

THIRD FIVE-YEAR REVIEW REPORT

for

MIDDLEFIELD-ELLIS-WHISMAN (MEW) SUPERFUND STUDY AREA Mountain View and Moffett Field, California

- Fairchild Semiconductor Corp. – Mountain View Superfund Site
- Raytheon Company Superfund Site
- Intel Corp. – Mountain View Superfund Site
- And portions of NAS Moffett Field Superfund Site

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1. Introduction

The purpose of a Five-Year Review is to evaluate the implementation and performance of a remedy to determine if the remedy will continue to be protective of human health and the environment.

In January 2014, the U.S Environmental Protection Agency's (EPA) Office of Superfund Remediation and Technology Innovation and EPA Region 9 Superfund Division agreed to conduct a streamlined Five-Year Review for the Middlefield-Ellis-Whisman Superfund Study Area¹ (MEW Study Area or MEW Site) in Mountain View and Moffett Field, California, where the groundwater remedy is in the process of being optimized and re-evaluated and the vapor intrusion remedy is currently being implemented. This streamlined Five-Year Review provides a snapshot of the current status and technical assessment of the groundwater and vapor intrusion work over the past five years since the Second Five-Year Review conducted in 2009, identifies issues, recommendations, and follow-up actions, and makes a protectiveness statement based on potential current and future exposure risk to human health and the environment.

The vapor intrusion remedy selected in the 2010 ROD Amendment for the MEW Site is expected to be protective of human health when fully implemented. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks at the MEW Site. To be protective in the long-term, the vapor intrusion remedy implementation procedures need to be assessed to take into account the impact of the near-term TCE risks on current operational framework.

The groundwater remedy at the MEW Site is currently protective of human health and the environment because exposure to groundwater is being controlled. In order to be protective in the long term, the following actions need to be completed:

- Determine the source of the TCE hot spot areas and extent of TCE contamination in the A and B1 aquifer zones;
- Evaluate and implement alternative cleanup strategies inside the slurry walls that do not necessarily require inward and upward gradients to control source area contamination;
- Implement the current optimization pilot tests at the source areas and TCE hot spot areas; and
- Based on the information collected, prepare a revised Focused Feasibility Study and Proposed Plan, and amend the current groundwater remedy in a ROD Amendment.

The EPA Region 9 Superfund Division MEW Site project team, with support from the U.S. Army Corps of Engineers, conducted this streamlined Five-Year Review assessing the protectiveness of the groundwater and vapor intrusion remedy being implemented at the MEW Site. EPA is the lead regulatory agency for directing the cleanup process for the MEW Superfund Site. The U.S. Navy is the lead agency for the cleanup at NAS Moffett Field. The San Francisco Bay Regional Water Quality Control Board representing the State of California is the support regulatory agency.

This streamlined-Five-Year Review is presented in seven sections:

- Introduction;
- Background;
- Description of the Cleanup Remedies;
- Status of the Issues Identified in the 2009 Five Year Review and the Progress over the past five years;

¹ The MEW Study Area includes Fairchild Semiconductor Corp. – Mountain View Superfund Site, Raytheon Company Superfund Site, Intel Corp. – Mountain View Superfund Site, and portions of NAS Moffett Field Superfund Site.

- EPA's Technical Review assessment based on review of the information and the response to three fundamental questions on whether the remedy is functioning as intended and whether there are any exposure assumptions, toxicity data, or new information that could question the protectiveness of the remedy;
- Issues, Recommendations and Follow-Up Actions; and
- EPA's Protectiveness Statement.

2. Background

The MEW Site is located in Mountain View and Moffett Field, California, and is comprised of multiple sites including: Fairchild Semiconductor Corp. – Mountain View Superfund site; Raytheon Company Superfund site; and Intel Corp. – Mountain View Superfund site; several other facilities; and portions of the former Naval Air Station (NAS) Moffett Field Superfund site. The MEW Site is a heavily populated, light-industrial, commercial, and residential area.

Historically, until the early 1960s, agricultural uses, including orchards, row crops and greenhouse gardening dominated the area. During the 1960s and 1970s, commercial/light industrial development began and several industrial companies conducted semiconductor, electronics, and other manufacturing and research in the MEW Area (the E. Middlefield Road, Ellis Street and N. Whisman Road area south of U.S. Highway 101 – Bayshore Freeway). Chemicals used in these operations were released into the subsurface and subsequently contaminated the soil and groundwater with volatile organic compounds (VOCs), primarily the solvent trichloroethene (TCE). Since the 1990s, major commercial office redevelopment and reuse has occurred in the MEW Area. The current property owners and tenants in the MEW Area were not operating at the time of the releases to the environment and are not directly involved with the investigation and cleanup activities at the MEW Site.

North of U.S. Highway 101, the former NAS Moffett Field was owned and operated by the U.S. Navy from the 1930s until 1994 when most of the property was transferred to the National Aeronautics and Space Administration (NASA). The Moffett Community Housing Areas, including the Wescoat Housing area, were transferred from the U.S. Air Force in 1994 and then to the U.S. Army in 2001. Activities by the U.S. Navy and NASA, including use of chemicals historically used for dry-cleaning, maintenance, and fuel operations activities, contributed to the soil and groundwater contamination at Moffett Field.

The primary groundwater and vapor intrusion chemical of concern at the MEW Site is TCE. The other groundwater chemicals of concern include: tetrachloroethene (PCE), cis- and trans-1,2-dichloroethene, vinyl chloride, 1,1-dichloroethane, 1,1-dichloroethene, 1,1,1-trichloroethane, Freon-113, chloroform, and 1,2-dichlorobenzene. TCE is the indicator chemical for the MEW Site, but the chemicals of potential concern identified as part of the groundwater and vapor intrusion cleanup remedy will continue to be monitored and addressed in the cleanup.

The groundwater beneath and in the vicinity of the MEW Site area is not used as a drinking water source. Drinking water in this area primarily comes from the Hetch Hetchy reservoir in the Sierra Nevada Mountains and is treated to meet all state and federal drinking water standards. Groundwater aquifers within the MEW Site consist of shallow and deeper aquifer systems and are separated by a laterally extensive aquitard approximately 40 feet thick. Within the shallow system four primary hydrogeologic aquifer zones have been identified: the A-zone aquifer and the underlying B1-, B2- and B3- aquifers. The regional B-C aquitard separates the B3-aquifer from the C-aquifer and the deep aquifer system. Current groundwater flow in the shallow aquifer zone is generally to the north, toward San Francisco Bay. The extent of the regional groundwater contamination plume is primarily confined to the A and B aquifer zones. The TCE shallow A-zone aquifer contamination is over 1.5 miles long and 0.5 mile wide and

extends from south of Middlefield Road northward onto Moffett Field and mixes with U.S. Navy and NASA sources of contamination. The combined area of contamination is referred to as the “regional groundwater contamination plume” or “Regional Plume.”

The source areas of contamination at the MEW Site are being addressed by each of the parties responsible for the contamination. Each individual MEW company, the Navy and NASA are responsible for investigation, cleanup, and source control for soil and groundwater contamination and for implementing the vapor intrusion remedy at their individual facility-specific properties and buildings. Contaminated groundwater that has bypassed the source control areas and has mixed together with other contaminated groundwater from other source areas is considered part of the regional groundwater contamination plume, and is being addressed by the MEW Regional Groundwater Remediation Program.

3. Cleanup Remedies

For the MEW Study Area, EPA issued one Record of Decision (ROD) in June 1989, two Explanations of Significant Differences (ESDs) in 1990 and 1996, and one Record of Decision Amendment in 2010 to select the remedies for soil and groundwater cleanup and for addressing the subsurface vapor intrusion pathway.

3.1 Soil and Groundwater Remedy

The selected soil and groundwater and soil remedial actions in the 1989 ROD are designed to:

- Control and remediate contamination in subsurface soils;
- Protect the local drinking water supplies;
- Restore the shallow and deep aquifers to meet Maximum Contaminant Levels (MCLs) and a 10^{-6} risk level, respectively; and
- Prevent the vertical migration of groundwater contamination into the deeper, underlying aquifers.

The soil cleanup remedy at the MEW Site includes: (1) excavation, with treatment by aeration; and (2) soil vapor extraction, with treatment by vapor phase granular activated carbon. Soil cleanup actions have been completed at all of the former source areas at the MEW Site.

The groundwater remedy for the MEW Site includes:

- Hydraulic remediation by groundwater extraction and treatment using air-stripping towers plus incorporation of pre-existing liquid-phase granular activated carbon at operating treatment systems.
- Maintaining inward and upward hydraulic gradients by pumping inside the existing slurry walls.
- Identification and sealing of any potential conduit wells.
- Reuse of extracted groundwater to the maximum extent feasible, with 100% reuse as a goal.

EPA issued an ESD to the ROD in September 1990, clarifying that the cleanup goals established in the ROD for the MEW Site were the cleanup standards, and TCE is to be used as an “indicator compound.” The other chemicals of concern listed in the ROD are also to be cleaned up to their respective cleanup standards. A second ESD, issued in April 1996, provided formal interpretation of the groundwater remedy to include liquid-phase granular activated carbon for groundwater treatment.

Ten facility-specific source control groundwater extraction and treatment systems and two regional groundwater extraction treatment systems are currently operating. Groundwater extraction and treatment systems began operation in 1982 and are expected to continue for many decades more until concentrations of TCE and the other MEW Site chemicals of concern meet groundwater cleanup standards.

In addition, four slurry walls were installed to physically contain the shallow groundwater contamination: three 40-foot deep walls around the former Fairchild facilities and one 100-foot deep slurry wall at the former Raytheon facility. To address soil contamination, approximately 36,000 cubic yards of soil were excavated and five soil vapor extraction systems were installed within the former source areas. Soil cleanup within the MEW facility-specific source areas was completed in 2001.

3.2 Vapor Intrusion Remedy

In a 2010 ROD Amendment, EPA selected the vapor intrusion remedy that addresses the potential long-term exposure risks from TCE and other MEW Site chemicals of concern through the subsurface vapor intrusion pathway, which was not addressed in the 1989 ROD.

The vapor intrusion remedial action objectives (RAOs) for the MEW Site are:

- to ensure that building occupants (e.g., workers and residents) are protected from Site contamination by preventing subsurface Site contaminants from migrating into indoor air or accumulating in enclosed building spaces exceeding indoor air cleanup levels for long-term exposure; and
- to accelerate the reduction of the source of vapor intrusion (i.e., Site contaminants in shallow groundwater and soil gas) to levels that are protective of current and future building occupants, such that the need for a vapor intrusion remedy would be minimized or no longer be necessary.

EPA's selected remedy to address the vapor intrusion pathway and ensure protection of human health of building occupants in the Vapor Intrusion Study Area² consists of the following:

- For Existing Buildings - The appropriate response action is determined by indoor air sampling and other lines of evidence for each building. If necessary, installation, operation, maintenance, and monitoring of an appropriate Sub-slab/Sub-membrane Ventilation System or alternatively, for existing commercial buildings, use of building's indoor air mechanical ventilation system if the property/building owner agrees to use, operate, and monitor the system to meet remedy performance criteria and the remedial action objectives.
- For future (new construction) buildings, installation of a vapor barrier and passive sub-slab ventilation system (with the ability to be made active) is required. In addition, implementation of Institutional Controls (ICs) and monitoring to ensure the long-term effectiveness of the vapor intrusion remedy is required.

The vapor intrusion remedy is currently being implemented and will be ongoing until shallow subsurface contamination no longer poses a vapor intrusion risk.

² The Vapor Intrusion Study Area is generally defined as the area where the estimated TCE shallow groundwater contamination exceeds 5 micrograms per liter (µg/L).

4. Progress During the Last Five Years

This section includes an update on progress towards accomplishing recommendations from the second Five-Year Review in 2009, as well as progress made in implementing the groundwater and vapor intrusion remedies at the MEW Site during the last five years (2009-2014).

