGANIZATION

This OU 1 Landfill 2007 Second Five-Year Review Report is organized as follows:

- **Section 1.0 – Introduction:** provides the purpose and/or authority for conducting the five-year review, lead agency conducting the five-year review, review number, trigger date, and organization for the five-year review document.
- **Section 2.0 – Operable Unit 1 Chronology:** describes site chronology.

- **Section 3.0 – Background:** describes the background of Sites 1 and 2 at Moffett Field, including general site description, land uses, site history, and initial responses at the sites.
- **Section 4.0 – Remedial Actions:** describes the remedial actions performed at the sites.
- **Section 5.0 – Progress Following First Five-Year Review:** summarizes progress of remedy implementation at Site 1 and Site 2 landfills since the first five-year review report was prepared in 2002.
- **Section 6.0 – Five-Year Review Process:** describes the five-year review process, including administrative components; community involvement; document and data review; site inspection; and interviews.
- **Section 7.0 – Technical Assessment:** presents the technical assessments of the sites.
- **Section 8.0 – Issues:** presents any issues identified during the technical assessment, potential affects of issues, and discussion of any unresolved issues raised by other parties.
- **Section 9.0 – Recommendations and Follow-up Actions:** includes recommendations and follow-up actions for Operable Unit 1.
- **Section 10.0 – Protectiveness Statement:** includes the protectiveness statement.
- **Section 11.0 – Next Review:** indicates the due date for the next five-year review.
- **Section 12.0 – References:** provides the referenced documents used for this report.
- **Appendix A – Document Review List:** provides the list of documents reviewed in support of preparing this report.
- **Appendix B – Landfill Inspection Forms:** provides the landfill inspection forms from January 2002 through April 2007.
- **Appendix C – Validated Analytical Data from January 2002 through April 2007:** provides the validated analytical data from January 2002 through April 2007.

2.0 OPERABLE UNIT 1 CHRONOLOGY

The detailed chronology for OU 1 is presented in Table 2-1, Chronology of Operable Unit 1. The Site 2 Former Landfill was operational from the 1940s until approximately 1952. Site 1 operated from 1963 until the mid-1970s. In 1986, Moffett Field was placed on the EPA's National Priorities List (NPL). Remedial Investigation (RI) activities began at OU 1 in 1988 and concluded with the publication of the *Remedial Investigation Report, Operable Unit 1, NAS Moffett Field* (International Technology Corporation [IT], 1993). The ROD was signed in August 1997 and identified the selected remedy for the site. Major elements of the selected remedy for the Site 1 Landfill include landfill cover construction; landfill gas venting trench; groundwater collection trench; groundwater and landfill gas monitoring; and institutional controls were implemented in 1998. Landfill cover maintenance and monitoring of landfill gas and groundwater began in July 1999.

Building 191 is located south of the Site 1 Landfill. Building 191 is equipped with a passive pump system that has operated nearly continuously since the early 1950s. The purpose for operating pumps at Building 191 is to maintain dry conditions on the Moffett runways. The first five-year review report for OU 1 was completed in year 2002.

3.0 BACKGROUND

Moffett Field, located near the southern end of San Francisco Bay (Figure 1-1), has served various military functions during the past 60 years. Moffett Field is bounded by United States Fish and Wildlife Service (USFWS) property to the north, Stevens Creek to the west, U.S. Highway 101 and residential areas to the south, and by Macon Road and E. Patrol Road to the east (Figure 1-2). Sites 1 and 2 are located in the northern portion of Moffett Field. The Site 2 Landfill is now referred to as the Site 2 Former Landfill because the waste material was removed from it.

3.1 REGIONAL GEOLOGY

Moffett Field is located at the northern end of the Santa Clara Valley basin approximately 1 mile south of San Francisco Bay. Regionally, the Santa Clara Valley contains interbedded alluvial, fluvial, and estuarine deposits to a maximum depth of 1,500 feet (*Saltwater Intrusion Investigation in the Santa Clara County Bayland Area, California* [Iwamura, T.I., 1980]). Locally, these sediments consist of varying combinations of clay, silt, sand, and gravel that represent the interfingering of estuarine and alluvial depositional environments during the late Pleistocene and Holocene epochs. The fluvial sediments were derived from the Santa Cruz highlands west of the basin and deposited on an alluvial plain bounded by alluvial fan deposits to the west and baylands to the northeast (Iwamura, T.I., 1980). The heterogeneous nature of channel and interchannel sediments deposited in the fluvial depositional environment are evident in subsurface explorations that have been performed at Moffett Field. These sediments most likely were deposited during the Holocene period when the worldwide sea level was rising toward its present elevation (Navy, 2002).

3.1.1 Site 1 Geology

The stratigraphy of the Site 1 Landfill is a complex interfingering of fine and coarse-grained units representing the boundary between alluvial and estuarine environments and fluctuations of the boundary caused by changes in sea level. Lithologic logs from shallow well borings indicate that the uppermost materials (0 to 60 feet) are comprised of silts to silty clays, which are brown to black, saturated, and moderately plastic. Intermittent throughout the upper 60 feet are interfingered sands and gravels, which vary in composition from a silty, sandy gravel to a clayey gravel. These permeable materials are medium gray to black or brown (Navy, 2002).

Lithologic logs of geophysical borings and monitoring wells deeper than 60 feet show mostly silty clay that is interfingered with sandy, clayey gravel, and sand lenses (IT, 1993). The silty clay is brown to light gray, saturated, and low to moderately plastic. Lithologic logs also indicate variable thicknesses and limited spatial extent of these lenses (IT, 1993).

Shallow subsurface soils from above the saturated uppermost Upper A aquifer zone and leachate well borings were tested for porosity and permeability by laboratory geotechnical testing methods. Samples from the leachate well borings were collected from native soils above the saturated zone. The results indicated that soils below the landfill and above the Upper A aquifer zone are generally clays having hydraulic conductivity values in the 3×10^{-5} feet/day (10^{-8} centimeter per second [cm/s]) range (IT, 1993).

3.1.2 Site 2 Former Landfill

The stratigraphic units characterized by borings at the Site 2 Former Landfill range in age from Pleistocene to Holocene. The lithology is a result of estuarine environments and fluctuations of an estuarine/alluvial boundary caused by changes in sea level. Saturated zones of silty sand and sandy clay below the uppermost clay layers make up the uppermost (A1) aquifer zone.

Lithologic logs from geophysical borings that penetrated the lower alluvial materials show that silty clay is interfingered with sandy, clayey gravel and sand lenses (IT, 1993). The boring logs show variable thicknesses and limited spatial extent of these lenses. Geophysical boring logs that penetrate the upper alluvial materials indicate a plastic silty clay. An intermediate zone exists, consisting of interfingered sand and silty sand, varying in color from tan to brown.

Subsurface-soils collected from the uppermost A1 aquifer zone and leachate wells were tested for porosity and permeability. Similar to the Site 1 Landfill soil, the test results indicated that the Site 2 Former Landfill soils were predominantly clays having hydraulic conductivity of about 3×10^{-5} feet/day (10^{-8} cm/s) range (IT, 1993).

3.2 REGIONAL HYDROGEOLOGY

The subsurface sediments were initially divided into upper and lower aquifers by Iwamura based on hydrogeologic characteristics (Iwamura, 1980). An investigation performed by the Navy classified these aquifers as the A, B, and C aquifers (*Remedial Investigation Report, Middlefield-Ellis-Whisman Area, Mountain View, California* [Harding Lawson Associates [HLA], 1988]). The A and B aquifers correspond to Iwamura's upper aquifer, and the C aquifer corresponds to Iwamura's lower aquifer. The B aquifer is subdivided into three subunits (B1, B2, and B3 aquifer zones). During a subsequent investigation, the Navy reclassified the B1 sediments as the Lower A aquifer zone based on lithologic and sedimentologic similarities between the A and B1 sediments (IT, 1991).

This report uses the nomenclature for aquifer zone subunits Upper A, Lower A, B2, and B3. The A, B, and C aquifers lie over what has been identified as the deep aquifers. Aquitards divide the aquifers and aquifer zones (Navy, 2002). The aquifer and aquitard descriptions are based on existing data and lithologic interpretation of soil borings and cone penetrometer tests.

The aquifer zones, aquitards, and their approximate depths are as follows:

Aquifer	Unit Subdivision	Range of Approximate Depths (feet bgs)	
		Top	Bottom
A	Upper A aquifer zone	0 to 13	15 to 35
	Upper A/Lower A aquitard	Discontinuous	Discontinuous
	Lower A aquifer zone	15 to 45	45 to 77
A/B	A/B aquitard	45 to 65	60 to 85

Aquifer	Unit Subdivision	Range of Approximate Depths (feet bgs)	
		Top	Bottom
B	B2 aquifer zone	60 to 80	95 to 135
	B2/B3 aquitard	95 to 105	99 to 111
	B3 aquifer zone	99 to 130	115 to 160
B/C	B3/C aquitard	115to140	155 to 180
C	na ^{1/}	155 to 160bgs	250
Deep	na ^{1/}	Generally deeper than 250	

bgs denotes below ground surface.

na^{1/} denotes aquifer zone breakdown, if any, is unknown or undefined in the aquifer at this time.

