

MEMORANDUM

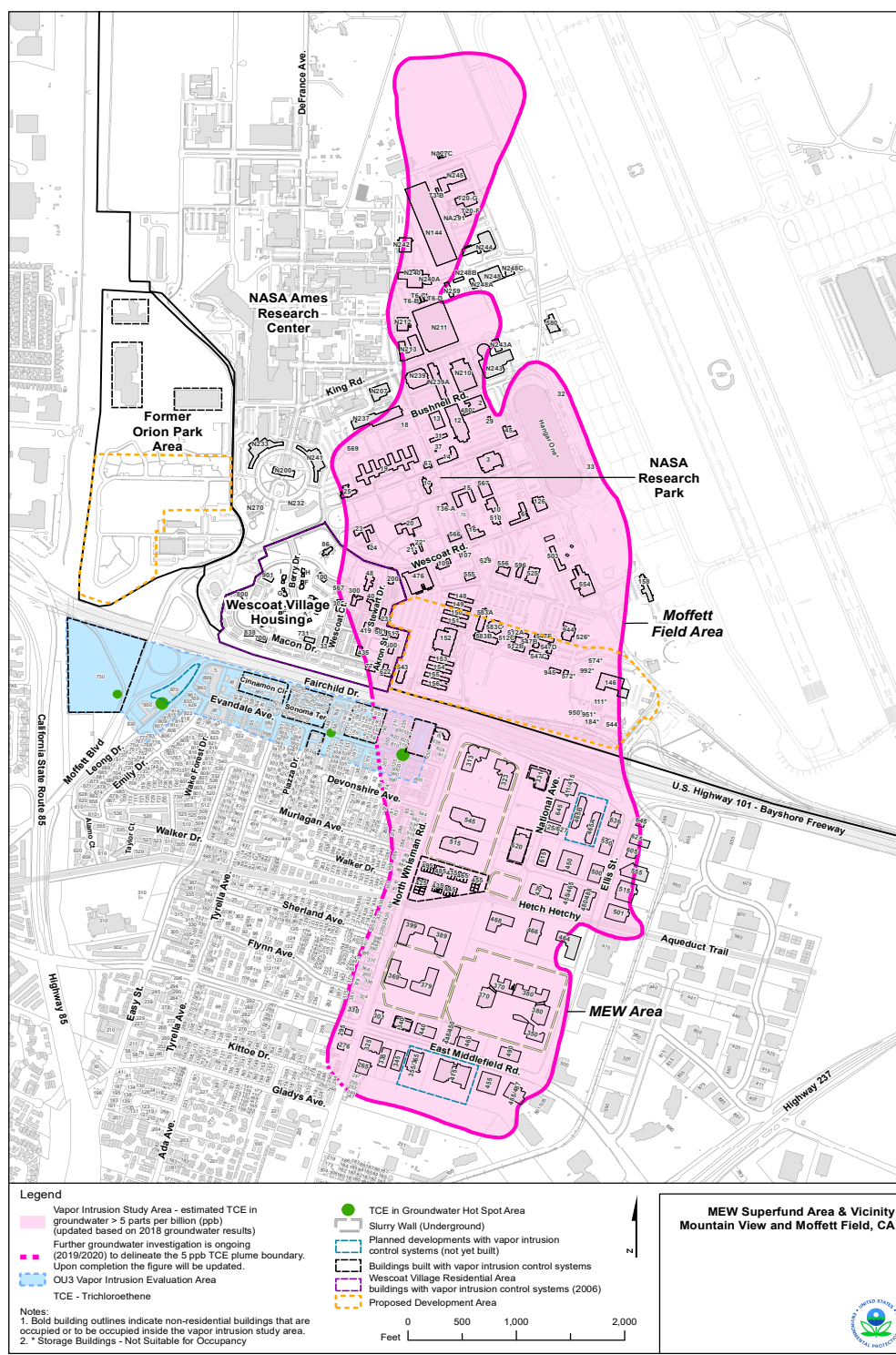
TO: Lenny Siegel, Center for Public Environmental Oversight (CPEO)
FROM: Peter Strauss
DATE: October, 2022
SUBJ: **The MEW/Moffett Field Superfund Site: A Guide to Vapor Intrusion Progress**

In 2010, U.S. EPA signed an amendment to the MEW (Middlefield-Ellis-Whisman) Record of Decision (ROD) to address vapor intrusion (VI) at the site. The MEW Superfund Study Area includes three separately listed civilian National Priorities List (NPL) sites (Fairchild Semiconductor, Raytheon, and Intel) and portions of the former Moffett Naval Air Station, which is also an NPL site. The commingled TCE-contaminated groundwater plume at this site is known as the MEW Regional Plume. EPA originally promulgated a ROD for this plume in 1989, a time when little was known about vapor intrusion.