4.1 Status of Previous Issues from 2009 Five Year Review

The Second Five-Year Review report for the MEW Site was signed on September 30, 2009. The protectiveness statement in the Report is as follows:

The remedy at the MEW Site is not protective because it does not adequately address potential health risks from long-term exposure to TCE and other VOCs through the vapor intrusion pathway. Remedial actions are necessary to ensure the protection of human health. EPA issued a Proposed Plan for the MEW Site vapor intrusion remedy in July 2009 and is accepting public comments through November 7, 2009. The remedy for the vapor intrusion pathway will be incorporated into the overall Site remedy through an amendment to the 1989 ROD (ROD Amendment).

The following actions need to be taken to ensure protectiveness of the remedy:

- *Finalize the ROD Amendment for the vapor intrusion pathway.*
- *Complete baseline sampling and evaluation of buildings within the Vapor Intrusion Study Area.*
- *Implement remedial actions on existing and future buildings within the Vapor Intrusion Study Area, as needed, in accordance with the ROD Amendment and design documents.*

EPA anticipates issuing a ROD Amendment in Winter 2010 and that implementation of the vapor intrusion remedy will take approximately three years to complete (November 2012).

The soil remedy is complete, and fully meets the cleanup standards set forth in the ROD. The groundwater remedy has removed over 92,000 pounds of VOCs, reduced VOC concentrations throughout the plume; and contained the plume in all aquifers, except for some specific areas that will be addressed through continued optimization efforts. The groundwater is not being used as a potable water supply, and there are no direct exposure pathways to the contaminated groundwater while groundwater cleanup continues. EPA will evaluate the need for institutional controls to continue to ensure there are no direct exposure pathways to contaminated groundwater.

The following actions must be taken to fully capture the regional shallow groundwater contamination plume at the downgradient boundary and limit vertical migration of contaminants to the B1/A2 and B2 Aquifers:

- *Enhance groundwater contaminant plume capture and groundwater cleanup efforts by implementing facility-specific and Regional Program optimization plans.*
- *Evaluate and perform pilot treatability studies of alternative groundwater cleanup technologies to expedite contaminant mass removal and cleanup time and reduce VOC concentrations throughout the groundwater VOC plume.*

The Second Five-Year review identified six issues that affected current or future protectiveness. These issues, the recommendations and follow-up actions, and the status of the work completed over the past five years to address the issues are discussed in the following subsections.

4.1.1 Removal efficiency decreasing in groundwater remedy

Issue: The mass removal efficiency is decreasing due to decreasing influent groundwater treatment system VOC concentrations. Based on current VOC concentration trends, the existing remedy is not expected to achieve Site cleanup levels for many more decades.

Recommendation: Prepare Site-wide Groundwater Feasibility Study to evaluate alternative technologies to effectively expedite groundwater cleanup at the Site.

Status: In June 2012, EPA prepared a draft Site-wide Groundwater Feasibility Study to evaluate alternative technologies and optimization of the existing groundwater remedy to accelerate mass removal and evaluate the timeframe for meeting groundwater cleanup standards. The draft Feasibility Study considered five alternatives, two alternatives which included current and optimized groundwater extraction and treatment, and three alternatives, which included in situ reductive dechlorination and oxidation treatment with and without monitored natural attenuation (MNA). The EPA National Remedy Review Board provided comments to EPA Region 9 indicating that the draft Feasibility Study lacked specific information on which the in situ reductive dechlorination and oxidation treatment technologies will be used at the individual facility-specific source area and that the decision criteria for MNA needed site-specific information. Stakeholders also commented on the draft Feasibility Study requesting that it include more discussion on the facility-specific limitations and advantages for each of the in situ reductive dechlorination and oxidation technologies.

Based on comments from stakeholders and the EPA National Remedy Review Board, EPA decided to move forward with optimization of the existing groundwater extraction and treatment systems. This may include conducting pilot tests of alternative groundwater technologies at specific source area locations, as part of the Feasibility Study process, in order to obtain more information about what technologies and optimization efforts might work in the different facility-specific areas.

A status of the optimization and pilot testing efforts is discussed in Section 4.2.3 and Section 4.2.4.

4.1.2 Hydraulic Containment Issues

Issue: Groundwater contamination plume is not fully captured by existing extraction wells.

Recommendation: Install new extraction wells and optimize extraction rates to achieve plume capture and enhance mass removal.

Status: The 2009 Second Five-Year Review identified areas within the regional groundwater contamination plume where capture did not appear to be demonstrated (i.e., a portion of the regional groundwater contamination plume was shown outside the capture zone areas). The specific areas where regional groundwater contamination plume capture was not fully defined are as follows:

- western margins of the Regional Plume in the A and B1 Zones – South of Highway 101 MEW Area (Evangale Avenue, Fairchild Drive and Devonshire Avenue);
- western margins of Regional Plume in the A/A1 and B1/A2 Zones – North of Highway 101 Moffett Field Area (Wescoat Housing Area);
- eastern margin of the Regional Plume in the A/A1 Zone (east of Well 73A);
- northernmost area of Regional Plume – North of Highway 101 – Moffett Field Area in the A1 and B1/A2 Zone; and
- B2 Zone Regional Plume area North of Highway 101 – Moffett Field Area (Perimeter and Cody Road).

As part of the hydraulic containment work, the MEW Regional Groundwater Remediation Program advanced 51 borings between November 2012 and April 2013 to collect grab groundwater samples to depths between 25 feet and 100 feet below ground surface to better define the regional groundwater contamination plume boundary to 5 micrograms per liter ($\mu\text{g/L}$) in the A, B1 and B2 aquifer zones and to select placement of ten monitoring wells. The estimated regional groundwater contamination plume boundary was confirmed in most of the areas, with the exceptions of the following three areas discussed below: (1) western margin of the regional groundwater contamination plume south of Highway 101 (residential area along Evandale Avenue and Fairchild Drive), (2) the northernmost extent of the Regional Plume in the shallow A/A1 Zone, and (3) a portion of the B2 contamination in Navy's Site 28 area on Moffett Field, discussed below.

Western margin of the regional groundwater contamination plume south of Highway 101 (residential area along Evandale Avenue and Fairchild Drive). The highest TCE grab groundwater concentrations were found within and outside of the western margins of the regional groundwater contamination plume, south of Highway 101 in the residential area along Evandale Avenue. Two TCE groundwater hot spot areas (e.g., TCE groundwater concentrations exceeding $1,000 \mu\text{g/L}$) have been identified along Evandale Avenue with maximum TCE groundwater concentrations of $130,000 \mu\text{g/L}$ detected in the first TCE hot spot area on Evandale Avenue closer to Whisman Road and $4,000 \mu\text{g/L}$ of TCE detected in a second TCE hot spot area further west on Evandale Avenue. The current regional groundwater remediation system is not adequately addressing the TCE contamination in these two groundwater hot spot areas. The sampling results and current cleanup of this area is discussed in Section 4.2.2. Additional grab groundwater sampling was conducted to further assess the western extent of the TCE groundwater contamination in the A and B1 aquifer zones. Based on the grab-groundwater sampling results, additional A and B1 Zone monitoring wells are being installed west of Whisman Road for inclusion in the MEW Regional Groundwater Remediation Program annual monitoring.

Northernmost extent of the regional groundwater contamination plume in the shallow A/A1 and B1/A2 Zones. The northernmost extent of the TCE Regional Groundwater Plume in the shallow A/A1 Zone has been defined to the $5 \mu\text{g/L}$. Additionally, as part of the efforts to demonstrate hydraulic containment in the northernmost toe of the regional groundwater contamination plume in the A/A1 Zone, the MEW Regional Groundwater Remediation Program and NASA Ames evaluated groundwater contaminant concentration trends to determine if the northernmost extent of the regional groundwater contamination plume is stable or decreasing, which provides one line of evidence to demonstrate that hydraulic containment is being achieved. Initial review of the trend analysis data indicates contaminant concentrations may be either stable or decreasing. Based on this review, 10 existing monitoring wells, which were previously removed from the annual groundwater sampling program, were added back into the monitoring program in 2012 to support further evaluation of plume stability in this area. One additional monitoring well will also be installed by NASA Ames in 2015 to monitor for both groundwater contamination migration and other hydraulic parameters outside the currently estimated B1/A2 zone capture zone area. A total of 32 monitoring wells in the northern area of the regional groundwater contamination plume will be monitored over time to evaluate the stability of the regional groundwater contamination plume.

B2 Zone contamination In Navy's Site 28 area on Moffett Field. As part of a supplemental investigation of the Building 88 and Traffic Island areas to better define the source of PCE and to determine the vertical extent of PCE contamination, the Navy installed 15 new monitoring wells in 2013, four of wells were installed in the B2 zone. The investigation results indicated groundwater concentrations of PCE, TCE and other MEW Site chemicals of concern, exceeding the respective groundwater cleanup standards in the B2 aquifer zone. The Navy's July 2014 report summarizes the supplemental investigation work, and provides technical recommendations for the optimization of contaminant mass removal.

4.1.3 Slurry wall gradients not maintained

Issue: Inward gradients within slurry walls and upward vertical gradients are not consistently maintained.

Recommendation: Implement changes to extraction well network and to improve capture and maintain inward and upward gradients, as appropriate.

Status: The previous 2009 Second Five-Year Review determined that the four slurry walls at the former Fairchild and Raytheon facilities were not fully functioning as intended as outward hydraulic gradients are consistently observed along the northern (downgradient) segments of these walls, indicating that some chemical migration is occurring across the slurry walls. Wells were previously installed downgradient of the northernmost portion of the slurry wall at the former Raytheon Facility to address the outward gradients.

Based on the results presented in the 2013 Annual Groundwater progress reports, Table 1 summarizes the current status of the inward and upward gradients within the slurry wall. Inward and/or upward gradients are not completely maintained at three of the four slurry walls.

4.1.4 Lack of Institutional Controls for Groundwater Remedy

Issue: No Institutional Controls for groundwater remedy.

Recommendation: Evaluate need for Institutional Controls in Site-wide Groundwater Feasibility Study.

Status: The need for ICs for the groundwater remedy was evaluated in EPA's 2012 draft Groundwater Feasibility Study (as discussed in Section 4.1, the draft Feasibility Study is on-hold pending results from the current optimization pilot tests). The draft Feasibility Study examined the use of proprietary controls and governmental controls as ICs for the remedy. Currently, Santa Clara Valley Water District Ordinance 90-1 requires permits for the construction of new wells or modification of existing wells in the MEW Site Area. These permits allow the Santa Clara Valley Water District to restrict the construction and handling of wells that could impact groundwater in the private areas of the MEW Site. Additionally, there are recorded access agreements and notices at most of the MEW facility-specific source area properties, which, among other things, inform the property owners of facility-specific Site-related environmental conditions, the requirements to avoid impacting the groundwater remedy, and provisions for access by EPA and the MEW Companies to operate the remedy. Prior to 2002, purchasers of a number of facility-specific source area properties entered into Prospective Purchaser Agreements with EPA which are recorded and include these notices and requirements for property owners, building occupants, and future property purchasers of the property. Since 2002, at both facility-specific source areas and other properties overlying the regional groundwater contamination plume areas, EPA has issued a number of Bona Fide Prospective Purchaser letters which include these notices and restrictions as a part of reasonable steps to be taken to comply with and not interfere with the MEW Site remedy.

There are no equivalent recorded restrictions on regional, non-facility-specific source area properties overlying the regional groundwater contamination plume. Within the shallow regional groundwater plume area of Moffett Field, NASA's Environmental Issues Management Plan contains restrictions on well construction, non-interference with the remedy, and provision of access to operate the remedy.

4.1.5 Indoor Air sampling

Issue: Indoor air sampling has not been performed at many of the buildings within the Vapor Intrusion Study Area.

Recommendation: Sample and evaluate unsampled buildings within the Vapor Intrusion Study Area.

Status: As of September 2014, 117 commercial/non-residential buildings and over 140 residences within the Vapor Intrusion Study Area have been sampled. All occupied, commercial/non-residential buildings within the Vapor Intrusion Study Area have had at least one sampling round completed. EPA is evaluating what additional monitoring and response actions are required, where needed, on a building-by-building basis.