3.2.1 Site 1 Hydrogeology

Most of the groundwater elevations in Site 1 monitoring wells are below sea level. It is estimated that one-third of Site 1 is located below the water table (Navy, 1997). Site-specific aquifer depths may vary from the general depths described in Section 3.2.

Borehole logs show that a silty clay aquitard several feet thick exists below the buried refuse and above the Upper A aquifer zone. The thickness of the aquitard beneath Site 1 varies and the hydraulic conductivity determined for samples from the subsurface using laboratory test methods is 3×10^{-5} feet/day (10^{-8} cm/s). It is not known whether the aquitard is continuous beneath the landfill.

In general, groundwater in the Upper A aquifer zone beneath the landfill (the uppermost aquifer) flows north to south; however, the regional gradient is south to north toward San Francisco Bay. The southward gradient at Site 1 is opposite from the regional gradient because of pumping of the storm drainage system associated with Building 191 located in the northwest portion of Site 26.

Building 191, located south of Site 1, began operating in the early 1950s. It is comprised of a subsurface concrete-lined vault that receives water from subsurface discharge lines. The vault receives water from nearby ditches and the subsurface drains around the area. Building 191 is equipped with a passive pump that operates continuously. The pump station influences groundwater gradients and reverses the natural groundwater flow direction because the drainage system that feeds the pump station is below the water table in some areas.

Three water bodies are associated with Site 1. They are 1) the man-made ephemeral Stormwater Retention Basin to the north, 2) Jagel Slough to the southeast, and 3) the saltwater evaporation pond to the east. It appears that low-permeability barriers exist between the water bodies limiting water movement between each body (Navy, 1997). As a result, differential head pressures are maintained between each water body (IT, 1993). Potential for flow from the landfill to the water bodies exists, but actual flow is limited by these restrictive barriers. Low

hydraulic conductivity, high organic contents associated with the clays, and low contaminant source concentrations combine to restrict flow and limit contaminant migration (Navy, 1997).

3.2.2 Site 2 Former Landfill Hydrogeology

Groundwater elevations at the Site 2 Former Landfill are all below mean sea level (msl). Water levels in monitoring wells range from 4 to 7 feet below msl. According to the Remedial Investigation Report (IT, 1993), the water table in the fill material is variable and represents a perched condition with downward seepage into the A1 aquifer zone. Aquifers beneath the Site 2 Former Landfill are similar to those found under the Site 1 Landfill.

Groundwater flow patterns at the Site 2 Former Landfill are influenced by pumping of the storm drainage system associated with the Building 191 pump station. The groundwater at the Site 2 Former Landfill flows to the north toward the Northern Channel. The gradient is steeper toward Building 191 due to active pumping. These conditions varied in 2006, when the pumps in Building 191 were turned off from May 26 to November 30 in order to support the slough dredging operations associated with Site 27.

3.3 BACKGROUND AND HISTORY OF OPERABLE UNIT 1

This section summarizes the background of the sites including information of the physical characteristics, land and resource use, and history of Sites 1 and 2.

3.3.1 Physical Characteristics

Site 1 is located in the northernmost region of Moffett Field (Figure 1-2). There are no drinking water or production wells in the area.

Site 1 is located in the northernmost portion of Moffett and encompasses approximately 12 acres. Site 1, historically also referred to as the Runway Landfill, lies at the north end of the runways between North Perimeter Road, the USFWS property, and the Stormwater Retention Basin. The landfill is surrounded by a fence, with the exception of the north side which is bordered by the Stormwater Retention Basin. Access to the site is restricted by two locked gates. The landfill is flat on the west side with an elevation of approximately 7 feet above mean sea level (msl). It is mounded on the eastern side where the elevation is approximately 23 feet msl at the apex. The extent of landfill waste is shown in Figure 1-4, Extent of Waste at Site 1 Landfill. Two culverts drain surface water from the site toward the south.

The Site 2 Former Landfill consists of a fenced in area approximately 6 acres in size. The land surface is relatively flat with a surface drain that extends around the east, south, and west side of the site before terminating in a subsurface storm drain. The site is fenced and secured by two locking gates. It is bordered to the west by North Perimeter Road, to the north by North Patrol Road, to the east by Building 561, and to the south by Macon Road.

3.3.2 Land and Resource Use

Land usage at Sites 1 and 2 is specified in the *Moffett Field Comprehensive Use Plan* prepared by National Aeronautics and Space Administration (NASA) (NASA, 1994). The plan states that

the primary uses for this area is an airfield clearance zone and open space. The plan further states that access should be limited and the area preserved in its natural state because of safety interests. There are currently no plans for this property to change ownership. Additional information on institutional controls, including a memorandum of agreement with NASA, is provided in the *Draft Final Interim Remedial Action Report, Site 1 and Site 2 Landfill Closure* (TtEMI, 2001).

3.3.3 History of Site 1

Site 1 was operated as a landfill from the mid-1960s until the late 1970s. Subsequently, the site was used as a pistol range. Detailed operation records for Site 1 were not maintained, however, a solid waste facility permit was obtained from Santa Clara County in 1979. This permit states that the landfill operated as a sanitary landfill and that it received wastes such as cardboard, lawn cuttings, prunings, wood waste, and asbestos insulation wrapped in double-plastic bags. According to civilian and military personnel interviews, the landfill received domestic refuse, as well as, waste from maintenance and military operations. Maintenance and military operations waste includes scrap equipment; paint and paint thinners; solvents; lacquer; ash; asbestos; jet fuels; waste oil; fuel filters (containing fuel sludge, lead compounds, and rust); transformer oil and filters; and polychlorinated biphenyl (PCB)-contaminated sawdust. However, data collected during field investigations support the information found in the permit and indicate that Site 1 was operated much like a solid waste landfill (Navy, 1997).

According to sources identified in the Remedial Investigation Report, refuse at Site 1 was placed in an excavation that ranged in depth from 2 to 21 feet below msl, but typically ranged from 8 to 12 feet below msl (IT, 1993). The refuse material was covered with 0.5 to 7 feet of gravelly sand. At times, the refuse was placed above the land surface to an elevation of up to 10 feet above msl. Although no disposal records for the landfill exist and the extent of refuse has not been fully determined, a conservative estimate of the total refuse volume at Site 1 is 423,000 cubic yards (Navy, 1997).

The ROD specifies consolidation of the Site 2 landfill wastes into Site 1 and construction of a multilayer landfill cover at Site 1 (Navy, 1997). The Site 2 waste was excavated, transported, and placed into the Site 1 Landfill in August 1997. A multilayer landfill cover was constructed at Site 1 between August 1997 and November 1997. Construction including gas vents, trenches, monitoring wells, drainage ditches, and roadwork, was completed in 1998.

Site 1 is presently covered with a landfill cover consisting of a 1-foot thick lower foundation layer (bottom), a 1-foot thick upper foundation layer, a 1-foot thick low-permeability clay layer, a geotextile biotic barrier layer, and a 1-foot thick vegetative soil layer (bottom). A groundwater extraction trench was constructed across the northern boundary of the landfill as a contingency measure intended to control contaminated groundwater migrating off site. The trench is approximately 5.5 feet deep (a bottom elevation of -5.0 feet msl) and lined with geosynthetic material as described in the *As-Built Report and Remedial Action Completion Report, Site 1 and Site 2 Landfill Closures* (IT, 2000a). Based on the drawings in the *As-Built Report and Remedial Action Completion Report, Site 1 and Site 2 Landfill Closures* (IT, 2000a), the geosynthetic liner extends from the surface of the landfill over the top of the trench and continues into the north side of the trench. This effectively forms an impermeable barrier between the trench and the Stormwater Retention Basin north of the landfill. Two collection wells (W1-22 and W1-23 [Figure 6-2, Potentiometric Surface, October 16, 2006]) are screened within the trench.

A gas-venting trench was installed across the western boundary of the landfill to allow potential landfill gas to vent to the atmosphere. The bottom of the gas-venting trench is approximately 4.0 feet below ground surface (elevation of -2.3 feet msl) and lined with geosynthetic membranes. A 4-inch perforated pipe was laid in the gas-venting trench before backfilling with drain rock (IT, 2000a). Several gas-venting wells are installed within the landfill to allow landfill gas to vent to atmosphere.

