

1. INTRODUCTION

This report documents February 2001 through January 2002 Self-Monitoring Program (SMP) and National Pollutant Discharge Elimination System (NPDES) data for the ground water monitoring and extraction program at Applied Materials Building 1, 3050 Bowers Avenue, Santa Clara, California (the Site) (Figure 1). This report is submitted by Applied Materials to satisfy the California Regional Water Quality Control Board, San Francisco Bay Region (RWQCB), Cleanup Requirements Order No. 90-134, Provisions 2.i.5 and 2.i.6. The Site SMP reporting schedule is presented in Table 1.

The primary volatile organic compounds (VOCs) of concern at the Site are 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethane (1,1-DCA), and 1,1-dichloroethene (1,1-DCE). Trichloroethene (TCE) has also been detected in Site ground water, primarily in the vicinity of Applied Materials Building 3, but is associated with Hewlett-Packard's tenure (prior to Applied Materials) and is not considered part of the Site plume.

1.1 Project Personnel

The following Weiss Associates (Weiss) personnel worked on this project from February 2001 through January 2002:

<u>Name and Title</u>	<u>Responsibilities</u>
Mary Stallard, Senior Project Geologist	Technical guidance, report quality assurance, and senior review
Joyce Adams, Project Geologist	Project management, report review
L. Maile Smith, Project Manager	Report writing, data analysis and synthesis
Marika Dalton, Staff Geologist	Field coordination, ground water monitoring and sampling, and data review and compilation
Andy Lutz, Staff Geologist	Field coordination, ground water monitoring and sampling, and data review and compilation
Jim Martin, Field Operations/Database Manager	Field coordination, database management, and ground water monitoring and sampling
Charles Crocker, Field Technician	Ground water monitoring and sampling
Mike Quinn, Field Technician	Ground water monitoring and sampling
Craig Adams, Technical Illustrator	Graphics

2. GROUND WATER FLOW

Potentiometric surface maps of the A water-bearing zone for July 11, 2001 and January 15, 2002 are presented as Figures 2 and 3, respectively. Water level elevations recorded in A-zone wells on these dates are presented in Table 2. Hydrographs for four representative A-zone wells (AM1-3, AM1-6, AM1-9, and AM1-11) are depicted in Figure 4. Water levels were approximately the same or slightly higher in A-zone wells in January 2002 as compared to January 2001. Ground water in the A water-bearing zone flows to the northeast.

The water levels in A2-zone wells AM1-10 and AM1-14 fluctuated during this reporting period, but remained relatively stable compared to historic levels. The water level in A2-zone well AM1-10 was higher in January 2002 compared to January 2001, although, the water level in well AM1-10 is a function of extraction pump operation. The water level in A2-zone well AM1-14 was lower in January 2002 compared to the January 2001 level. Water level elevation measurements from A2-zone wells are included in Table 2.

Table 3 presents pumping rate data recorded between February 2000 and January 2002 for extraction wells AM1-1, AM1-5E, and AM1-10. Presently, well AM1-10 is the only active ground water extraction well at the Site. Between February 6, 2001 and February 20, 2002, extraction well AM1-10 pumped an average of 0.47 gallons per minute (gpm). The extraction and treatment program appears to provide hydraulic containment of the plume and is progressing toward cleanup standards in an acceptable manner. As discussed further in Section 4, AM1-1 has been off since July 30, 1999, and AM1-5E has been off since September 1996.

3. GROUND WATER ANALYSES

Ground water from 19 on- and offsite wells was sampled and analyzed for VOCs in January 2002 as part of the Site Pumping Modification Program (PMP), according to the SMP schedule (Table 1). Ground water from four wells (AM1-1, AM1-3, AM1-10, and AM1-11) was also sampled and analyzed for natural attenuation parameters as approved by the RWQCB in November 2000 (see Section 7). In addition, as requested by the RWQCB in their December 2001 letter (RWQCB, 2001a), ground water from four select Site wells was also analyzed for 1,4-dioxane in January 2002 (see Section 3.1.4). A detailed workplan outlining the 1,4-dioxane sampling event was submitted to the RWQCB on January 7, 2002 (Weiss, 2002), and was subsequently approved by the RWQCB (RWQCB, 2002).