4.1.6 Need Vapor Intrusion Remedy

Issue: Existing remedy does not address the vapor intrusion pathway.

Recommendation: Amend the ROD to select a remedy to address the vapor intrusion pathway.

Status: In August 2010, EPA signed a Record of Decision Amendment selecting the vapor intrusion remedy to address the subsurface vapor intrusion pathway at the MEW Site.

4.2 Progress and New Information During the Past Five Years

4.2.1 Groundwater

According to the previous Second 2009 Five-Year review, an estimated 92,295 pounds of VOCs had been removed and an estimated 4.3 billion gallons of contaminated groundwater had been treated since start-up of the treatment systems through 2008. Between 2009 and 2013, an estimated additional 11,912 pounds of VOCs have been removed and an additional 1.2 billion gallons of groundwater have been treated. Table 2 summarizes the volume of groundwater treated and mass removed for each facility-specific treatment system.

As of December 2013, the average TCE groundwater concentration at the MEW Site has decreased by approximately 90% in the shallowest A aquifer zone, and by approximately 85% in overall Site groundwater, based on an analysis by the MEW Regional Groundwater Remediation Program.

Between 2009 and 2014, several facilities have conducted additional source characterization using high resolution techniques such as a Membrane Interface Probe (MIP) process resulting in real-time depth discrete permeability readings and relative VOC concentration data. Results of these characterizations indicate that there are small discrete zones of high concentrations located close to the original source release.

In 2013, as part of the in-situ bioremediation pilot test program at the 355/365 and 401 E. Middlefield Road source area properties, seven borings were drilled and logged using a MIP process. Results of this sampling suggested that a Light Non-aqueous Phase Liquid (LNAPL) layer existed within the first two feet of what would have been the top of the saturated zone at the original source. This MIP characterization technique was also used at the 401 National Avenue source area property. The 401

National Avenue assessment found high Site-related contaminant concentrations generally corresponded well with coarse-grained geological materials and continuing, to a more limited extent, into adjacent areas of fine-grained geological materials. In both characterizations, the TCE concentrations found were among some of the highest reported contaminant concentration levels detected in samples collected in the former facility-specific source areas. The Navy also completed high resolution characterization to better define source areas at the Navy's Site 28 on Moffett Field. The high resolution results of the investigation allowed the Navy to find the PCE and TCE source and hotspot locations which will enable a more focused approach for conducting treatability studies in the area.

4.2.2 Residential Indoor Air Sampling and EPA Potential Source Investigation in Vicinity of TCE Groundwater Hot Spot Areas

In December 2012, when the TCE hot spot areas in shallow groundwater were identified in the residential area on Evandale Avenue, EPA promptly notified owners and residents of 30 homes near the hot spot areas, and subsequently collected indoor air samples from the 30 homes in January 2013. Indoor air sample results at two residences exceeded EPA's residential TCE indoor air cleanup level of 1 microgram per cubic meter ($\mu\text{g}/\text{m}^3$) and vapor intrusion mitigation systems were installed. The systems successfully lowered the TCE concentrations to below the indoor air cleanup level. In March 2013, EPA expanded the residential indoor air sampling area. From January 2013 through September 2014, indoor air sampling was conducted at over 100 residences to assess the potential vapor intrusion pathway.

EPA is currently investigating both the potential source of the TCE groundwater hot spot areas on Evandale Avenue and the extent of groundwater contamination. In September 2013 and Spring 2014, EPA conducted MIP, Cone Penetrometer Testing and collected several hundred groundwater, soil gas, and manhole gas samples to further evaluate other potential TCE hot spot areas, the extent of TCE hotspot area contamination, and potential migration and vapor intrusion potential into nearby residences. EPA continues to work to identify the source of the TCE groundwater hot spot areas.

4.2.3 Groundwater Pilot Test of Residential TCE Groundwater Hot Spot Area

An in-situ chemical oxidation (ISCO) pilot test is being conducted at the two TCE groundwater hotspot areas on Evandale Avenue. During February, April, and August 2014, sodium permanganate, a strong chemical oxidant, was injected into the subsurface at the TCE groundwater hotspot areas on Evandale Avenue. A comparison of groundwater analytical sampling results from pre- and post- ISCO samples collected from within the treatment areas have shown an initial reduction in TCE concentrations; decreasing from 9,600 $\mu\text{g}/\text{L}$ of TCE to 2,700 $\mu\text{g}/\text{L}$ of TCE at one hot spot location, and from 100,000 $\mu\text{g}/\text{L}$ of TCE to 28 $\mu\text{g}/\text{L}$ of TCE at the other hot spot location. However, the pre- and post- injection TCE groundwater sample results collected from wells downgradient from the ISCO injection areas have not shown a similar level of decrease. Although a decrease in TCE was found in the groundwater samples collected from within the pilot test area at the time of treatment, some rebound of TCE groundwater concentrations is expected once the sodium permanganate is consumed in the subsurface. The ISCO injections appear to be effective in reducing TCE concentrations – only to the extent the oxidant (i.e., sodium permanganate) can be directly delivered to the where the contamination is located. Therefore, groundwater contamination downgradient from the two hot spot areas in the A-zone aquifer, and the western B1-zone will likely still need to be addressed separately. The first injection of sodium permanganate in the second hot spot area on Evandale was in August 2014. The ISCO pilot test summary results report for the two hot spot areas is expected to be completed in the winter of 2015.

4.2.4 Groundwater Optimization Efforts and Pilot Test/Treatability Study Progress

In 2013, as part of EPA's efforts to collect additional data and information needed as part of the Feasibility Study process, EPA discussed with the MEW Companies, Navy and NASA the conceptual approach and next steps to optimizing the existing groundwater remedy to accelerate mass removal in the former facility-specific source areas and the regional groundwater plume area. The optimization evaluation efforts include adjusting the groundwater extraction flowrates, modifying the extraction well network, and conducting pilot tests and treatability studies of alternative groundwater cleanup technologies. The optimization progress and status for each facility-specific area and the MEW Regional Groundwater Remediation Program area are summarized in Table 3.

4.2.5 Vapor Intrusion

EPA is currently implementing the vapor intrusion remedy at the MEW Site. As of September 2014, 117 commercial/non-residential buildings within the Vapor Intrusion Study Area have been sampled. In addition, over 140 residences have been sampled. Interim mitigation measures, such as sealing foundations and conduits, and/or modification of the building ventilation systems, have been implemented at over 40 commercial/non-residential buildings within the Vapor Intrusion Study Area and at three residences. In 2013 and 2014, vapor intrusion control systems were installed in two new commercial buildings within the Vapor Intrusion Study Area. Sampling to determine the appropriate response action is ongoing and the Site-wide long-term monitoring plan is under development.

The vapor intrusion remedy includes ongoing ICs to ensure that the remedy is properly implemented over time and that all parties are aware of the remedy's implementation and ongoing requirements. There are three categories of ICs specifically selected for the vapor intrusion remedy. First, for all properties with an implemented vapor intrusion control system, the remedy requires recorded proprietary controls which run with the land that inform future property owners of the ongoing operation of the remedy at the property. Second, the remedy requires governmental controls in the form of City of Mountain View planning and permitting procedures. These procedures are intended to inform and allow for EPA to comment when work conducted anywhere overlying the shallow TCE regional groundwater contamination plume may either impact the remedy itself or cause a new pathway for vapors to enter any overlying structure. The ICs also include the implementation of informational mechanisms, which are two-fold: 1) use of an information-gathering service that can keep EPA and the MEW Companies informed of property ownership changes in the MEW Site area and 2) provision of information to owners and occupants in the MEW Site area to ensure understanding of the remedy and its requirements. For Moffett Field, the ICs selected for the vapor intrusion remedy are those requirements found in NASA's 2005 Environmental Issues Management Plan (EIMP). The 2005 EIMP applies only to the NASA Research Park area. Thus, for the full implementation of the Moffett Field Area ICs, NASA has expanded the applicability of the vapor intrusion remedy requirements to areas of groundwater contamination outside the NASA Research Park. Full implementation of the vapor intrusion ICs will be described in the Site-wide ICs Implementation Plan currently under development.

4.2.6 Community Outreach

EPA outreach efforts over the past five years at the MEW Site have been extensive and have largely focused on the vapor intrusion sampling investigation and vapor intrusion remedy implementation, alternative groundwater cleanup technologies, and the TCE hot spot source investigation and ISCO pilot study in the residential area. EPA's Proposed Plan for the Vapor Intrusion pathway was published in July 2009 and a public comment period was conducted over a four-month period until November 2009. During the past five years, EPA has held community meetings within the residential neighborhoods,

nearby schools, and commercial office workplaces and has personally met with property owners, residents, tenants and other stakeholders to explain EPA's ongoing work activities and answer questions. Sampling and community meeting notices and informational fact sheets were published frequently during this time and distributed by hand to the appropriate neighborhoods and emailed to interested community members and stakeholders on EPA's email distribution list. Additional updates on progress were provided at Mountain View City Council meetings, NAS Moffett Field Restoration Advisory Board meetings and MEW/Moffett Field Community Advisory Board meetings. The Community Advisory Board is led by the Technical Assistance Grant (TAG) recipient, the Center for Public Environmental Oversight. The TAG recipient and Technical Advisor frequently update the community at public meetings and distribute information to their email distribution list, which provides the community with the Technical Advisor's analysis of Site work.

EPA maintains an informational website for the MEW Site: www.epa.gov/region9/mew, which includes fact sheets, meeting notices, maps, EPA's Final First and Second Five-Year Review reports, annual groundwater and vapor intrusion progress reports, work plans, and other technical documents.

5. Technical Summary

5.1 Technical Assessment

5.1.1 *Question A: Is the remedy functioning as intended by the decision documents?*

The review of the existing data indicates that the groundwater remedy is generally performing as intended as described in the 1989 ROD and two ESDs, in that it continues to reduce TCE concentrations throughout the regional groundwater contamination plume. The extent of the regional groundwater contamination plume appears to be hydraulically contained with the exception of western margins of the plume in A and B1 aquifer zones along Evandale Avenue and Fairchild Drive. Monitoring actions have been taken to demonstrate containment including the sampling of groundwater along transects in areas where there were fewer monitoring wells and the installation of additional wells along plume boundaries to be used to evaluate plume stability. Recent investigations at MEW facility-specific and Navy source areas using the MIP indicate that there are small discrete zones of high concentrations typically located close to the original source release to the subsurface. Additional work is needed to determine the source and transport of TCE to fully contain and clean up the contamination.

Nearly 12,000 pounds of VOCs have been removed from the contaminated groundwater and treated by nine facility-specific and two regional groundwater treatment systems during the past five years. The 1989 ROD requires that the extracted groundwater will be reused to the maximum extent feasible, with 100 percent reuse as a goal. However, the extracted groundwater is currently only discharged under a general NPDES permit to Stevens Creek or to the sanitary sewer under a City of Mountain View Industrial Wastewater permit.

The declining efficiency of the operations of the current groundwater remedy, as evidenced by an evaluation of declining treatment system influent levels, indicates that groundwater cleanup levels will not be achieved for many decades. This length of time is inconsistent with the vapor intrusion remedy remedial action objective to accelerate the reduction of the source of vapor intrusion (i.e., Site contaminants in shallow groundwater and soil gas) to levels that are protective of current and future building occupants, such that the need for a vapor intrusion remedy would be minimized or no longer be necessary. The MEW Companies, Navy and NASA are currently performing pilot tests and treatability studies of alternate groundwater cleanup technologies and collecting additional facility-specific source

area characterization data to support the revisions to the draft Feasibility Study. However, challenges have arisen in implementing certain pilot studies at specific facility-specific source area properties due to issues with obtaining the necessary access to implement the pilot studies.

The groundwater is not currently used for drinking water, and Santa Clara Water Valley Water District has governmental controls in place to prevent the installation of wells in the contaminated aquifer zones.