3.3.4 History of the Site 2 Former Landfill

The Site 2 Former Landfill, also referred to as the Golf Course Landfill, is located west of the golf course at the intersection of North Patrol Road and Zook Road (Figure 1-2). Site 2 is bordered to the north by North Patrol Road, the Northern Channel, and Cargill Salt Company salt evaporation ponds. The site is generally flat and surrounded by a fence.

At Site 2, records of landfill operation were not maintained, but the landfill operated from the 1940s until approximately 1952 (IT, 1993). The landfill reportedly received domestic refuse, as well as wastes from maintenance and military operations, such as scrap equipment; paint and paint thinners; solvents; lacquer; oil; fuel filters; and sawdust contaminated with polychlorinated biphenyls (PCBs) (Navy, 1997).

Trenching performed by the Navy during April 1996, to more accurately define the landfill boundary, showed the presence of inert fill and construction debris, but not large amounts of waste materials (IT, 1993). Two test pits excavated in July 1996 indicated the presence of only inert materials such as construction debris. In September 1996, the Navy excavated eight additional trenches in the northern half of Site 2 to provide additional visual waste identification; the location of waste relative to the water table; and the overall volume of waste in the subsurface at Site 2. Municipal-type waste was found isolated in a specific waste area and was easily distinguished from inert construction debris or native clays beneath the waste. Observations during trenching indicated that portions of the waste were saturated with groundwater and the volume of waste at Site 2 was much smaller than estimated in the remedial investigation/feasibility study.

The Site 2 Former Landfill was excavated by the Navy in July and August 1997. At that time, approximately 23,000 cubic yards of refuse were transferred and consolidated within the Site 1 Landfill. The excavation was backfilled with soil overburden removed during the clearing and grubbing of the landfill surface. Following excavation activities, clean imported soil was graded and hydroseeded (TtEMI, 2001).

3.4 INITIAL RESPONSE AT SITES 1 AND 2

The initial response at Site 1 included site characterization. This characterization included an Initial Assessment Study, a confirmation study, a solid waste assessment test (SWAT), an air SWAT, a remedial investigation, and post-remedial investigations (TtEMI, 2001).

Low contaminant concentrations found in samples of leachate, surface debris, and boreholes at both sites supported use of the EPA presumptive remedy for the sites (TtEMI, 2001). The EPA has concluded that engineered containment will be used where the wastes pose a relatively low, long-term threat and treatment is impracticable (40 CFR 300.430[a][i][iii][B]).

The analysis of risks to human health posed by Site 1 is limited to exposure to soil or soil gas because groundwater is and will not likely be used as a source of drinking water or for other beneficial use in the future (TtEMI, 2001). The groundwater in the Upper A aquifer zone beneath the northern portion of Moffett Field does not meet the state standards for yield of 200 gallons per day or 3,000 milligrams per liter of total dissolved solids (TDS) (Navy, 1997). Therefore, the evaluation of risk is limited to ingestion or dermal contact with soils, inhalation of wind-eroded surface soils, and inhalation or explosion of landfill gas (TtEMI, 2001).

Post-Remedial Investigation activities were performed at Site 2 to define the extent of buried material prior to its relocation in the Site 1 Landfill. Trenching was performed in April 1996, September 1996, and July 1997. The results of the trenching indicated that the extent of area used for waste disposal was less than 1 acre and waste thicknesses appeared to be less than 10 feet deep at most locations (Navy, 1997). In July and August 1997, Site 2 was excavated and the extent of wastes was found to be greater than indicated by the trenching. Approximately 23,000 cubic yards of refuse were excavated from Site 2 and consolidated within Site 1 (TtEMI, 2001).

4.0 REMEDIAL ACTIONS

The following sections discuss the remedy selected; implementation; and system operation and maintenance (O&M) for Site 1.

4.1 REMEDY SELECTION

The ROD does not identify remedial action objectives for specific response actions described (Navy, 1997). Rather, the ROD states that the selected remedy for Sites 1 and 2 meets the statutory requirements of Section 121 of CERCLA (Navy, 1997). The statute requires that the remedial actions selected meet the following objectives:

- Be protective of human health and the environment
- Comply with applicable or relevant and appropriate requirements (ARARs), unless a statutory waiver is justified
- Be cost-effective
- Utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practical
- Satisfy the preference for treatment that reduces toxicity, mobility, or volume as a principal element, or provide an explanation as to why this preference cannot be satisfied

4.1.1 Description of Remedy

The ROD was signed by the Navy, EPA Region 9, California Department of Toxic Substances Control (DTSC), and the Water Board, in August 1997 (Navy, 1997). The following summary in the ROD describes the selected remedy:

- Consolidating wastes from Site 2 into Site 1 in accordance with substantive provisions of Title 23 California Code of Regulations (CCR), Chapter 15; backfilling and restoring Site 2; and designating Site 1 as a Corrective Action Management Unit (CAMU) in accordance with 22 CCR, Division 4.5, Chapter 14, Article 15.5, Section 66264.552.
- Covering the Site 1 Landfill in accordance with California Solid Waste Management Regulations in CCR, Title 14 - Natural Resources, Division 7, Chapter 3, Article 7.8 - Disposal Site Standards, Closure and Post-closure (14 CCR) and 23 CCR, Chapter 15, or federal regulations in 40 CFR, Part 258.60, whichever are more stringent.
- Conducting groundwater monitoring at Sites 1 and 2 in accordance with provisions of 14 CCR and 23 CCR, Chapter 15. Conducting groundwater monitoring at Site 2 for a minimum period of three years after Site 2 waste is consolidated at Site 1, to ensure groundwater at Site 2 is not adversely affected. Pursuant to 23 CCR, Chapter 15, Article 5, Section 2550.4, the Navy will derive and propose concentration limits for each

constituent of concern. Federal ambient water quality criteria (AWQC) and Water Board Basin Plan water quality objectives will be considered in deriving the CCLs.

- Installing a subsurface groundwater collection trench along the northern border of Site 1 to intercept potential future leachate migration before it reaches surface water, if necessary. If groundwater monitoring data exceed the criteria derived in accordance with 23 CCR, Chapter 15, Article 5 (item 3 above), the Navy will immediately notify the regulatory agencies and will evaluate the groundwater contamination in accordance with CERCLA and will obtain concurrence from the EPA and the State on remediation decisions.
- Conducting landfill gas monitoring at Site 1 in accordance with applicable provisions of 14 CCR and 23 CCR, Chapter 15.
- Installing a passive gas-venting trench along the western boundary of Site 1 to prevent potential off-site, subsurface migration of landfill gases.
- Conducting post-closure maintenance activities at Site 1 in accordance with applicable provisions of 14 CCR and 23 CCR, Chapter 15, or 40 CFR, Part 258.61, whichever is more stringent.
- Institutional controls - Fencing, signs, O&M of Building 191 pump station and drain/sub-drain system, and restrictions on cover disturbances. The Navy will resolve any issues with NASA regarding the process to develop appropriate restrictive provisions to ensure continued O&M of the Building 191 pump stations and to maintain the integrity of the Site 1 cover. The Navy will enter into an agreement with NASA or develop another appropriate vehicle to accomplish this task.

4.2 REMEDY IMPLEMENTATION

Pre-construction activities began on June 30, 1997. The start of excavation and transfer of Site 2 wastes to Site 1 on July 28, 1997, marked the beginning of the remedial action. Construction of the remedy was completed November 16, 1998. Table 2-1 of this report provides key milestones. Details regarding the implementation of the selected remedy are documented in the *Draft Final Interim Remedial Action Report, Site 1 and Site 2 Landfill Closures* (TtEMI, 2001) and the *As-Built Report and Remedial Action Completion Report, Site 1 and Site 2 Landfill Closures* (IT, 2000a).

Soil confirmation samples were collected at the Site 2 Former Landfill following the excavation activities. A total of 37 soil confirmation samples were collected from the bottom and sidewalls of the excavation. The analytical results of confirmation samples were compared to the EPA Region 9 industrial preliminary remediation goals (PRGs). The excavation at the Site 2 Former Landfill continued until the confirmation sample results met the EPA Region 9 PRGs.

As stated in the *Draft Final Interim Remedial Action Report, Site 1 and Site 2 Landfill Closures*, the remedy selected for Site 1 included the consolidation of wastes from Site 2 into Site 1 (TtEMI, 2001). Material excavated from Site 2 was transferred to Site 1 for use in the lower foundation layer (LFL). The material was spread, graded, and compacted onto the prepared subgrade. Portions of Site 1 were moved to construct the design contours of the LFL. The

former pistol range located at Site 1 and other areas within the site were regraded. The Site 1 Landfill cover consists of an upper foundation layer (UFL), a low-permeability clay layer (LPCL), a biotic barrier, and a vegetative cover. The UFL consists of a 1-foot compacted soil layer. The LPCL consists of a 1-foot layer of compacted Palo Alto clay. A biotic barrier consisting of 10 ounces per square yard of non-woven geotextile fabric was installed over the LPCL. The minimum overlap of the geotextile fabric was 12 inches. The vegetative cover consists of 1 foot of compacted soil. A collection trench was installed across the northern boundary of the site. A gas-venting trench was installed on the west side of the landfill. Surface drainage ditches were added and three 12-inch culverts were constructed. Rip-rap was added for erosion control along the northern slope leading into the Stormwater Retention Basin and the site was hydroseeded. A perimeter road was constructed around the landfill and the area was secured with a fence with two locking gates. Gas vents were installed across the landfill. Four survey monuments were installed to monitor settlement (TtEMI, 2001).