Historical and current chemical data for ground water are presented in Table 4 and in Table A-1 of Appendix A. As requested by the RWQCB, analytic reports for these samples are not presented in this report (RWQCB, 1996). Chain-of-custody records and tables summarizing the quality assurance and quality control (QA/QC) parameters for the Site are included as Appendix B. Appendix C contains the QA/QC acceptance criteria for Site ground water samples.

All monitoring wells were sampled using either dedicated bladder pumps or disposable polyethylene bailers, and samples from extraction wells AM1-1 and AM1-10 were collected from sampling ports. The sample from extraction well AM1-5E was collected using a disposable bailer due to pump malfunctions. Ground water analyses were conducted by STL San Francisco (STL) of Pleasanton, California. Analysis for 1,4-dioxane was conducted by Zymax Envirotechnology (Zymax) of San Luis Obispo, California.

3.1 Analytic Results

During this reporting period, VOC concentrations were within historical ranges in all wells. Isoconcentration maps for 1,1,1-TCA, 1,1-DCA, and 1,1-DCE in the A-zone are presented as Figures 5 through 7. Isoconcentration maps for other compounds are not presented due to relatively insignificant concentrations and distribution. Concentration maps of VOCs in the A2 water-bearing zone are presented as Figures 8, 9, and 10. Figures 11 and 12 show 1,1,1-TCA, 1,1-DCA, and 1,1-DCE concentration trends over the last five years for several key Site and 3175 Bowers Avenue wells. No VOCs were detected above method detection limits (MDLs) in B-zone wells AM1-2 and AM1-9.

Analytical results for A- and A2-zone ground water sampled between February 2001 and January 2002 are discussed in more detail below.

3.1.1 1,1,1-TCA

During the February 2001 through January 2002 reporting period, no A-zone ground water samples contained 1,1,1-TCA exceeding the 200 parts per billion (ppb) California Department of Health Services (DHS) Maximum Contaminant Level (MCL). Ground water from the following A-zone wells had 1,1,1-TCA detections:

- Source area well AM1-1 contained 2.3 ppb 1,1,1-TCA in January 2002, down from 8.6 ppb in January 2001;
- Source area extraction pit AM1-EP contained 25 ppb 1,1,1-TCA in January 2002, which is within the historical range for this analyte;
- Site boundary wells AM1-6 and AM1-7 contained 3.3 ppb and 11 ppb 1,1,1-TCA, respectively, remaining consistent with historical trends; and,
- Site boundary well AM1-5E and downgradient (Building 3) well HP-5 contained 1.1 ppb and 0.58 ppb 1,1,1-TCA, respectively, decreasing from January 2001 levels.

During this reporting period, no other ground water samples collected from on- or offsite A-zone wells contained 1,1,1-TCA above the MDL of 0.5 ppb.

In A2-zone well AM1-10, 1,1,1-TCA was detected at 44 ppb in January 2002, continuing to decline from historical levels (Figure 12). No 1,1,1-TCA was detected in A2-zone well AM1-14 above the 0.5 ppb MDL.

3.1.2 1,1-DCA

During the February 2001 through January 2002 reporting period, most A-zone ground water samples contained less than the 5 ppb MCL for 1,1-DCA, or were non-detect for the analyte. Additionally, no A-zone well was more than 2 ppb above the MCL. Ground water from the following A-zone wells had 1,1-DCA detections:

- Source area well AM1-1 contained 1.6 ppb 1,1-DCA, and source area extraction pit AM1-EP contained 3.4 ppb 1,1-DCA (both values similar to historical results);
- Ground water from wells AM1-7 and AM1-11 were the only samples to exceed the 1,1-DCA MCL of 5 ppb (5.8 ppb and 6.8 ppb, respectively), although concentrations in both wells remained stable compared to January 2001;
- The concentration of 1,1-DCA in Site boundary well AM1-5E (0.94 ppb) decreased from its January 2001 level, and the 1,1-DCA concentration in AM1-6 (3.0 ppb) remained within its historical range; and,
- Offsite well AV-1A showed a decrease in 1,1-DCA from January 2001 (3.2 ppb) to January 2002 (2.6 ppb).

During this reporting period, no other ground water samples collected from on- or offsite A-zone wells contained 1,1-DCA above the 0.5 ppb MDL.