The vapor intrusion remedy is currently being implemented, and it is expected to be protective when fully implemented. All commercial buildings within the Vapor Intrusion Study Area have been sampled, and vapor intrusion mitigation measures have been or are currently being implemented at buildings where necessary. Long-term monitoring programs for commercial buildings within the Vapor Intrusion Study Area are currently being developed. A Site-wide Institutional Controls Implementation Plan will be developed that will describe the ICs for the vapor intrusion remedy, including those already in place and any that will need to be adopted either Site-wide or for individual buildings and properties.

5.1.2 Question B: *Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?*

The 2010 ROD Amendment for vapor intrusion used toxicity values from the Integrated Risk Information System (IRIS) 2009 public comment draft of the TCE Toxicological Review, which followed the EPA's protocol for evaluating new toxicity data and interpretation to derive updated toxicity information. Using this draft evaluation and site-specific exposure concerns, indoor air cleanup levels were set at $1 \mu\text{g}/\text{m}^3$ and $5 \mu\text{g}/\text{m}^3$ in indoor air for residential and commercial/non-residential exposures, respectively. These indoor air cleanup standards are protective of both long-term cancer concerns at the 1 in a million (10^{-6}) risk level as well as non-cancer effects.

In September 2011, EPA published the *Toxicological Review of Trichloroethylene in Support of the Integrated Risk Information System (IRIS)* (2011 IRIS TCE Toxicological Review) after EPA completed review and comment from the public, as well as final Science Advisory Board and National Research Council reviews. The 2011 TCE Toxicological Review includes modified toxicity values. Using the final TCE toxicity values, the 1 in a million (10^{-6}) cancer risk level is $0.5 \mu\text{g}/\text{m}^3$ for residential exposure scenario and $2 \mu\text{g}/\text{m}^3$ for commercial/non-residential long-term exposure scenario using the MEW Site-specific 10-hr workday worker exposure assumption. Additionally, the IRIS TCE Toxicological Review established a non-cancer inhalation reference concentration of $2 \mu\text{g}/\text{m}^3$ based on continuous exposure to be protective for the developing fetus with regard to the potential for congenital heart defects arising due to maternal TCE exposure during fetal development. In July 2014 EPA Region 9 issued a memorandum regarding *EPA Region 9 Interim Action Levels and Response Recommendations to Address Potential Developmental Hazards Arising from Inhalation Exposures to TCE in Indoor Air from Subsurface Vapor Intrusion* and in August 2014 EPA's Office Of Superfund Remediation and Technology Innovation issued a memorandum to the EPA Regional Superfund offices on *Compilation of Information Relating to Early/Interim Actions at Superfund Sites and the TCE IRIS Assessment*. As such, EPA Region 9 is recommending a TCE accelerated response action level of $2 \mu\text{g}/\text{m}^3$ at the MEW Site for the residential exposure scenario. For conditions where there is less than continuous exposure, (e.g., commercial/non-residential exposure scenario), a time-weighting proportionality is used resulting in a TCE accelerated response action level of $7 \mu\text{g}/\text{m}^3$ based the MEW Site-specific 10-hour workday worker exposure scenario.

Therefore, the TCE residential and commercial indoor air cleanup levels of 1 µg/m³ and 5 µg/m³ set forth in the 2010 ROD Amendment are protective of both long-term cancer effects, at the low end of the health protective risk management range, as well as the non-cancer short-term concerns.

Although there have been changes in the toxicity value for TCE, its corresponding maximum contaminant level for drinking water has not changed. The TCE groundwater cleanup level for TCE of 5 µg/L is considered protective.

Recent groundwater sampling collected to confirm the extent of the groundwater plume in the residential neighborhood in the western portion of the MEW Site, identified TCE groundwater hot spot areas that were not previously known and are not specifically being addressed by the current regional groundwater extraction system. EPA is currently overseeing implementation of in-situ chemical oxidation pilot tests in two groundwater hot spot areas to evaluate potential cleanup options for these hot spot areas. In addition, EPA is investigating the source of the TCE hot spot areas and extent of TCE contamination in the residential area as well as evaluating potential vapor migration pathways.

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

EPA's 2011 TCE Toxicological Review assessment concluded that TCE exposure poses potential human health hazards for non-cancer toxicity to multiple organs and to the developing fetus, including fetal cardiac malformations. This and other findings of the TCE assessment indicate that women in the first trimester of pregnancy are one of the most sensitive populations to TCE inhalation exposure and that the TCE impacts during fetal development are by definition near-term impacts. In a June 30, 2014 memorandum, EPA Region 9's toxicologists recommended interim action levels and response recommendations to address potential developmental hazards arising from inhalation exposures to TCE in indoor air from subsurface vapor intrusion. On July 9, 2014, EPA Region 9 Director of Superfund distributed the toxicologists' memorandum to the EPA Region 9 Superfund Division recommending that these action levels and response actions be considered at all EPA Region 9 sites with actual or potential risks from vapor intrusion. On August 27, 2014, EPA's Office of Superfund Remediation and Technology Innovation, issued a memorandum suggesting that the regions should consider initiating early or interim actions when appropriate to ensure protection of human health.

While the TCE indoor air cleanup levels selected in the 2010 ROD Amendment are protective of these non-cancer effects, consistent with the Region 9 recommendations, EPA is currently assessing how the current MEW vapor intrusion remedy and development of a site-specific operational framework will continue to be implemented in light of the 2011 TCE Toxicological Review assessment and 2014 EPA TCE memoranda.

5.2 Technical Summary

The MEW Site groundwater remedy is generally performing as intended. The regional groundwater contamination plume boundaries have generally been stable over the past five years, with the exception of certain TCE groundwater hot spot areas along Evandale Avenue. These TCE hot spot areas, found during sampling to better define the western plume boundary, were not previously known and are not adequately captured by the current pump and treat systems. Additionally, the groundwater remedy requires inward and upward gradients within the slurry walls, which have not been consistently maintained at three of the four slurry walls during the past five years.

Approximately 12,000 pounds of VOCs have been removed from the groundwater over the past five years. However, the existing groundwater remedy is not expected to achieve the MEW Site groundwater cleanup standards for many more decades. Additional work is needed to (1) determine the source and extent of the TCE groundwater hot spot areas, (2) better characterize the facility-specific source areas to support the proposed optimization and remedial efforts, and (3) demonstrate hydraulic containment and cleanup at the western margins of the regional groundwater contamination plume, including the A and B1 Zones in the residential area west of N. Whisman Road, and the B2 Zone north of Highway 101, the northernmost extent of the regional groundwater contamination plume, and the B2 Zone in the Navy's Site 28 area.

The vapor intrusion remedy as implemented to date is performing as intended. Buildings have been assessed, and where necessary, interim vapor intrusion mitigation measures have been taken to reduce indoor air concentrations to meet the indoor air cleanup levels, while the long-term remedial measures are being implemented and long-term monitoring programs are being developed. While the TCE indoor air cleanup levels for the MEW Site continue to be protective for both long-term and short-term health concerns, consistent with EPA policy, regulations, and EPA Region 9 recommendations, EPA is currently assessing how the current vapor intrusion remedy and development of a site-specific operational framework to address potential developmental hazards arising from short-term exposures to TCE indoor air, will continue to be implemented at the MEW Site in light of the 2011 TCE Toxicological Review assessment.

6. Issues, Recommendations, and Follow-Up Actions

Based on the review of the data collected over the past five years (2009-2014) and the new information since the 2009 Second Five-Year Review, the following issues and EPA's corresponding recommendations and follow-up actions, and whether the issue affects current and future protectiveness, are identified below.

Issues	Recommendations/ Follow-up Actions	Milestone Date	Affects Current Protectiveness (Yes/No)	Affects Future Protectiveness (Yes/No)
New TCE groundwater hot spot areas identified in residential area on Evandale Avenue.	Determine the source of TCE groundwater hot spot areas on Evandale Avenue and the lateral and vertical extent of TCE contamination in residential area. If other TCE hot spot areas are found, evaluate and address contamination by treatment or hydraulic control.	09/2016	No	Yes
Assessment needed of how the current vapor intrusion remedy implementation procedures take into account the impact of the short-term TCE risks on current operational framework.	Complete assessment and determine appropriate MEW Site-specific operational procedures and framework to address short-term TCE concerns.	03/2016	No	Yes
The extent and capture of TCE contamination in the B1 Zone and downgradient of the TCE groundwater hotspot areas in the A-zone in the residential area on the west	Develop and implement cleanup approach to address contamination in the A and B1 zone areas in the residential area.	09/2017	No	Yes

Issues	Recommendations/ Follow-up Actions	Milestone Date	Affects Current Protectiveness (Yes/No)	Affects Future Protectiveness (Yes/No)
has not been fully defined and addressed.				
Declining efficiency and effectiveness of existing groundwater remedy will not achieve groundwater cleanup levels and will not meet the vapor intrusion remedial action objective to accelerate the reduction of the source of vapor intrusion (i.e., Site contaminants in shallow groundwater and soil gas) to levels that are protective of current and future building occupants, such that the need for a vapor intrusion remedy would be minimized or no longer be necessary for many decades.	Enhance regional groundwater contamination plume capture and groundwater cleanup efforts by implementing facility-specific and regional program optimization plans. Evaluate and implement pilot tests and treatability studies of alternative groundwater cleanup technologies to expedite contaminant mass removal and cleanup timeframe and reduce VOC concentrations in different representative source and regional groundwater contamination plume areas. Complete Feasibility Study to evaluate remedial alternatives that can effectively meet the RAO for the vapor intrusion remedy.	9/2018	No	Yes
Inward gradients within slurry walls and upward vertical gradients are not consistently maintained at three of the slurry wells.	Evaluate alternative cleanup strategies inside the slurry walls and implement treatability studies that do not require maintaining inward and upward gradients to control facility-specific source area contamination as part of the Feasibility Study process.	9/2018	No	Yes
No Institutional Controls selected for the groundwater remedy to ensure there is no direct exposure to contaminated groundwater	Include groundwater institutional controls to ensure there is no direct exposure to contaminated groundwater as part of Feasibility Study, Proposed Plan, and ROD Amendment process.	9/2018	No	Yes

In addition, follow-up actions that improve the effectiveness of the remedy, reduce costs, provide technical improvement, improve management of O&M, accelerate site close out, or improve energy conservation and sustainability, but don't affect current protectiveness, that were identified during this Five-Year Review are as follows:

- Conduct potential water use survey to determine if the treated water at the MEW Site could be reused.

7. Protectiveness Statement

The vapor intrusion remedy selected in the 2010 ROD Amendment for the MEW Site is expected to be protective of human health when fully implemented. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks at the MEW Site. To be protective in the long-term, the vapor intrusion remedy implementation procedures need to be assessed to take into account the impact of the potential TCE short-term exposure risks on current MEW Site remedy operational framework.

The groundwater remedy at the MEW Site is currently protective of human health and the environment because exposure to groundwater is being controlled. In order to be protective in the long term, the following recommendations and follow-up actions need to be completed:

- Determine the source of the TCE hot spot areas on Evandale Avenue and extent of TCE contamination in the A and B1 aquifer zones;
- Evaluate alternative cleanup strategies inside the slurry walls and implement treatability studies that do not necessarily require maintaining inward and upward gradients to control source area contamination;
- Evaluate and implement the current optimization pilot tests and treatability studies of alternative groundwater cleanup technologies at the facility-specific source areas, TCE hot spot areas, and representative areas of the regional groundwater contamination plume to expedite contaminant mass removal and cleanup timeframe; and
- Based on evaluation of the information collected, complete a Feasibility Study to evaluate remedial alternatives that can effectively meet the vapor intrusion remedial action objective to accelerate the reduction of the source of vapor intrusion (i.e., Site contaminants in shallow groundwater and soil gas) to levels that are protective of current and future building occupants, such that the need for a vapor intrusion remedy would be minimized or no longer be necessary.

7.1 Next Five-Year Review

The next Five-Year Review will be completed in 2019, five years after the signature of this Five-Year Review report.