A groundwater elevation survey was performed on a quarterly basis in accordance with Appendix E of the *Site 1 Landfill Final Closure Plan and Post-Closure Maintenance Plan* until 2005 (TtEMI, 1998a). In 2005 the groundwater monitoring schedule was amended to semiannual in accordance with the *Site 1 Landfill Post-Closure Long-Term Monitoring Plan* (TtFW, 2005b).

The following steps were completed when performing the groundwater elevation survey:

1. Remove the well cover and allow the water level in the well to stabilize.
2. Lower the water level probe into the well until the light or sound alarm indicates that the probe has touched the water surface.
3. The static depth to water is read directly from the tape by holding the tape to the permanent mark on the well casing or cover.
4. The probe is then raised and lowered twice to confirm the reading.
5. Readings are averaged to determine the depth to water.

All available wells are measured each quarter, regardless of whether they are used for groundwater sampling.

Groundwater sampling was performed on a quarterly basis at Site 1 from January 2002 to November 2004 in accordance with Appendix E of the *Site 1 Landfill Final Closure Plan and Post-Closure Maintenance Plan* until 2005 (TtEMI, 1998a). Beginning in January 2005, the groundwater monitoring schedule was amended to semiannual in accordance with the *Site 1 Landfill Post-Closure Long-Term Monitoring Plan* (TtFW, 2005b). Groundwater sampling at Site 2 was performed on quarterly basis from August 1999 through October 2002. Groundwater sampling at Site 2 was discontinued in 2002 following this based on concurrence from EPA Region 9 and the Water Board. The groundwater samples are collected using low-stress sampling methodology (flow rates less than 500 milliliters per minute) with a peristaltic pump and disposable tubing. Field quality control samples are collected in accordance the *Final Sampling and Analysis Plan Addendum for Post-Closure Monitoring (Site 1) and Groundwater Monitoring (Site 2)* (Foster Wheeler Environmental Corporation [FWENC], 2001a) and the *Site 1 Landfill Post-Closure Long-Term Monitoring Plan* (TtFW, 2005b).

The samples are analyzed for the following parameters:

- Dissolved metals by EPA Method 200.8/6010B/7742
- Dissolved mercury by EPA Method 7470A
- Total metals by EPA Method 200.8/6010B/7742 (Until March 2004)
- Total mercury by EPA Method 7470A (Until March 2004)
- Volatile organic compounds (VOCs) by EPA Method 8260B
- Semivolatile organic compounds (SVOCs) by EPA Method 8270C
- Pesticides by EPA Method 8081A
- PCBs by EPA Method 8082 (Until October 2005)

The following groundwater monitoring wells and collection trench wells are sampled during each event:

- W1-1R
- W1-5
- W1-8
- W1-12R
- W1-14
- W1-15
- W1-16
- W1-19
- W1-24
- W1-22 (collection trench well)
- W1-23 (collection trench well)
- W1-24

Landfill gas monitoring is performed in accordance with the Site 1 Landfill Final Closure Plan and Post-Closure Maintenance Plan (TtEMI, 1998a), the Postclosure Monitoring (Site 1) and Groundwater Monitoring (Site 2) Sampling and Analysis Plan (IT, 2000b), Final Sampling and Analysis Plan Addendum (FWENC, 2001a), and the Site 1 Landfill Post-Closure Long-Term Monitoring Plan (TtFW, 2005b). A Landtec GA-90 meter is used to measure methane concentrations at each gas vent on the landfill and at designated perimeter monitoring locations along the site boundary.

4.3 SYSTEM OPERATION/OPERATION AND MAINTENANCE

O&M activities at Site 1 are described in the Site 1 Landfill Final Closure Plan and Post-Closure Maintenance Plan (TtEMI, 1998a), the *Final Site-Specific Contractor Quality Control Plan for Sites 1 and 2 Groundwater Monitoring and Maintenance* (FWENC, 2001b), and the *Site 1 Landfill Post-Closure Long-Term Maintenance Plan* (TtFW, 2005a).

Since 2005, landfill inspections have been performed as prescribed by the Site 1 Landfill Post-Closure Long-Term Maintenance Plan (TtFW, 2005a). Prior to 2005, inspections were performed in accordance with the *Final Site-Specific Contractor Quality Control Plan for Sites 1 and 2 Groundwater Monitoring and Maintenance* (FWENC, 2001b). Maintenance activities are performed based on the findings of the inspections. Additionally, vegetation is cut as required to maintain height of about 6 inches for a neat appearance and to reduce fire hazard. The

Santa Clara County Department of Environmental Health also inspects Site 1 quarterly. The inspection schedule follows (TtFW, 2005a).

Site 1 Inspection Schedule

Activities	Immediately	Quarterly ¹	Semiannually	Other
Special Events, (i.e., storms/fires)	X			
Security		X		
General Site		X		
Landfill Cover/Cover/Grading		X		
Landfill Gas Vents		X		
Landfill Gas Monitoring Wells		X		
Gas Venting Trench		X		
Collection Trench Wells		X		
Monitoring Wells		X		
Piezometers		X		
Stormwater Runoff Control		X		
Settlement and Subsidence			X ²	Every 5 years ²

¹ Inspections are performed on a quarterly basis by Santa Clara County DEH and TN&A. The inspections must be performed at a minimum on a semiannual basis in accordance with Table 4-1, Site 1 Landfill General Inspection Checklist and Frequency (TtFW, 2005a).

² The settlement and subsidence survey was performed on a semiannual basis in 2002 and 2003. The previous survey was completed in March 2005. The next settlement and subsidence survey will be performed 5 years from the previous surveying (TtFW 2005a).

The minimum inspection frequency recommendation has been adhered to since the completion of the Site 1 remedy installation. Recently, inspections have been performed more frequently than specified in the plans due to the need to monitor ground squirrel activity and provide maintenance, as required. General inspections are currently performed on a quarterly basis. General site inspection forms for Site 1 are included in Appendix B.

Landfill markers (LM-1 through LM-4) and settlement markers (SM-1 through SM-6) were added after remedial activities were completed at Site 1. The landfill and settlement markers were first surveyed in November 1998. Because of habitat alteration activities, SM-2 and SM-3 were destroyed. Therefore, replacement markers SM-2R and SM-3R were installed and resurveyed on October 22, 2003. Landfill survey monuments are surveyed by a licensed California surveyor every five years, in accordance with Title 27 CCR, Section 21090(e)(2). A quantitative evaluation of landfill settlement is scheduled for 2008.

Methane measurements, water level measurements, and groundwater samples have been collected at Site 1 on a quarterly basis from January 2002 to November 2004. Beginning January 2005, monitoring has subsequently been performed on a semiannual basis. Sections 5.4.1.1 through 5.4.1.3 provide a technical assessment of the landfill gas, water level, and groundwater sampling results, respectively.

Annual reports are submitted to EPA Region 9 and the Water Board. Each annual report summarizes Site 1 background information, maintenance activities, methods and procedures for monitoring and sampling; gas sampling data, groundwater level data, groundwater analytical data, and references for Site 1.

Maintenance activities and associated years in which they were performed at Site 1 are as follows:

- Re-seed areas (2002)
- Paint bollards, vents, wells (2002, 2006)
- Cut vegetation on landfill cover and in drainage ditches to maintain height of approximately 6 inches (as needed to maintain 6-inch height) (2002, 2005, 2006)
- Fill and compact squirrel burrows (2002, 2003, 2004, 2005, 2006)
- Habitat alteration for ground squirrel mitigation (2002, 2003)
- Repair cracks and depressions in the perimeter road (2002)
- Re-label gas vents (2002)
- Repair concrete collars on landfill gas vents (2004)
- Landfill marker surveys (2002, 2003, 2005)
- Settlement marker surveys (2002, 2003, 2005)

Burrowing animals including the California ground squirrel and nesting owls were previously identified at Site 1. The *Final Habitat Alteration Work Plan for Site 1 Landfill* (HAWP) (FWENC, 2002) was implemented to minimize potential impact to the site from burrowing animals. Mitigation measures included population control of the ground squirrels, installation of a barrier fence, and habitat alteration. Inspection for ground squirrel burrows at Site 1 is performed on a semiannual basis. Raptor perches are also present to encourage the presence of predatory species and require maintenance. Maintenance activities include semiannual inspection of the site for burrowing squirrels and nesting owls. Any squirrel burrows are collapsed and filled. Owl burrows will be monitored and reported. Any additional squirrel population control measures that are implemented will be consistent with the Maintenance Plan and approved by the Navy and appropriate agencies.