Ground water sampled from A2-zone well AM1-10 contained 57 ppb 1,1-DCA in January 2002, down from 130 ppb in January 2001 (Figure 12). No 1,1-DCA was detected in A2-zone well AM1-14 above the 0.5 ppb MDL.

3.1.3 1,1-DCE

During the February 2001 through January 2002 reporting period, most A-zone ground water samples contained less than the 6 ppb MCL for 1,1-DCE, or were non-detect for the analyte. Additionally, no A-zone well was more than 4 ppb above the MCL. Ground water from the following A-zone wells had 1,1-DCE detections:

- Ground water sampled from source area well AM1-1 in January 2002 contained 1.4 ppb 1,1-DCE, down from 4.5 ppb in January 2001 (Figure 11);
- The highest reported concentration of 1,1-DCE in this reporting period was 10 ppb each in wells AM1-7 and AM1-11, although concentrations are similar to those measured in January 2001 and are within the respective historical range for each well;
- Concentrations of 1,1-DCE in Site boundary well AM1-6 increased slightly from 6 ppb in January 2001 to 9 ppb in January 2002, although this remains within the historical range for this well;
- The concentration of 1,1-DCE in Site boundary well AM1-5E decreased from 11 ppb in January 2001 to 1.1 ppb in January 2002; and,
- Ground water sampled from Building 3 well HP-2 contained 4.0 ppb 1,1-DCE in January 2002, which is consistent with the concentration measured in January 2001 (3.9 ppb).

During this reporting period, no other ground water samples collected from on- or offsite A-zone wells contained 1,1-DCE above the 0.5 ppb MDL. Neither A2-zone well AM1-10 nor AM1-14 contained 1,1-DCE above the 0.5 ppb MDL.

3.1.4 1,4-Dioxane

In January 2002, ground water from four Site wells was analyzed for solvent stabilizer 1,4-dioxane. The compound was commonly added to 1,1,1-TCA, although 1,4-dioxane is not routinely analyzed because it is not detectable at low concentrations using standard laboratory methods. Since there is little available information on the distribution of solvent stabilizers in regional ground water, the RWQCB requested a screening level 1,4-dioxane sampling program of Site ground water impacted by the historical VOC release at the Site (RWQCB, 2001a).

Ground water samples were collected and analyzed from wells AM1-1 (A-zone source area), AM1-3 (upgradient), AM1-5E (downgradient), and AM1-10 (A2-zone source area) (Figure 2). The

sampling locations define the area of the historical 1,1,1-TCA plume at the Site and include the Site well with maximum 1,1,1-TCA concentrations (AM1-10). Samples were analyzed by Zymax using a modified United States Environmental Protection Agency (USEPA) Method 8270 with isotope dilution.

No 1,4-dioxane was detected above the 1.0 ppb MDL in any ground water sample collected during this sample event, therefore, no further analysis for this analyte is required (RWQCB, 2002; Weiss, 2002). The DHS drinking water action level for 1,4-dioxane is 3 ppb.

3.1.5 Other VOCs

Other VOCs detected in Site monitoring wells—which include TCE, Freon 11, and Freon 113—remained within the range of respective historical results. The only analyte detected above its MCL (5 ppb) was TCE in wells AM1-9, HP-2, HP-5, and HP-8, ranging from 5.7 ppb to 37 ppb. TCE, predominantly detected near Building 3, is associated with Hewlett-Packard's tenure at the Site prior to Applied Materials, and is not considered part of the Site plume.

3.1.6 Natural Attenuation Parameters

Natural attenuation parameters measured in January 2002 remain similar to measurements obtained in January 2001. Further discussion of the significance of these parameters is located in Section 7.

3.2 QA/QC Review

The analytic data and accompanying QA/QC information collected for this project are reviewed in detail to ensure the results are accurate and precise. Furthermore, the analytic data for each sampling point are compared with historical records to affirm they are representative. The QA/QC parameters and acceptance criteria are summarized in Appendix B and presented in Appendix C.

4. PUMPING MODIFICATION PROGRAM

4.1 Background

On March 22, 1996, the RWQCB approved a PMP for the phased shutdown of Site extraction well AM1-5E. The intent of the pumping modification program was to accelerate both ground water remediation near the source area and subsequent plume attenuation near the downgradient Site boundary. This focused remediation at the source area was expected to reduce the risk of VOCs being drawn across the Site and possibly into the neighboring property at 3175 Bowers Avenue.