List of Attachments:

References
Tables
Figures
EPA Five-Year Review Summary Form

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TABLES

Table 1: Status of Inward and Upward Gradients within Slurry Walls

MEW Facility-Specific Slurry Wall Location Area	Inward and upward gradient maintained?	Efforts to achieve inward and upward gradient? If not, what other work is being performed?
Raytheon 350 Ellis St	Not completely. Groundwater measurements in 2013 demonstrated an inward gradient except in two well pairs along the northern slurry wall. Six of the ten A/B1 well pairs show an upward gradient; while the remaining four show a slight downward gradient. The five B1/B2 well pairs consistently show an upward vertical gradient.	No changes to extraction system to maintain inward or upward gradient currently proposed.
Fairchild/Schlumberger 369 and 441 N Whisman Rd (Former Fairchild Buildings 13, 19 and 23)	Not completely. Horizontal gradients are generally inward along the southern, eastern and western slurry wall and outward on the northern slurry wall (downgradient side of the slurry wall). Five well pairs are used to evaluate vertical gradient. Two of the five well pairs show upward gradients; one of five well pairs show a neutral gradient; and two of the five well pairs showed a downward gradient.	Between March and May 2010, three extraction wells were restarted and operated to improve achieving the inward and upward gradients.
Fairchild/Schlumberger 515/545 N Whisman Road (Former Fairchild Buildings 1 through 4)	Not completely. Horizontal gradients are generally inward along the southern, eastern and western slurry wall and outward on the northern slurry wall. Vertical gradient in two of the four well pair showed a downgradient migration.	Between March and May 2010, five extraction wells were restarted and operated to improve capture and to improve achieving the inward and upward gradients.
Fairchild/Schlumberger 401 National Avenue (Former Fairchild Building 9)	Yes, inward and upward gradients have been maintained.	Between March and May 2010, two extraction wells were restarted and continue to maintain the inward and upward gradients.

Table 2 – Status of Facility-Specific and Regional Groundwater Treatment Systems

Facility-Specific Groundwater Treatment System	Volume Treated (Million gallons)	Mass Removed between 2009 and 2013 (lbs VOCs)	Cumulative Mass Removed (lbs VOCs) ¹	Comments
Fairchild/Schlumberger:				
515/545 N Whisman Road and 313 Fairchild Drive (former Buildings 1 -4)	470	4,552	53,200	Groundwater elevations, graphical flow net analysis, capture zone width calculations, and VOC concentration trends provide converging lines of evidence that the extraction wells at Buildings 1-4 are achieving adequate horizontal and vertical capture. Since 2004, TCE concentrations have been decreasing (43% of wells), stable or no significant statistical trend (57% of wells).
369 and 441 N Whisman Road (former Buildings 19, 13, and 23)	N/A ²			Groundwater elevations, graphical flow net analysis, capture zone width calculations, and VOC concentration trends provide converging lines of evidence that the Site extraction wells are achieving adequate horizontal and vertical capture. Since 2004, TCE concentrations have been decreasing (37% of wells), stable or no significant statistical trend (55% of wells).
401 National Avenue (former Building 9)	N/A ²			Groundwater elevations, graphical flow net analysis, capture zone width calculations, and VOC concentration trends provide converging lines of evidence that the extraction wells at Building 9 are achieving adequate horizontal and vertical capture. Since 2004, TCE concentrations have been decreasing (15% of wells), stable or no significant statistical trend (69% of wells). Two wells show an increasing trend since 2004, but have decreased by an order of magnitude since 1996.
Raytheon:				
350 Ellis Street	78	1833	16,429	Overall plume capture appears to be adequate within the facility-specific property. Trend analyses of Site monitoring wells indicate decreasing or no statistically significant TCE concentration trends in all monitoring wells.
Intel:				
355/365 East Middlefield Road	Not Applicable	Not Applicable	364	As part of the in-situ bioremediation pilot test, the groundwater extraction and treatment system has been suspended since 2005.
SMI Holding LLC:				
455, 485/487, and 501/505 East Middlefield Road	44	20	72	Multiple lines of evidence show that the groundwater extraction system is providing adequate capture, and groundwater concentrations are generally decreasing.
NEC/Renasas:				
501 Ellis Street	15	11	47	Plume capture is occurring. Trend analyses of Site monitoring and extraction wells indicate decreasing or no statistically significant TCE concentration trends at 80% of Site wells.
Vishay/SUMCO:				
405/425 National Avenue	46	734	8,178	Multiple lines of evidence indicate that the extent of hydraulic containment provided by facility-specific groundwater extraction meet the target capture zones
MEW Regional:				
				Groundwater elevations, graphical flow net analysis, capture zone width calculations, vertical gradients, and VOC concentration trends provide converging lines of evidence that the Site extraction wells are achieving adequate horizontal and vertical capture of the regional plume. Since 2004, approximately 38% of the RGRP wells display decreasing TCE concentration trends and 57% show no statistical trend or are stable.

Facility-Specific Groundwater Treatment System	Volume Treated (Million gallons)	Mass Removed between 2009 and 2013 (lbs VOCs)	Cumulative Mass Removed (lbs VOCs)¹	Comments
South of U.S. Highway 101	170	2,238	10,700	
North of U.S. Highway 101	281	2,322	10,800	
Navy:				
West-Side Aquifers Treatment System (WATS) – Navy Site 28.	21	180	5,685	2013 capture zone maps indicate adequate capture of VOC contamination in the upper and lower A-aquifer by the groundwater extraction system in the target zone.
NASA:				
Ames	39	22	61	
Total	1,164	11,912	105,536	

Notes:

1/ When cumulative total was not reported in 2013 annual groundwater progress reports, approximate value was read from figures provided in the 2013 annual groundwater progress reports.

2/ Totals included in amounts reported for Fairchild/Schlumberger former Buildings 1-4

Table 3 - Status of Facility-Specific Optimization/Pilot Tests/Treatability Studies

Facility/Responsible Party	Proposed Optimization	Status of Work	Comments
Fairchild/Schlumberger:			
515/545 N Whisman Road and 313 Fairchild Drive (Former Buildings 1 through 4)	Optimize Pump and Treat; considering alternative technologies based on pilot test results in plume.	Groundwater model to be used to evaluate alternative groundwater extraction scenarios and prepare work plan.	Groundwater model assumptions submitted to EPA May 2014. Optimized modeling runs will be submitted to EPA in 2015.
369 and 441 N Whisman Road (Former Buildings 19, 13, and 23)	Optimize Pump and Treat; considering alternative technologies based on pilot test results in plume.	Groundwater model to be used to evaluate alternative groundwater extraction scenarios and prepare work plan.	Groundwater model assumptions submitted to EPA May 2014. Optimized modeling runs will be submitted to EPA in 2015.
401 National Avenue (Former Building 9)	In Situ Chemical Oxidation Pilot Study has been proposed to increase mass removal in areas with high VOCs.	Completed high resolution sampling at 401 National property to better target source areas.	Pilot study work plan submitted in July 2014. EPA comments provided in September 2014. After EPA approval of work plan, implementation of ISCO pilot study is anticipated in 2015.
464 Ellis Street (Former Building 20)	Optimize Pump and Treat	Groundwater model to be used to evaluate alternative groundwater extraction scenarios and prepare work plan.	Groundwater model assumptions submitted to EPA May 2014. Optimized modeling runs will be submitted to EPA in 2015.
644 National Avenue (Former Building 18)	Optimize Pump and Treat	Groundwater model to be used to evaluate alternative groundwater extraction scenarios and prepare work plan.	Groundwater model assumptions submitted to EPA May 2014. Optimized modeling runs will be submitted to EPA in 2015.
Raytheon:			
350 Ellis Street	Optimize Pump and Treat	Completed field work to support groundwater optimization. .	EPA approved extension request for optimization work pending property redevelopment
Intel/Raytheon:			
355/365 and 401 East Middlefield Road	In Situ Bioremediation Injections	Completed high resolution sampling and additional injections of emulsified soybean oil and sodium lactate. Installed monitoring well downgradient of source area.	Monitoring and evaluating the enhanced in-situ bioremediation pilot test in 2014-2015.
SMI Holding LLC:			
455, 485/487, and 501/505 East Middlefield Road	Enhanced reductive dechlorination (ERD) with bio-augmentation or ERD/in-situ chemical reduction (ISCR) with bio-augmentation	Completing microcosm study to evaluate amendments and prepare work plan due August 2014. Extension request submitted for work plan originally due in August 2014 related to property access issues.	SMI seeking permission to use injectable or flowable iron for abiotic rather than biotic degradation (so methane and/or vinyl chloride will not be formed).
NEC/Renasas:			
501 Ellis Street	Monitored Natural Attenuation	Draft Work Plan for Trial Shut of Groundwater Extraction System, 501 Ellis Street, Mountain View, CA (Geosyntec 2011). EPA did not approve plan due to long-term potential vapor intrusion concerns and requested SVE system.	Work on hold due to new tenant building improvements. Work Plan to be updated and re-submitted in 2015.
Vishay/SUMCO:			
405/425 National Avenue	High resolution sampling and optimization plan based on results.	Work Plan approved by EPA.	Sampling to be completed in 2014 and optimization plan to be submitted in 2015.

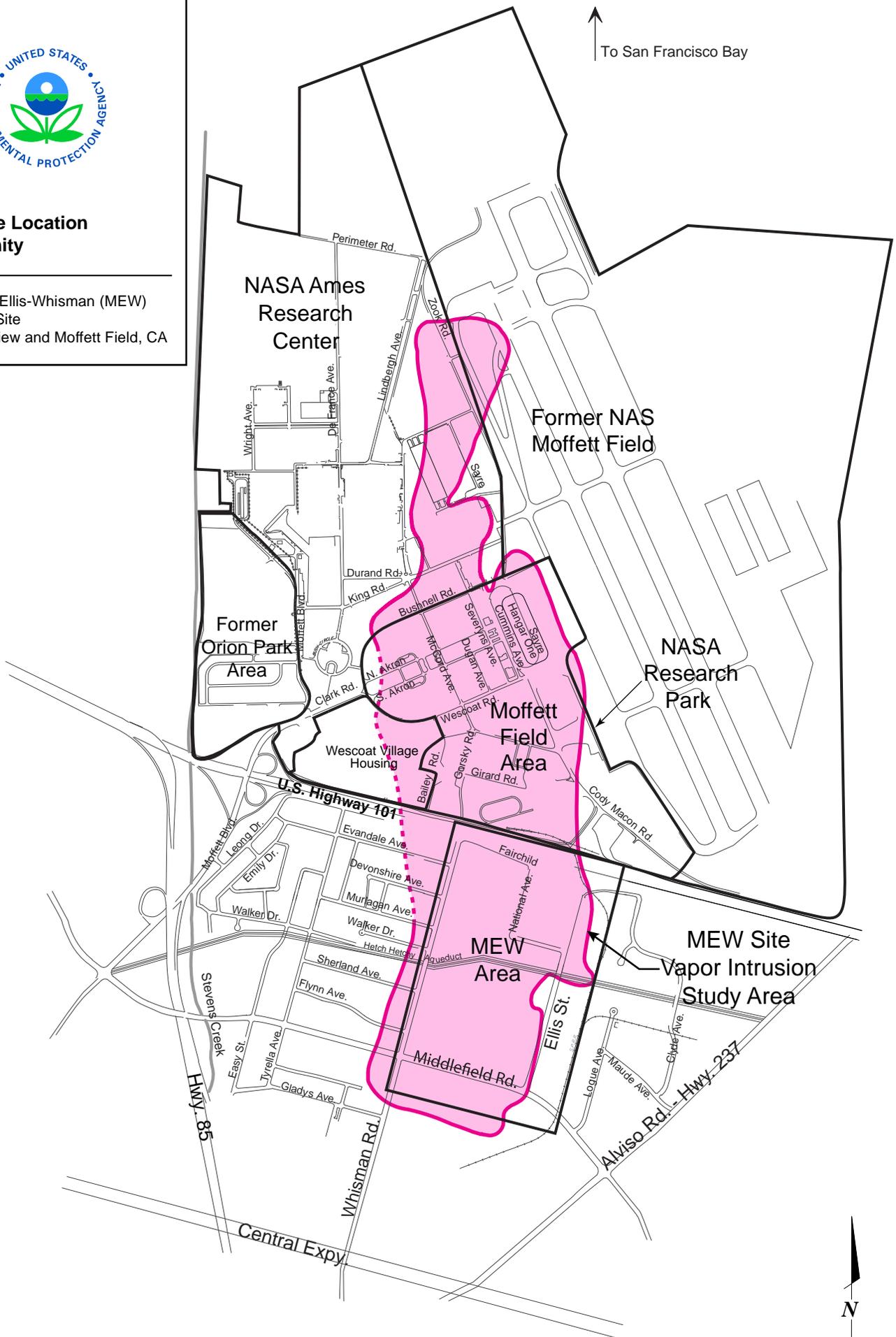
Facility/Responsible Party	Proposed Optimization	Status of Work	Comments
MEW Regional Groundwater Remediation Program:			
South of U.S. Highway - 101 – MEW Area	Optimize Pump and Treat	Groundwater model will be used to evaluate alternative groundwater extraction scenarios and prepare work plan.	Groundwater model assumptions submitted to EPA May 2014. Optimized modeling runs will be submitted to EPA in 2015.
North of U.S. Highway 101 – Moffett Field Area	Optimize Pump and Treat.	Groundwater model to be used to evaluate alternative groundwater extraction scenarios.	Groundwater model assumptions submitted to EPA May 2014. Optimized modeling runs will be submitted to EPA in 2015.
Navy:			
West-Side Aquifers Treatment System (WATS) – Navy Site 28.	Evaluating remedial options.	Completed in situ anaerobic biotic/abiotic Pilot Test between 2010 through 2012. Completed supplemental sampling and installed 15 additional wells in 2013 to better define source areas.	Draft Supplemental Investigation Report for former Building 88 and Traffic Island Areas submitted in July 2014 (CB&I 2014). Additional work planned in 2015-2016.
NASA:			
Northern portion of Regional Plume area	Optimize Pump and Treat	Final Work Plan submitted to characterize groundwater in the vicinity of NASA 1A and 2A and in the A2/B1 Zone.	Additional Final Plume Definition Assessment in the Northernmost A2/B1 Aquifer in 2015;