4.4 OPERATION AND MAINTENANCE COSTS

The O&M costs include cover, drainage structure, and road maintenance; water level measurements; groundwater sampling, analyses, and quarterly reporting; landfill gas monitoring; well and monument maintenance; settlement surveys; security fencing maintenance; and HAWP development.

Reported costs for system operation/O&M, as required by the EPA Comprehensive Five-Year Review Guidance, are provided below.

Date	OU 1 Total Estimated Cost Rounded to the Nearest \$1,000	OU 1 Total Actual Cost Rounded to the Nearest \$1,000
Total O&M Cost 2002	\$250,000	\$291,000
Total O&M Cost 2003	\$250,000	\$442,000 ²
Total O&M Cost 2004	\$250,000	\$243,000
Total O&M Cost 2005	\$250,000	\$157,000 ³
Total O&M Cost 2006	\$250,000	\$91,000 ³
Total O&M Cost 2007¹	\$105,000	\$46,000 ³
Five-Year Total	\$1,355,000	\$1,270,000

¹ Total O&M cost for 2007 is based on the service provider contract period of performance from January 2007 through May 2007.

² The actual cost for year 2003 is significantly higher than the estimated cost because the Final California Squirrel Management Plan and the Final Habitat Alteration Work Plan were implemented during this year.

³ The actual cost for years 2005 through 2007 are significantly lower than the estimated cost because O&M activities during these years primarily consist of monitoring groundwater and landfill gas, and of maintaining the landfill surface and related man-made features.

4.5 ENFORCEMENT ACTIONS

No enforcement actions have been taken at OU 1.

5.0 PROGRESS FOLLOWING FIRST FIVE-YEAR REVIEW

This section summarizes progress of remedy implementation at the Site 1 and Site 2 landfills since the first five-year review report was prepared in 2002. The status of the recommendations and follow-up actions that were listed for Sites 1 and 2 in the first five-year review report is provided in following sections.

5.1 PROGRESS FOR THE SITE 1 LANDFILL

This table summarizes the status of Issues, Recommendations, and Follow-up Actions for the Site 1 Landfill from the first five-year review, and indicates whether actions have been completed or are ongoing.

Issue	Recommendations/ Follow-up Actions	Responsible Party	Oversight Agency	Completion Date	Affects Protectiveness? (Y/N)	
					Current	Future
Squirrels Burrow on Landfill Slopes and Area Surrounding the Landfill	Continue to monitor squirrel activity and fill holes, as necessary.	Navy	Water Board EPA Santa Clara County DEH	In Progress	N	N
	Complete development of Habitat Alteration Work Plan to remove the preferred squirrel habitat and provide additional control of the squirrels.	Navy	Water Board EPA	October 2002	N	N
	Implement Habitat Alteration Work Plan with regulatory agency concurrence.	Navy	Water Board EPA	May 2003	N	N
Concentration Limits Need to be Set per the ROD	Set concentration limits in accordance with ROD requirements. To include these concentration limits in the Technical Memorandum for Sites 1 and 2 Groundwater Evaluation Process.	Navy	Water Board EPA	April 2004	N	N

Issue	Recommendations/ Follow-up Actions	Responsible Party	Oversight Agency	Completion Date	Affects Protectiveness? (Y/N)	
					Current	Future
Concentration Limits Need to be Set per the ROD (continued)	Evaluate groundwater data in accordance with procedures developed with the regulatory agencies, which will be presented in the Technical Memorandum for Sites 1 and 2 Groundwater Evaluation Process.	Navy	Water Board EPA	March 2005 ¹	N	N

¹ Groundwater Report for Operable Unit 1, Rev 0, March 31, 2005.

5.2 PROGRESS FOR THE SITE 2 FORMER LANDFILL

This table summarizes the status of Issues, Recommendations, and Follow-up Actions for the Site 2 Former Landfill from the first five-year review, and indicates whether actions have been completed or are ongoing.

Issue	Recommendations/ Follow-up Actions	Responsible Party	Oversight Agency	Milestone Date	Affects Protectiveness? (Y/N)	
					Current	Future
ROD Requirement of Minimum Three Years of Groundwater Monitoring	Complete minimum three years of groundwater monitoring per the ROD requirements	Navy	Water Board EPA	October 2002	N	N
Concentration Limits Need to be Set per the ROD	Set concentration limits in accordance with ROD requirements. To include these concentration limits in the Technical Memorandum for Sites 1 and 2 Groundwater Evaluation Process.	Navy	Water Board EPA	April 2004	N	N

Issue	Recommendations/ Follow-up Actions	Responsible Party	Oversight Agency	Milestone Date	Affects Protectiveness? (Y/N)	
					Current	Future
Concentration Limits Need to be Set per the ROD (continued)	Evaluate groundwater data in accordance with procedures developed with the regulatory agencies, which will be presented in the Technical Memorandum for Sites 1 and 2 Groundwater Evaluation Process.	Navy	Water Board EPA	March 2005 ¹	N	N

¹ Groundwater Report for Operable Unit 1, Rev 0, March 31, 2005.

6.0 FIVE-YEAR REVIEW PROCESS

The EPA's Comprehensive Five-Year Review Guidance (EPA, 2001) and the Navy Policy for Conducting Comprehensive Environmental Response, CERCLA Statutory Five-Year Reviews (Navy, 2001) outline the five-year review process and the elements required. This section of the document describes the process and summarizes the data reviewed.

6.1 ADMINISTRATIVE COMPONENTS

The required administration components include the notification of potentially interested parties, the identification of the five-year review team, and the schedule for the five-year review.

6.1.1 Notification of Potentially Interested Parties of Initiation of Review Process

The Navy made a presentation about the OU 1 Second Five-Year Review during the Restoration Advisory Board (RAB) meeting on September 13, 2007. Potentially interested parties, including representatives from the community; federal, state, and local government agencies attended and/or participated in this RAB meeting. A registration form was available to meeting attendants and participants to document their request(s) to receive a copy of this document. The public notification for the Final Second Five-Year Review Report for OU 1 will be placed in the local newspaper.

6.1.2 Identification of Five-Year Review Team

The five-year review team consists of the Base Realignment and Closure Environmental Coordinator, Mr. Darren Newton, with technical support from T N & Associates, Inc. (TN&A).

6.1.3 Cost of O&M

The total planned cost of O&M versus the total actual cost of O&M is summarized in Section 4.4.

6.1.4 Outline of Components and Schedule of Five-Year Review

The second five-year review consists of the following tasks:

- Community involvement
- Document review
- Data review
- Site inspection
- Interview(s)
- Preparation of OU 1 2007 Five-Year Review Report

6.2 COMMUNITY INVOLVEMENT

Public meetings were not held as part of the second five-year review. Results of the five-year review will be provided to the public via the RAB document sign-up process and placement of a copy of the final report in the local information repository at the Mountain View Public Library.

6.3 DOCUMENT REVIEW

This second five-year review consists of a review of relevant documents including the Monitoring and Maintenance Plans, Technical Memorandum, O&M records, and monitoring data. Appendix A provides a list of documents reviewed in support of the five-year review.

6.4 DATA REVIEW

Methane measurements, water level measurements, and groundwater samples have been collected at Site 1 on a quarterly basis from January 2002 to November 2004. Beginning January 2005, monitoring has subsequently been performed on a semiannual basis (TtFw, 2005b). Groundwater sample test results were compared to CCLs established in the *Technical Memorandum, Site 1 Groundwater Evaluation Process* (TtFW, 2004). No COCs were detected consistently in groundwater samples from Site 2 at concentrations that could be of concern to the environment. Appendix C provides the validated groundwater sampling data from January 2002 through April 2007. Monitoring and maintenance reports are prepared for each associated reporting period. The monitoring reports summarize the monitoring and sampling results for that time period and describe maintenance activities performed at the sites.

The Navy fulfilled the OU 1 ROD requirement of performing quarterly groundwater monitoring at Site 2 for a minimum period of three years after Site 2 landfill waste was consolidated within the Site 1 Landfill. Groundwater monitoring at Site 2 was performed from August 1999 through October 2002. Groundwater sampling analytical data from July 1999 to October 2001 was included in the OU 1 2002 First Five-Year Review Report. This report includes groundwater sampling analytical data from January 2002 to October 2002 from Site 2. Groundwater sample test results were compared to CCLs established in the *Technical Memorandum, Site 1 Groundwater Evaluation Process* (TtFW, 2004). During the three-year sampling period, no COCs were detected consistently in groundwater samples from Site 2 at concentrations that could be of concern to the environment. Therefore, the Navy, the Water Board, and the EPA concurred to discontinue groundwater monitoring at Site 2 after October 2002. A summary of the monitoring results at Site 2 is presented below. Appendix C presents the validated groundwater sampling data from 2002.