The PMP involved a phased increase in the pumping rate of source area extraction well AM1-1 while simultaneously decreasing—and ultimately ceasing—pumping in downgradient boundary well AM1-5E. On August 27, 1996, the RWQCB verbally approved proceeding to Phase II of the pumping modification program. Phase II entailed the complete shutdown of well AM1-5E and a simultaneous increase of the AM1-1 extraction rate to about 10 gpm. On June 15, 1999, Applied Materials received approval from the RWQCB for the present phase of the PMP: ceasing to pump ground water from the A water-bearing zone (RWQCB, 1999). The discontinuation of A-zone extraction will determine if a passive management strategy is at least as effective as continuing with previous remedial efforts, which have experienced declining efficiency over the past five years. Extraction well AM1-1 has been off since July 30, 1999, leaving A2-zone extraction well AM1-10 the sole contributor of ground water to the treatment system.

During all PMP monitoring events, data evaluation and determination of program success involves comparing 1,1-DCA and 1,1-DCE concentrations in downgradient boundary wells to “trigger” concentrations for these compounds established for each of the downgradient wells (Table 4). The respective trigger concentrations for 1,1-DCA and 1,1-DCE in each well represent the 99% upper confidence level for the mean of data collected during the two years prior to Phase I. These trigger concentrations are used as a benchmark in determining the success of the pumping modification program. Per agreement with the RWQCB, reactivation of extraction well AM1-1 may occur if specific VOC concentrations exceed specified trigger levels in the boundary, guard, or offsite wells (Table 4).

4.2 Analytic Results

Analytic results, MCLs, and established trigger concentrations for 1,1-DCA and 1,1-DCE in wells AM1-5, AM1-5E, AM1-6, AM1-7, AM1-11, AV-1A, AV-1B, and AV-7A are presented in Table 4, and Figures 11 and 12. During this reporting period, VOC concentrations were within historical ranges for all wells, and no trigger concentrations were exceeded (Table 4).

At 3175 Bowers Avenue, 1,1-DCA concentrations in wells AV-1A and AV-1B were below the 5 ppb MCL. During this reporting period, 1,1-DCE was not detected in well AV-1A above the MDL, and remained well below the 6 ppb MCL in well AV-1B. Neither 1,1-DCA nor 1,1-DCE was detected in well AV-7A above the 0.5 ppb MDL during this reporting period.

Given the relatively steady concentration trends in Site wells and the downgradient 3175 Bowers Avenue wells, Weiss concludes the Site PMP is successfully containing the plume onsite. The PMP appears to be at least as effective as continuing with previous remedial efforts in reducing or maintaining downgradient 1,1-DCE and 1,1-DCA concentrations.

5. EXTRACTION SYSTEM AND MONITORING WELL STATUS

Between February 2001 and January 2002, the extraction system performed routinely, except as noted below, and sampling complied with the schedule as outlined in Table 1 (also see Section 6.1). Extraction system pumping data for the reporting period is presented in Table 3. Well details and measured well depths are shown on Table 5. All well depth measurements, which are monitored yearly as a standard confirmation of well integrity, were within expected ranges.

5.1 Air Stripper

No repairs or adjustments outside the scope of routine maintenance were performed on the air stripper between February 2001 and January 2002.

5.2 A-Zone Extraction Wells AM1-1 and AM1-5E

The pump for extraction well AM1-1 has been off since July 30, 1999. The pump for extraction well AM1-5E has been off since September 11, 1996.

5.3 A2-Zone Extraction Well AM1-10

As of approximately June 13, 2001, the performance of the pump in well AM1-10 began to decline. The pump was re-primed on June 22, and on July 11, a loose wire was discovered within the pump control relay and was subsequently repaired. Between July 23 and 27, the pump in well AM1-10 again performed inadequately, and was re-primed and adjusted on July 27. On August 2, the pump was removed and cleaned. Subsequently, the pump has been operating routinely and properly. Between February 6, 2001 and February 20, 2002, 279,952 gallons of ground water were pumped from AM1-10. The average pumping rate for the period was 0.47 gpm.