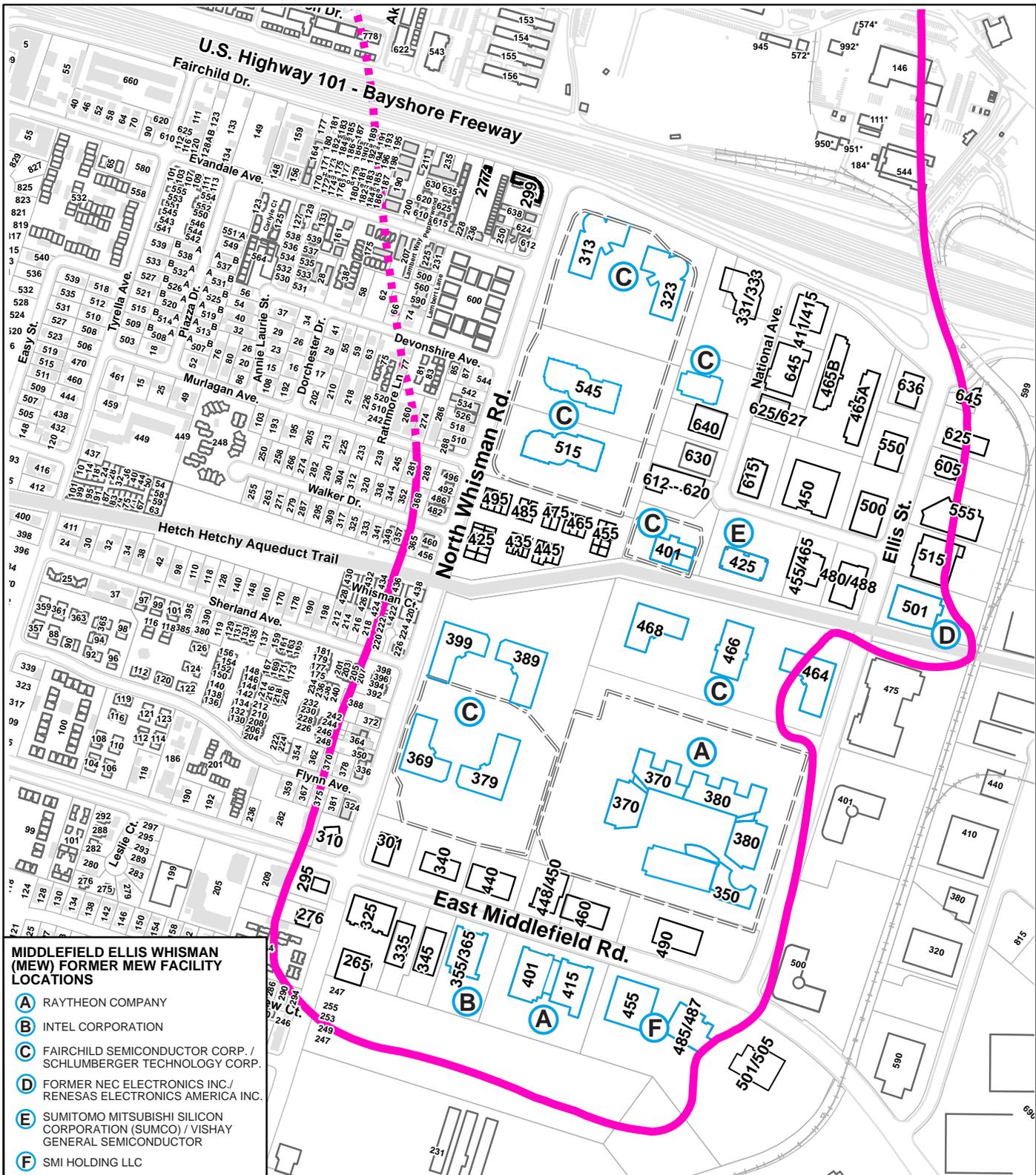
FIGURES



Figure 1
MEW Site Location
and Vicinity

Middlefield-Ellis-Whisman (MEW)
Superfund Site
Mountain View and Moffett Field, CA





- MIDDLEFIELD ELLIS WHISMAN (MEW) FORMER MEW FACILITY LOCATIONS**
- A** RAYTHEON COMPANY
 - B** INTEL CORPORATION
 - C** FAIRCHILD SEMICONDUCTOR CORP. / SCHLUMBERGER TECHNOLOGY CORP.
 - D** FORMER NEC ELECTRONICS INC./ RENESAS ELECTRONICS AMERICA INC.
 - E** SUMITOMO MITSUBISHI SILICON CORPORATION (SUMCO) / VISHAY GENERAL SEMICONDUCTOR
 - F** SMI HOLDING LLC

LEGEND

- Estimated TCE in shallow groundwater > 5 parts per billion (ppb)
- Further groundwater investigation is ongoing (2013-2014) to delineate the 5 ppb TCE plume boundary. Upon completion the figure will be updated.
- Slurry Wall (Underground)

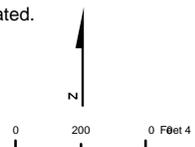
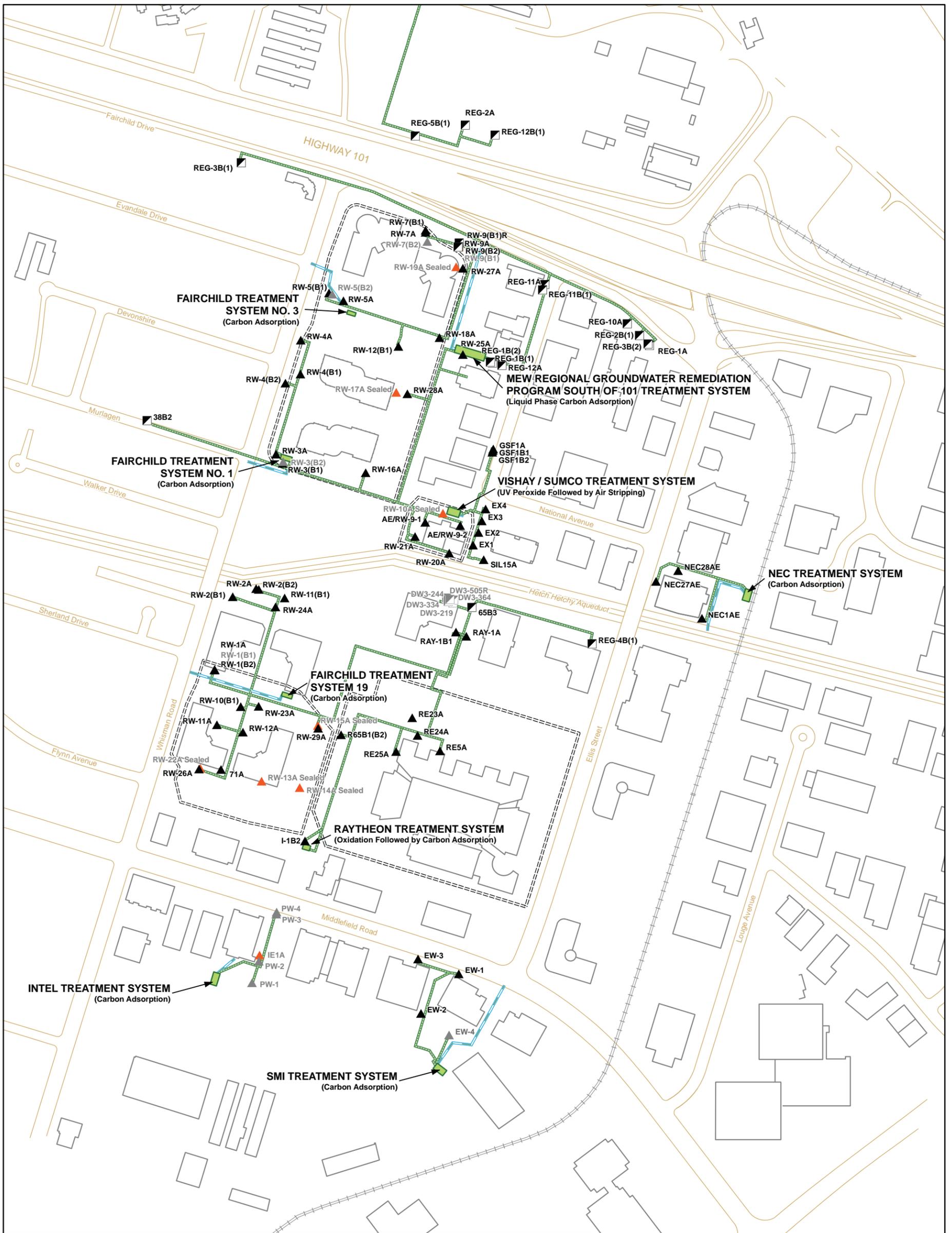


Figure 2
Former Facility Source Areas –
South of U.S. Highway 101

Middlefield-Ellis-Whisman (MEW) Superfund Site
 Mountain View and Moffett Field, CA



Legend

- ▣ Regional Recovery Well
- ▣ Inactive Regional Recovery Well
- ▣ Destroyed Regional Recovery Well
- ▲ Source Control Recovery Well
- ▲ Inactive Source Control Recovery Well
- ▲ Destroyed Source Control Recovery Well
- Treatment Pipeline
- Discharge Pipeline
- Treatment Plant
- Slurry Wall
- Building
- Road
- VTA Light Rail