6.4.1 Site 1 Landfill

Data reviewed from Site 1 include methane measurement data, water level measurement data, and groundwater sampling analytical data. Each of these is briefly discussed below. Results of other O&M data collection are also summarized.

6.4.1.1 Methane Measurement Data

As part of landfill maintenance activities, landfill gas measurements are routinely obtained from 19 passive gas vent wells within the landfill, four landfill gas monitoring wells (LGMW) on the

perimeter of the landfill, and an additional 21 perimeter methane monitoring locations at approximately 150-foot intervals at the site boundary. A portable Landtec GA 90 meter is used to measure landfill gas concentrations. The locations of all gas monitoring locations and the percent methane concentrations for October 16, 2006, are shown on Figure 6-1, Percent Methane Concentration Contours, October 16, 2006. Table 6-1, Percent Methane at the Site 1 Landfill, January 2002 through April 2007, shows the percent methane concentrations from January 2002 through April 2007.

Methane concentrations have generally been highest near the center of the landfill gas vent GV-11 with concentrations ranging from 3.5 percent by volume (October 2005) to 61.9 percent by volume (April 2006) and extending northeast towards gas vent GV-7 (62.5 percent by volume in April 2006) and gas vent GV-8 (59.8 percent by volume in April 2006). Methane has not been detected in the gas-venting trench. None of the perimeter wells (LGMW 1-1 through LGMW 1-4) nor perimeter monitoring points have shown concentrations of methane above the concentration limit of five percent by volume as specified in 27 CCR, Section 2092 1(a)(2) and in the ROD (Navy, 1997).

6.4.1.2 Water Level Measurement Data

Water level measurements are routinely recorded at 14 wells and piezometers at Site 1. At Site 1, groundwater flows from the north toward the south and is influenced by the pumping of the storm drainage system associated with the Building 191 pump station. Figure 6-2 shows the potentiometric surface on October 16, 2006, at Site 1. The gradient is relatively flat across the site (approximately 0.0008 feet per foot). Water elevations at the site are relatively stable showing very little change or seasonal variation since July 2002.

The geology beneath Site 1 consists of a complex interfingering of fine grained units. Shallow groundwater beneath the Site 1 Landfill is found in the A1 aquifer zone. The primary direction of groundwater flow is to the south, influenced by pumping at Building 191, which discharges water into the Northern Channel. A component of the groundwater beneath the site may discharge to nearby surface-water bodies (an evaporation pond and/or the Former Jagel Slough). Groundwater beneath the site is neither considered a potable water source, nor is used for municipal water supply or agricultural purposes (Navy, 1997). Analytical results for samples collected from groundwater wells at Site 1 are discussed in Section 6.4.1.3 Review of these results indicates that groundwater from Site 1 conveyed and discharged by pumps associated with Building 191 does not likely pose an environmental a risk.

6.4.1.3 Groundwater Sampling Data

Groundwater samples are collected from eight monitoring wells and two collection trench wells at Site 1. The following three tables show the locations of analytes detected and the sampling event they were detected: Table 6-2, Frequency and Location of VOCs and Pesticides Detected at the Site 1 Landfill, January 2002 through April 2007; Table 6-3, Frequency and Location of Total Metals Detected at the Site 1 Landfill, January 2002 through March 2004; Table 6-4, Frequency and Location of Dissolved Metals Detected at the Site 1 Landfill, January 2002 through April 2007. Table 6-5, Minimum, Maximum and Average Analyte Concentrations at Site 1 Landfill, January 2002 through April 2007, shows the minimum, maximum, and average analyte concentrations detected at Site 1. The complete data are presented in Appendix C. CCLs were established in the Technical Memorandum, Site 1 Groundwater

Evaluation Process (TtFW, 2004), in accordance with ROD requirements (Navy, 1997). These CCLS are listed in Appendix C.

Table 6-2 shows the VOCs and pesticides detected in groundwater along with the location and identity of the sampling event in which detection occurred. Validated analytical results for VOCs, PCBs and, pesticides are included in Appendix C. PCBs have not been detected in groundwater samples collected during the review period. Carbon disulfide has been detected above its respective CCL of 0.21 micrograms per liter ($\mu\text{g/L}$) in four wells in concentrations ranging from 0.31 $\mu\text{g/L}$ (well W1-5, October 2002) to 4.1 $\mu\text{g/L}$ (well W-12, April 2002). Carbon disulfide has not been detected above the CCL in any samples collected since April 2003. Heptachlor epoxide was detected above its respective CCL of 0.36 $\mu\text{g/L}$ in only one sample during the review period at a concentration 0.37 $\mu\text{g/L}$ (well W1-24, October 2006). VOCs, SVOCS, PCBs, or pesticides from Site 1 do not appear to be affecting the shallow aquifer based on the infrequent, sporadic low and trace concentrations detected.

Tables 6-3 and 6-4 depict the metals detected in groundwater, along with the location and identity of the sampling event in which detection occurred. Validated analytical results for metals are included in Appendix C. Total magnesium has been detected above its respective CCL of 94 $\mu\text{g/L}$ in all wells at concentrations ranging from 884 $\mu\text{g/L}$ (well W1-22, October 2003) to 3,080 $\mu\text{g/L}$ (well W1-19, January 2003). Dissolved magnesium has also been detected above its respective CCL of 94 $\mu\text{g/L}$ in all wells at concentrations ranging from 837 $\mu\text{g/L}$ (well W1-22, January 2003) to 2,350 $\mu\text{g/L}$ (well W1-19, July 2003). Dissolved barium has been detected above its respective CCL of 40 $\mu\text{g/L}$ in all wells at concentrations ranging from 45.9 $\mu\text{g/L}$ (well W1-23, October 2006) to 1,260 $\mu\text{g/L}$ (well W1-22, October 2006). Dissolved copper has been detected above its respective CCL of 5.15 $\mu\text{g/L}$ in wells W1-22 and W1-23 at concentrations ranging from 10.1 $\mu\text{g/L}$ (well W1-23, October 2006) to 24.7 $\mu\text{g/L}$ (well W1-22, April 2007). All other dissolved metals were below their respective CCLs.

All of these metals are found in seawater (Study and Interpretation of the Chemical Characteristics of Natural Water, U.S. Geological Survey Water Supply Paper 1473, 2nd Edition [Hem, 1971]) and are considered part of the composition of natural groundwater at Site 1 due to the proximity of natural salt water (*Final Site 1 Landfill 2005 Annual Report Revision 1*, [TtFW, 2006]).

6.4.1.4 Results of Other O&M Data Collection

In accordance with the ROD (Navy, 1997), Site 1 Landfill Final Closure Plan and Post-Closure Maintenance Plan (TtEMI, 1998a), and Site 1 Landfill Post-Closure Long-Term Maintenance Plan (TtFW, 2005a), settlement and subsidence data are collected and stormwater runoff, landfill cover integrity, and site security are monitored. Settlement markers are surveyed every five years, most recently during the First Quarter 2005. Table 6-8, Monument and Road Settlement Marker Data, Site 1 Landfill, January 2002 through March 2005, presents the landfill and road settlement data from January 2002 through March 2005. Throughout the monitoring, no problems were observed. Santa Clara County performs quarterly inspections of the landfill, and no problems have been noted by the County related to activities summarized in this section.

6.4.2 Site 2 Former Landfill

Groundwater sampling analytical data from January 2002 to October 2002 was reviewed from Site 2. These data are briefly discussed below.

6.4.2.1 Groundwater Sampling Data

Table 6-6, Frequency and Location of VOCs, Pesticides, and Total Petroleum Hydrocarbons (TPH) detected at the Site 2 Former Landfill, January 2002 through October 2002, shows the locations of analytes detected and the sampling event in which detection occurred. Table 6-7 shows the minimum, maximum and average analyte concentration detected at Site 2. The complete data are presented in Appendix C. CCLs were established in the *Technical Memorandum, Site 1 Groundwater Evaluation Process* (TtFW, 2004), in accordance with ROD requirements (Navy, 1997). These CCLs are listed in Appendix C.

None of the monitoring parameters were detected above their respective CCLs. VOCs, PCBs, and pesticides from Site 2 do not appear to be affecting the shallow aquifer based on the infrequent, low and trace concentrations detected. Therefore, conditions at Site 2 support unrestricted exposure and unrestricted use.

The groundwater monitoring at the Site 2 Former Landfill was discontinued subsequent to October 2002. The EPA and Water Board prepared closure letters for discontinuing groundwater monitoring at Site 2 on January 31, 2003, and February 25, 2003, respectively.