The remedy selected in the 2010 ROD Amendment addresses the potential long-term exposure risks from trichloroethylene (TCE) and other chemicals of concern through the vapor intrusion pathway, the migration of volatile chemicals from the subsurface into overlying buildings. The objective of the vapor intrusion ROD amendment is to protect the health of current and future building occupants, including workers and residents in buildings overlying the site's shallow subsurface TCE contamination.

This report summarizes up-to-date information on vapor sampling and mitigation of buildings that lie within the MEW Vapor Intrusion Study Area. **Table 1** shows each building with its address or building number, the existing or proposed remedy, the year of the last sample, whether the last sampled concentration was below EPA's site-specific clean-up standards, whether the last sample was above concentrations in nearby outdoor air, whether the sample was taken with the Heating Ventilation and Cooling (HVAC) system on, off, or both, and notes clarifying any of these variables. It is followed by **Tables 2 through 4**, taken from the Record of Decision, which explain the Response Action Tiering System for existing and future buildings.

Because this work has been supported by a U.S. EPA Technical Assistance Grant (TAG) to CPEO for the MEW Superfund Site, this memo is limited to the MEW Vapor Intrusion Study Area. This includes a large fraction of Moffett Field that was affected by the MEW Regional Plume. This report does not cover smaller TCE plumes in the eastern portion of Moffett Field or the former Orion Park Military Housing on the western side.



MEW Regional Plume, Including Operable Unit 3

The Original MEW Area

The MEW Site is so-named because it is bounded by three Mountain View, California city streets: Middlefield Road, Ellis Street, and Whisman Road, as well as U.S. Highway 101. The MEW area is approximately 184 acres.

During the 1960s and 1970s, several industrial companies, including Fairchild Semiconductor, Raytheon Semiconductor, and Intel, operated semiconductor and other manufacturing and research activities at the MEW Area. It was the first concentration of silicon-based integrated circuit (chip) wafer fabrication in the world, leading the Santa Clara Valley to become known, worldwide, as Silicon Valley.

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). After subsurface VOCs were discovered in the early 1980's, EPA proposed adding the sites to the National Priorities List (NPL) in 1984. Companies began interim cleanup almost immediately, and in 1989 EPA finalized a legally binding Record of Decision, focused on remediating groundwater and soil.

Since the 1990s, major 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 contaminant releases to the environment and are not directly involved with the investigation and cleanup activities at the MEW Site. The parties responsible for the contamination in the MEW Area (the "Responsible Parties," also referred to as the "MEW Companies") no longer own or operate any facilities in the MEW Area.

Within the last decade, EPA extended the MEW area after it discovered contamination had migrated west of Whisman Road to Stevens Creek, through a leaky sewer line that had served the industrial area in the 1960s. This area, known as Operable Unit 3 (OU3), is approximately 45 acres. It is largely residential with a few commercial buildings. However, most of the buildings that lie within this area are not covered by any of the available documents.

Initially, in January 2013, EPA sampled 30 homes, two of which had TCE above EPA's residential action level. In July 2022, EPA explained, "most of the commercial properties were sampled, a number of residential properties were tested, but the farther one moved from the hotspots between Evandale and Fairchild, there was less interest in voluntary testing." Furthermore, there is no count or estimate on the number of homes that are located within OU3, nor is there an official estimate of the percentage of homes tested. In addition, to protect the privacy of residents, EPA does not disclose the exact locations of residential properties that have been tested and/or mitigated for vapor intrusion.



Buildings in Vapor Intrusion Study Area South of 101

Moffett Field

Moffett Field sits directly north across Highway 101 from the MEW site. In 1933 the 1,500-acre Moffett Naval Air Station site was first commissioned as a naval air station to support the Navy's "lighter-than-air" program. In 1939, the National Advisory Committee for Aeronautics, the predecessor to the National Aeronautics and Space Administration (NASA), established what is now known as the Ames Research Center on a portion of the property. After a period of Army operation, the airfield was transferred back to the Navy in 1942 as Naval Air Station Moffett Field. It was closed in 1994 as a result of the 1991 recommendations of the national Base Realignment and Closure (BRAC) Commission.