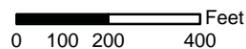
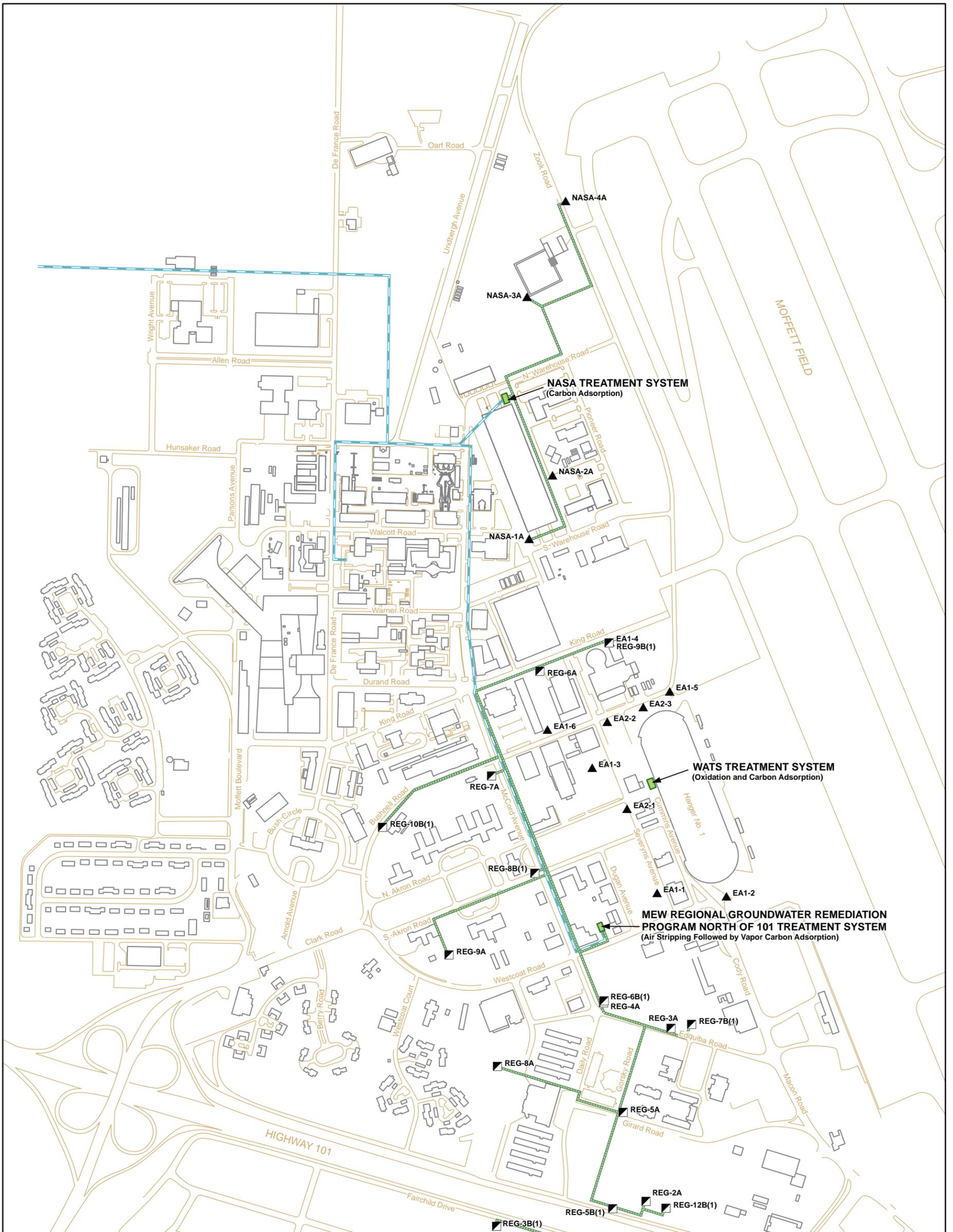


Figure 3
Locations Regional and Source Control Extraction Wells and Groundwater Treatment Systems – South of U.S. Highway 101

Middlefield-Ellis-Whisman (MEW) Superfund Site
 Mountain View and Moffett Field, CA



Legend

- Regional Recovery Well
- ▲ Source Control Recovery Well
- Treatment Pipeline
- Discharge Pipeline
- Treatment Plant
- Building
- Road

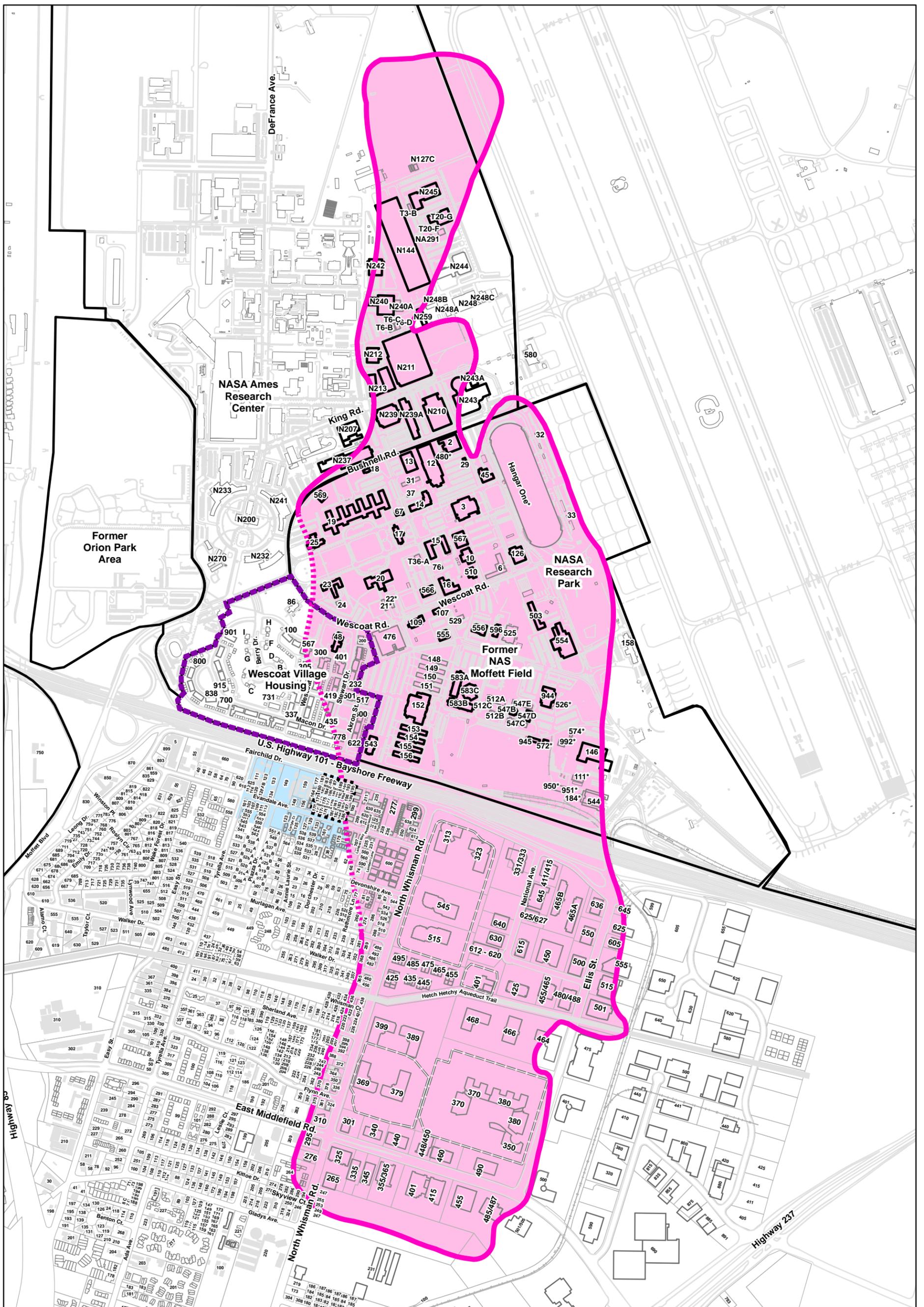


0 150 300 600 Feet



Figure 4
Locations Regional and Source Control Extraction Wells and Groundwater Treatment Systems – North of U.S. Highway 101

Middlefield-Ellis-Whisman (MEW) Superfund Site
 Mountain View and Moffett Field, CA



LEGEND

- Slurry Wall (Underground)
- Further groundwater investigation is ongoing (2013-2014) to delineate the 5 ppb TCE plume boundary. Upon completion the figure will be updated.
- Vapor Intrusion Study Area - estimated TCE in groundwater > 5 parts per billion (ppb) (updated based on 2013 groundwater results)

- Residential Indoor Air Sampling Area
- Classics homes built with vapor intrusion control system.
- Wescoat Village Residential Area (New homes built in 2006 with vapor intrusion control system.)

Note:

1. Bold building outlines indicate non-residential buildings that are occupied or to be occupied inside the vapor intrusion study area.
2. * Storage Buildings - Not Suitable For Occupancy

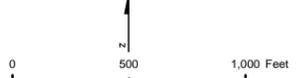
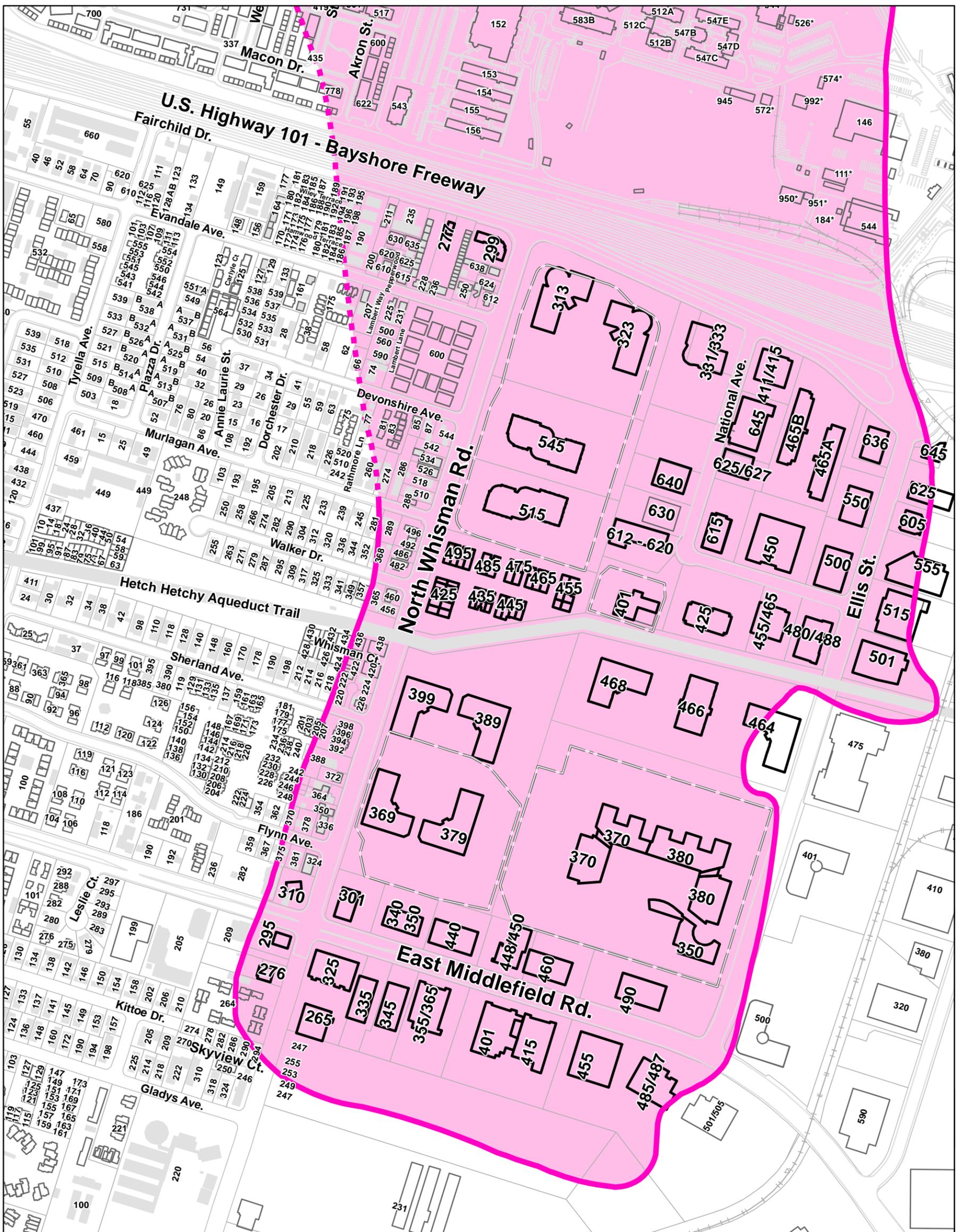


Figure 5
Vapor Intrusion Study Area

Middlefield-Ellis-Whisman (MEW) Superfund Site
Mountain View and Moffett Field, CA



LEGEND

- Vapor Intrusion Study Area – estimated TCE in groundwater > 5 parts per billion (ppb) (updated based on 2012 groundwater results)
- Further groundwater investigation is ongoing (2013) to delineate the 5 ppb TCE plume boundary. Upon completion the figure will be updated.
- Slurry Wall (Underground)

Note:

1. Bold building outlines indicate non-residential buildings that are occupied or to be occupied inside the vapor intrusion study area.
2. * Storage Buildings - Not Suitable For Occupancy
3. For Vapor Intrusion Study Area North of U.S. Highway 101 – Moffett Field Area, see North of U.S. Highway 101 – Moffett Field Area Map.