6.5 SITE INSPECTION

Regularly scheduled inspections of Site 1 are performed and documented in accordance with the ROD (Navy, 1997) and the site-specific project plans (Section 4.3). Contractors, the Navy, and local regulatory agencies perform these scheduled inspections. Inspection forms are included in Appendix B.

No significant issues have been identified regarding the integrity of the remedial actions implemented at Site 1. The remedy is functioning as designed.

6.6 INTERVIEWS

Mr. Chris Rummel, inspector, Santa Clara County Department of Environmental Health (DEH) was interviewed on September 27, 2007. The interview summary is included in Appendix B.

Mr. Rummel inspects the site on a quarterly basis to assure that IR Site 1 Landfill is maintained per requirements of Title 27 of the California Code of Regulations for closed landfills. Mr. Rummel serves as the Local Enforcement Agency for the California Integrated Waste Management Board. Navy Resident Officer in Charge of Construction (ROICC) personnel, Gary Munekawa and David R. Smith, and TN&A team members participate in each quarterly inspections performed by Mr. Rummel.

Mr. Rummel has not documented any deficiencies during quarterly inspections, except for ground squirrel burrowing. This deficiency requires routine mitigation that consists of collapsing and backfilling the burrows. No traps or rodenticides are used to mitigate this deficiency.

Quarterly inspection reports prepared by the Santa Clara County DEH and TN&A personnel are included in Appendix B.

7.0 TECHNICAL ASSESSMENT

This technical assessment section of the OU 1 2007 Five-Year Review Report asks the following three questions:

Question 1: Is the remedy functioning as intended by the decision documents?

Question 2: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy still valid?

Question 3: Has any other information come to light that could call into question the protectiveness of the remedy?

Each of these questions is addressed in the following subsections, building upon the information and data summaries already presented.

7.1 QUESTION 1: IS THE REMEDY FUNCTIONING AS INTENDED BY THE DECISION DOCUMENTS?

The EPA's guidance document for five-year reviews (EPA, 2001) identifies several areas that need to be considered when evaluating whether the remedy selected in the decision documents is functioning as designed. Areas of consideration include:

- Remedial Action Performance - Is the remedy operating as designed?
- System O&M - Will the system and current O&M activities maintain the effectiveness of the response actions?
- Cost of O&M - Compare planned vs. actual costs.
- Institutional Controls and Other Measures Implementation - Are these functioning as planned?
- Monitoring Activities - Do the current monitoring activities provide adequate information to determine the protectiveness and effectiveness of the remedy implemented?
- Optimization Opportunities - Are there any areas for improvement?
- Early Indications of Potential Issues - Are there problems that could lead to the remedy being not protective or suggest protectiveness is at risk unless changes are made?

7.1.1 Remedial Action Performance

The review of documents, ARARs, risk assumptions, and the results of the site inspection indicated that the Site 1 cover is functioning as intended by the ROD (Navy, 1997). The construction of a landfill cover; installation of the gas-venting trench and subsurface

groundwater collection trench; groundwater and gas monitoring wells; use of institutional controls; and post-closure maintenance has met the statutory requirements of Section 121 of CERCLA. The constructed landfill cover is an effective barrier eliminating the potential surface human and biological contact exposure pathway.

The gas vents installed at the site continue to provide for the efficient and safe discharge of methane to the atmosphere. During quarterly monitoring, none of the perimeter wells (LGMW1-1 through LGMW 1-4) nor perimeter monitoring points have shown concentrations of methane above the concentration limit of five percent as specified in 27 CCR, Section 20921 (a)(2) and in the ROD (Navy, 1997). Methane has not been detected in the gas-venting trench. The remedy conforms with the ARARs.

The groundwater collection trench on the north side of the landfill was installed to provide immediate protection to the adjacent Stormwater Retention Basin (Navy, 1997). Two collection trench wells are screened in the trench should it become necessary to pump water from the trench. Groundwater is monitored on a routine basis, and the collection wells in the trench have not shown significant quantities of water.

7.1.2 System Operations and O&M

There are no continuous operating systems associated with Site 1. O&M activities are performed in accordance with the Site 1 Landfill Final Closure Plan and Post-Closure Maintenance Plan (TtEMI, 1998a), the Final Site-Specific Contractor Quality Control Plan for Sites 1 and 2 Groundwater Monitoring and Maintenance (FWENC, 2001b), and the Site 1 Landfill Post-Closure Long-Term Maintenance Plan (TtFW, 2005a). The remedy is cost-effective and utilizes permanent solutions.

Squirrel control activities were performed in 2002 and 2003 according to the Final California Ground Squirrel Management Plan for the Site 1 Landfill and HAWP (FWENC, 2002). The mitigation activities included fumigation of 32 active burrows throughout the landfill and installation of metallic and non-metallic flashing along the Site 1 barrier fence and swing gates. In the past, the ground squirrels were using the berm along the Perimeter Road and the riprap on the west fence line near the runway as habitat. The earthen berm along the southern and western lengths of the Site 1 Landfill perimeter road was made impervious to animal burrowing by installing a 12-inch layer of 4-inch average diameter cobbles on the ground surface. The voids in the riprap along the western edge of the Stormwater Retention Basin were filled to prevent squirrels from entering the void places. Since mitigation activities were completed, squirrel burrowing at the Site 1 Landfill has decreased significantly.

Ground squirrels burrow into the landfill cover, but have not penetrated the cover. Observed burrow depths range from 3 to 10 inches below ground surface (bgs). These burrows ranged from 2 to 4 inches in outer diameter (O.D.). The method used to assess burrowing animal impact(s) to the integrity of the landfill cover, including the geotextile fabrics, requires inspection personnel to diligently look for gravel, geotextile fabric, landfill waste, or other debris in the holes and on the ground surface adjacent to the holes. During documented inspections, personnel have not observed any of the following:

- Hole diameters exceeding 4 inches;

- Signs that holes have been enlarged at the surface;
- Presence of gravel, geotextile fabric, landfill waste, and/or other debris in holes and/or on adjacent ground surfaces; and
- Burrowing Owl white wash or pellets in holes and/or on adjacent ground surfaces.

Intrusive methods for assessing burrowing animal impact(s) to the integrity of the landfill cover, such as use of hand shovel to explore the burrow, are not practiced due to the negative impact it would have on the vegetative layer of the landfill cover.

7.1.3 Engineering and Institutional Controls

Site 1 has a locked fence surrounding three sides of the landfill (the Stormwater Retention Basin is on the north side of the site) controlled by the Navy. Institutional controls agreed on by the Navy and NASA are specified in the *Memorandum of Agreement* (MOA) signed on November 15, 1999. In the MOA, NASA agreed to continue O&M of the Building 191 pump station and associated drainage system. NASA also agreed not to undertake any activities that would compromise the integrity of the landfill cover. The Navy agreed to any required maintenance to maintain the integrity of the landfill cover.

There are currently no plans for the Site 1 property to change ownership. According to the EPA Comprehensive Five-Year Review Guidance (EPA 540-R-01-007, June), the ultimate responsibility for performing five-year reviews should remain with the Federal agency or department that initiated the CERCLA remedial actions. In instances of Federal-to-Federal transfer of jurisdiction, custody, or control of real property, the Federal agency or department having initiated CERCLA remedial actions generally should perform any required or appropriate five-year reviews. Alternatively, the lead agency may assure that reviews are performed by entering into reliable site-specific agreements with the Federal agency or department gaining control of the property, where those arrangements remain consistent with CERCLA and EO 12580. In instances of deed transfer of Federal property to third parties, the Federal agency or department having initiated CERCLA remedial actions generally should perform any required or appropriate five-year reviews, unless other reliable site-specific procedures are arranged with the transferee (or others), and those arrangements remain consistent with CERCLA and EO 12580.

Monitoring and maintenance requirements for the Site 1 Landfill are provided in the Site 1 Landfill Final Closure Plan and Post-Closure Maintenance Plan (TtEMI, 1998a), the Final Site-Specific Contractor Quality Control Plan for Sites 1 and 2 Groundwater Monitoring and Maintenance (FWENC, 2001b), and the Site 1 Landfill Post-Closure Long-Term Maintenance Plan (TtFW, 2005a). These activities must be performed for 30 years beginning in 1997, regardless of ownership. Changes to monitoring and maintenance requirements can only be made according to CERCLA protocol and approval from agencies and other stakeholders.

7.1.4 Monitoring Activities

Groundwater sampling has been performed on a quarterly basis at Site 1 in accordance with Appendix E of the Site 1 Landfill Final Closure Plan and Post-Closure Maintenance Plan

(TtEMI, 1998a) until 2005. In 2005 the groundwater monitoring schedule was amended to semiannual in accordance with the Site 1 Landfill Post-Closure Long-Term Monitoring Plan (TtFW, 2005b). The monitoring program currently implemented is appropriate to determine the protectiveness and effectiveness of the remedy.

7.1.5 Optimization

The optimization opportunities will include revision to the Site 1 landfill General Inspection List to include specific monitoring line items for geotextile material, hole diameters, and burrowing owl white wash and pellets, and to evaluate changing the schedule for groundwater and/or landfill gas monitoring from semiannual to annual (Table 4-1, Site 1 Landfill General Inspection Checklist and Frequency).

7.1.6 Early Indicators of Potential Problems

There are no indicators of potential problems associated with the remedy selected and implemented for Site 1.

7.2 QUESTION 2: ARE THE EXPOSURE ASSUMPTIONS, TOXICITY DATA, CLEANUP LEVELS, AND REMEDIAL ACTION OBJECTIVES USED AT THE TIME OF THE REMEDY SELECTION STILL VALID?

The exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection remain valid. When evaluating the validity of the selected remedy, it is important to consider changes in standards, newly promulgated standards or "to be considered" standards, changes in exposure pathways, changes in land use, or if any new contaminants and/or contaminant sources and/or remedy by-products have been identified.

There have been no changes in the physical conditions at the site that would affect the protectiveness of the remedy. There are no newly promulgated standards or "to be considered" standards that have a significant impact on the remedy selected. When the ROD (Navy, 1997) was written, the primary ARAR for Site 1 was CCR Title 23. As identified in the Site 1 Landfill Final Closure Plan and Post-Closure Maintenance Plan (TtEMI, 1998a), Title 23 was replaced by Title 27 without any significant changes to the regulations.

To verify and ensure long-term protectiveness, groundwater samples are compared with the CCLs identified in the Final Technical Memorandum, Site 1 Groundwater Evaluation (TtFW, 2004). The CCLs are listed in Appendix C.

Volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), or pesticides from Site 1 do not appear to be affecting the shallow aquifer based on the infrequent, sporadic low and trace concentrations detected.

All of the metals detected in groundwater samples from Site 1 are found in seawater (Study and Interpretation of the Chemical Characteristics of Natural Water, U.S. Geological Survey Water Supply Paper 1473, 2nd Edition [Hem, 1971]) and are considered part of the composition of natural groundwater at Site 1 due to the proximity of natural salt water (*Final Site 1 Landfill 2005 Annual Report Revision 1*, [TtFW, 2006])

There are no new contaminant sources or changes in the exposure pathway assessment based on the implementation of the remedy selected. The land use at the site has not changed, nor is it expected to change in the near future. Groundwater beneath the site is not considered as beneficial for use due to low yield and high TDS (Navy, 1997). The landfill has been covered thereby eliminating the human and biological contact exposure pathway.

The ROD for OU 1 identifies the 1995 Basin Plan as an ARAR. Moffett is located within the South Bay Basin and the South San Francisco Bay according to this plan. The Basin Plan has been revised since 1995 and the most recent revision was released in December 2006. Revisions include changes to South San Francisco Bay water quality objectives. Specifically, water quality objectives for toxic pollutants for surface waters have been revised. These revisions notwithstanding, the CCLs for the respective toxic pollutants are equal to or less than the four-day and one-hour averages established for surface water protection. For example, the CCL, four-day average, and one-hour average for copper are 5.15, 6.9, and 10.8 micrograms per liter ($\mu\text{g/L}$), respectively. In addition, the CCL, four-day average, and one-hour average for nickel are 8.2, 11.9, and 62.4 $\mu\text{g/L}$, respectively. This relationship between CCLs and Basin Plan water protection standards provides protectiveness of the remedy.

7.3 QUESTION 3: HAS ANY OTHER INFORMATION COME TO LIGHT THAT COULD CALL INTO QUESTION THE PROTECTIVENESS OF THE REMEDY?

The final question in conducting a technical assessment of the selected remedy includes the evaluation of any new information that may have become available that could call into question the protectiveness of the remedy selected. Potential new information includes ecological risks, unidentified risks from natural disasters (for example, flooding), or land use changes.

No information has become available that could call into question the protectiveness of the remedy. Although there are burrowing squirrels at the landfill, the squirrel activity has been closely monitored, burrows have been promptly filled with soil, and the squirrels have not burrowed through the landfill cover.

By design, the geotextile biotic barrier at the Site 1 Landfill is covered with a vegetation soil layer having a thickness of 1 foot. The burrows observed at the Site 1 Landfill range from 3 to 10 inches bgs. These burrows ranged from 2 to 4 inches in O.D. During documented inspections, personnel have not observed gravel, geotextile fabric, landfill waste, or other debris when looking into the burrows from the surface. In addition, personnel have not observed any of these materials on the ground surface adjacent to the burrow openings. Therefore, there is no indication that the burrowing animals have penetrated the geotextile biotic barrier.

There have been no natural disasters that have adversely impacted the effectiveness of the selected remedy.

The land use of the site has not changed, nor is it expected to change in the near future. The possibility exists for the adjacent property to become open to the public at which time, the issue of land use, security, and access will be addressed.

7.4 SITE 1 TECHNICAL ASSESSMENT SUMMARY

According to the data reviewed and the site inspections, the cover at Site 1 is functioning as intended by the ROD (Navy, 1997). There have been no changes in the physical conditions of the sites that would affect the protectiveness of the remedy. ARARs cited in the ROD have been met (Navy, 1997). There is no other information that calls into question the protectiveness of the remedy.

7.5 SITE 2 TECHNICAL ASSESSMENT SUMMARY

Groundwater sample results were compared to CCLs established in the *Technical Memorandum, Site 1 Groundwater Evaluation Process* (TtFW, 2004), according to ROD requirements (Navy, 1997). These CCLs are identified in Appendix C.

None of the monitoring parameters analyzed in groundwater samples were present at concentrations above their respective CCLs. VOCs, PCBs, and pesticides from Site 2 do not appear to be significantly impacting the shallow aquifer based on the infrequent low and trace concentrations detected.

8.0 ISSUES

Issues identified including the respective issues impacts on current and future protectiveness are identified in this section.

8.1 SITE 1 LANDFILL ISSUES

Issue	Currently Affects Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
Squirrels Burrow on Landfill Slopes and Area Surrounding the Landfill	N	N
Cracked Gas-Vent Slabs	N	N

No unresolved issues have been raised by support agencies or the community including State and other federal agencies; local governments; citizens; and other interested parties.

8.2 SITE 2 FORMER LANDFILL ISSUES

There are no issues at the Site 2 Former Landfill.

9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

9.1 RECOMMENDATIONS AND FOLLOW-UP ACTIONS FOR THE SITE 1 LANDFILL

This section summarizes recommendations and follow-up actions needed in maintaining the protectiveness of the remedy for the Site 1 Landfill.

Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Y/N)	
					Current	Future
Squirrels Burrow on Landfill Slopes and Area Surrounding the Landfill	Continue to monitor squirrel activity and fill holes as necessary	Navy	Water Board EPA Santa Clara County DEH	Ongoing	N	N
Cracked Gas-Vent Slabs	Repair cracked gas-vent slabs	Navy	Water Board EPA Santa Clara County DEH	December 2007	N	N
Verify Landfill Cover is not Penetrated	Revise Site 1 Landfill General Inspection List (Table 1-3) to include monitoring line items for geotextile material; burrow diameters and burrowing owl white wash and pellets	Navy	Water Board EPA Santa Clara County DEH	September 2007	N	N
Groundwater and Landfill Gas Monitoring	Evaluate groundwater and landfill gas monitoring frequency	Navy	Water Board EPA Santa Clara County DEH	January 2008	N	N

9.2 RECOMMENDATIONS AND FOLLOW-UP ACTIONS FOR THE SITE 2 FORMER LANDFILL

Groundwater monitoring, as required by the ROD, and data review and evaluation were completed in late 2002. Review of analytical results for samples from Site 2 showed that groundwater was not adversely impacted by previous operations. The EPA and Water Board prepared closure letters for discontinuing groundwater monitoring at Site 2 on January 31, 2003, and February 25, 2003, respectively. There are no recommendations or follow-up actions because there are no further activities for the Site 2 Former Landfill.

10.0 PROTECTIVENESS STATEMENT

The remedy at Operable Unit 1 is protective of human health and the environment. The final remedy included a multi-layer landfill cover following consolidation of wastes from the Site 2 Former Landfill; groundwater and landfill gas monitoring; a groundwater collection trench; a passive gas venting trench; and institutional controls. The landfill cover, in conjunction with in-place engineering and institutional controls, prevents surface exposure of humans and animals to site contaminants. The ongoing monitoring program is appropriate to determine and ensure the long-term protectiveness and effectiveness of the remedy.

11.0 NEXT REVIEW

The next five-year review for Site 1 is required by September 2012, which is five years from the date of this review.

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FIGURES