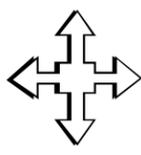
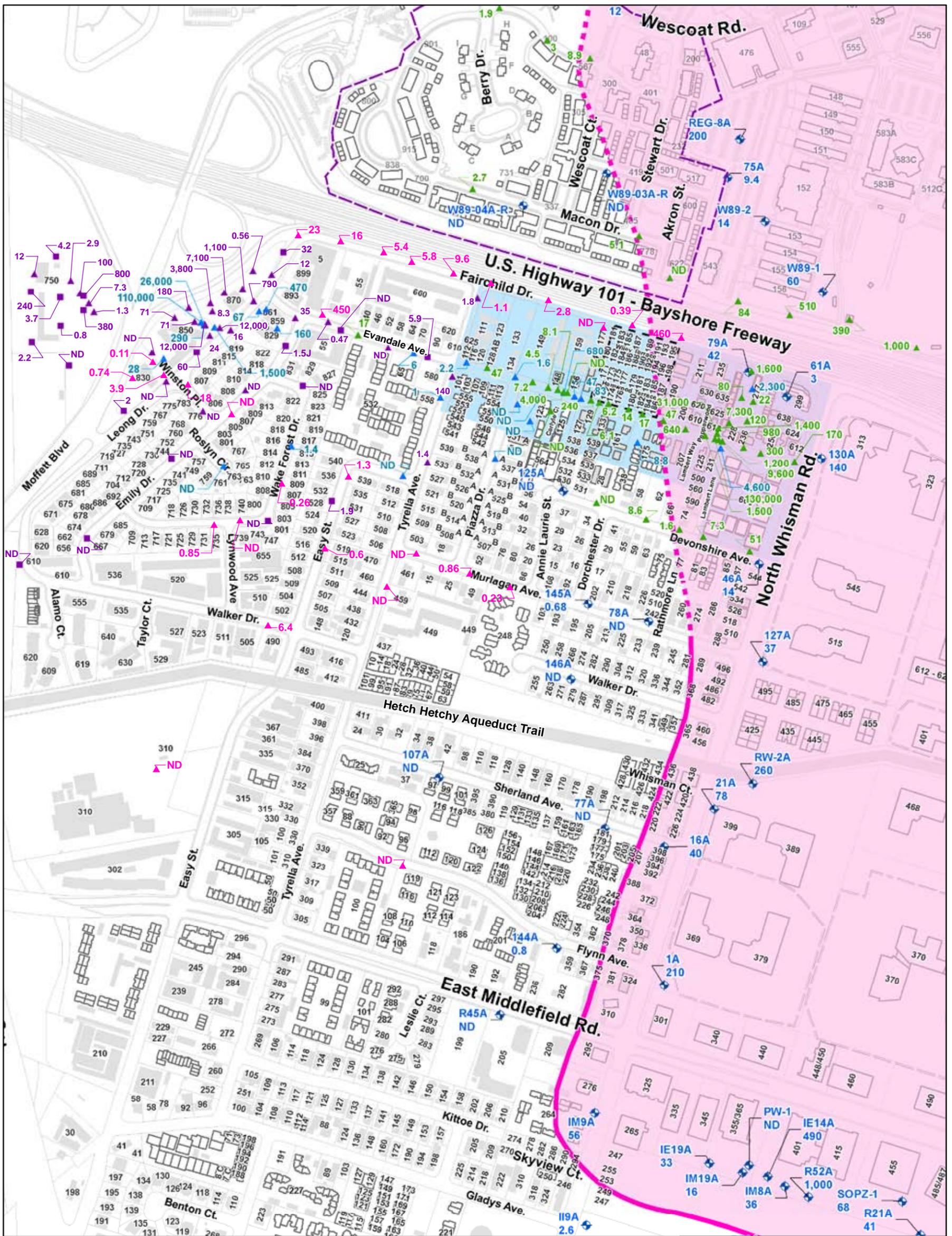


Figure 6
Vapor Intrusion Study Area –
South of U.S. Highway 101

Middlefield-Ellis-Whisman (MEW) Superfund Site
 Mountain View and Moffett Field, CA



LEGEND

- Slurry Wall (Underground)
- Further groundwater investigation is ongoing (2014) to delineate the 5 ppb TCE plume boundary. Upon completion the figure will be updated.
- Vapor Intrusion Study Area – estimated TCE in groundwater > 5 parts per billion (ppb) (updated based on 2013 groundwater results)
- Residential Indoor Air Sampling Area
- Classics homes built with vapor intrusion control system.
- Wescoat Village Residential Area (New homes built in 2006 with vapor intrusion control system.)

Note:
Only selected monitoring well data used to estimate Vapor Intrusion Study Area boundary are shown.

Grab Groundwater Locations

- 2014 EPA grab groundwater location
- 2013 EPA grab groundwater location
- 2012/2013 MEW grab groundwater location
- 2011 EPA grab groundwater location
- 2005 EPA grab groundwater location

Groundwater Monitoring Well Locations

- Groundwater monitoring well location
- The result shown is the TCE concentration in ppb from groundwater monitoring well samples collected in 2013.

ND = Not Detected (below 0.5 ppb TCE)

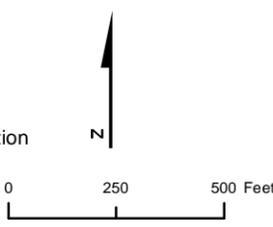


Figure 8
TCE Shallow Groundwater Results
Residential Areas in Vicinity of
MEW Superfund Site

Middlefield-Ellis-Whisman (MEW) Superfund Site
Mountain View and Moffett Field, CA

Five-Year Review Summary Form

EPA Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: MEW Superfund Study Area (1) Fairchild Semiconductor Corp. – Mountain View – EPA ID: CAD09598778 (2) Raytheon Co. – EPA ID: CAD09598778 (3) Intel Corp. – Mountain View – EPA ID: CAD061620217		
Region: 9	State: CA	City/County: Mountain View and Moffett Field, Santa Clara County
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	Has the Site achieved construction completion? No	
REVIEW STATUS		
Lead agency: EPA If “Other Federal Agency” was selected above, enter Agency name: Click here to enter text.		
Author name (Federal or State Project Manager): Alana Lee, EPA Project Manager		
Author affiliation: EPA Region 9		
Review period: 1/5/2014 – 9/25/2014		
Date of site inspection: Not Applicable		
Type of review: Policy		
Review number: 3		
Triggering action date: 9/30/2009		
Due date (five years after triggering action date): 9/30/2014		

Five-Year Review Summary Form (continued)

Issues/Recommendations

Issues and Recommendations Identified in the Five-Year Review

OU(s): Click here to enter text.	Issue Category: Remedy Performance			
	Issue: New TCE groundwater hot spot areas identified in residential area on Evandale Avenue.			
	Recommendation: Determine the source of TCE groundwater hot spot areas on Evandale Avenue and the lateral and vertical extent of TCE contamination in residential area. If other TCE hot spots are found, evaluate and address contamination by treatment or hydraulic control.			
Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	PRP	EPA	09/2016
OU(s): Click here to enter text.	Issue Category: Remedy Performance			
	Issue: Assessment needed of how the current vapor intrusion remedy implementation procedures take into account the impact of the short-term TCE risks on current operational framework.			
	Recommendation: Complete assessment and determine appropriate MEW Site-specific operational procedures and framework to address short-term TCE concerns.			
Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	EPA	EPA	03/2016
OU(s): Click here to enter text.	Issue Category: Remedy Performance			
	Issue: The extent and capture of TCE contamination in the B1 Zone and downgradient of the TCE groundwater hotspot areas in the A-zone in the residential area on the west has not been fully defined and addressed.			
	Recommendation: Develop and implement cleanup approach to address contamination in the A and B1 zone areas in the residential area.			
Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	PRP	EPA	09/2017
OU(s): Click here to enter text.	Issue Category: Remedy Performance			
	Issue: Declining efficiency and effectiveness of existing groundwater remedy will not achieve groundwater cleanup levels and will not meet the vapor intrusion remedial action objective to accelerate the reduction of the source of vapor intrusion (i.e., Site contaminants in shallow groundwater and soil gas) to levels			

	that are protective of current and future building occupants, such that the need for a vapor intrusion remedy would be minimized or no longer be necessary for many decades.			
	Recommendation: Enhance groundwater contaminant plume capture and groundwater cleanup efforts by implementing facility-specific and regional program optimization plans. Evaluate and implement pilot tests and treatability studies of alternative groundwater cleanup technologies to expedite contaminant mass removal and cleanup timeframe and reduce VOC concentrations in different representative source and Regional Plume areas. Complete Feasibility Study to evaluate remedial alternatives that can effectively meet the RAO for the vapor intrusion remedy.			
Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	PRP	EPA	09/2018
OU(s): Click here to enter text.	Issue Category: Remedy Performance			
	Issue: Inward gradients within slurry walls and upward vertical gradients are not consistently maintained at three of the slurry wells.			
	Recommendation: Evaluate alternative cleanup strategies inside the slurry walls and implement treatability studies that do not require maintaining inward and upward gradients to control facility-specific source area contamination as part of the Feasibility Study process			
Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	PRP	EPA	09/2018
OU(s): Click here to enter text.	Issue Category: Remedy Performance			
	Issue: No Institutional Controls selected for the groundwater remedy to ensure there is no direct exposure to contaminated groundwater			
	Recommendation: Include groundwater institutional controls to ensure there is no direct exposure to contaminated groundwater as part of Feasibility Study, Proposed Plan, and ROD Amendment process.			
Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	PRP	EPA	09/2018

Protectiveness Statement

Protectiveness Statement:

The vapor intrusion remedy selected in the 2010 ROD Amendment for the MEW Site is expected to be protective of human health when fully implemented. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks at the MEW Site. To be protective in the long-term, the vapor intrusion remedy implementation procedures need to be assessed to take into account the impact of the potential TCE short-term exposure risks on current MEW Site remedy operational framework. The groundwater remedy at the MEW Site is currently protective of human health and the environment because exposure to groundwater is being controlled. In order to be protective in the long term, the following recommendations and follow-up actions need to be completed: Determine the source of the TCE hot spot areas on Evandale Avenue and extent of TCE contamination in the A and B1 aquifer zones; Evaluate alternative cleanup strategies inside the slurry walls and implement treatability studies that do not necessarily require maintaining inward and upward gradients to control source area contamination; Evaluate and implement the current optimization pilot tests and treatability studies of alternative groundwater cleanup technologies at the facility-specific source areas, TCE hot spot areas, and representative areas of the regional groundwater contamination plume to expedite contaminant mass removal and cleanup timeframe; and Based on evaluation of the information collected, complete a Feasibility Study to evaluate remedial alternatives that can effectively meet the vapor intrusion remedial action objective to accelerate the reduction of the source of vapor intrusion (i.e., Site contaminants in shallow groundwater and soil gas) to levels that are protective of current and future building occupants, such that the need for a vapor intrusion remedy would be minimized or no longer be necessary.