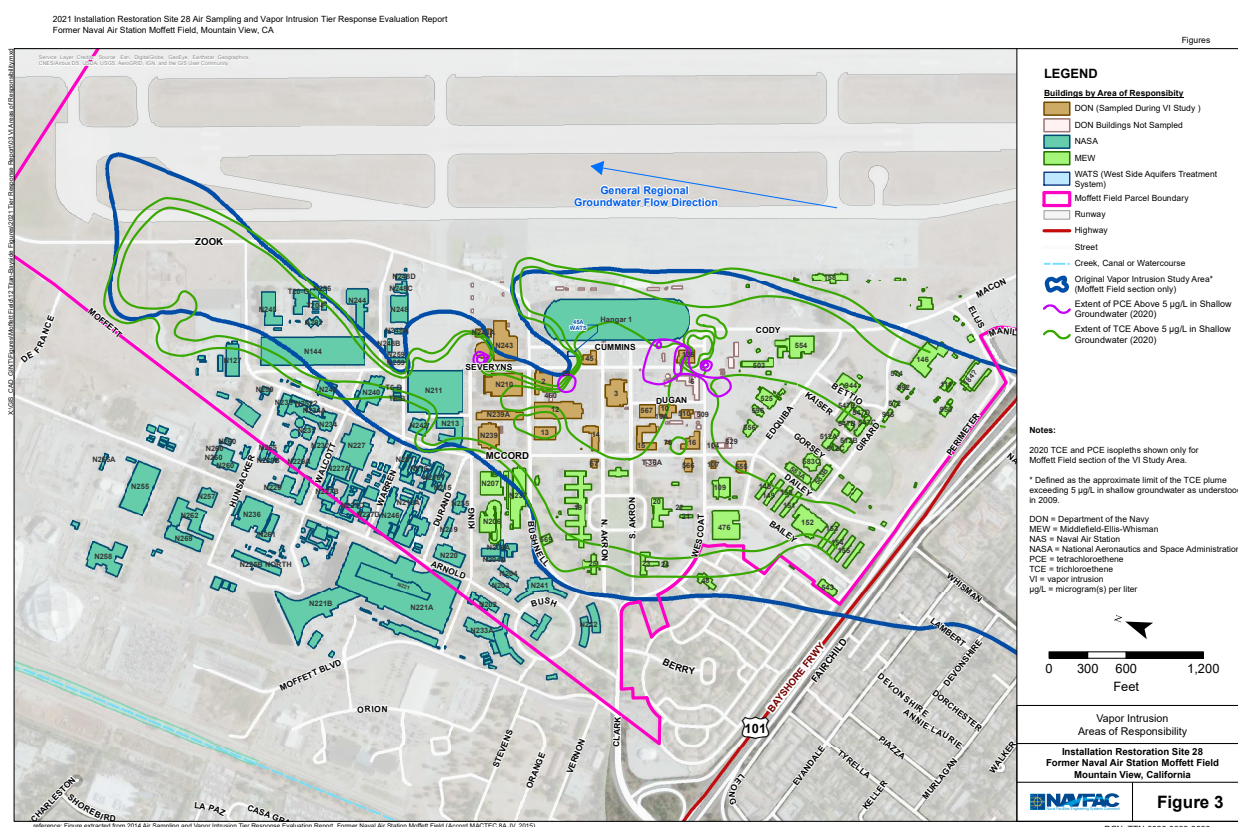
The BRAC Commission directed the Navy to transfer most of its property to NASA Ames, with the two on-base housing areas, Orion Park and Wescoat, going to the Air Force. As part of another BRAC round, the Air Force transferred the housing areas to the Army in 2001.

Currently, the former Navy property hosts numerous government agencies, including an Armed Forces Reserve Center and the California Air National Guard, and NASA leases out a majority of the property to Google, which is headquartered just across Stevens Creek. It is used for airfield operations, military housing, storage, educational facilities, research and development, offices, and retail space. NASA's redevelopment plans in the Moffett Field Area include demolition of all non-historic structures. Google and other lessees are already converting Moffett

Field into sustainable research facilities including office, educational, recreational, and residential uses.

Military activities at the site, including aircraft maintenance, contaminated groundwater, soil, and wetlands with volatile organic compounds (VOCs), fuel, and many other chemicals of concern. The VOCs used at Moffett commingled with the large plume of contaminants that crossed under Highway 101 from MEW. The north-of-101 portion of the plume, which is also subject to review and analysis under the TAG grant, is approximately 245 acres.

The U.S. Navy has been conducting cleanup activities pursuant to a 1990 Federal Facility Agreement (FFA) with EPA and the State of California. A 1993 FFA Amendment requires the U.S. Navy to remediate its source areas of contamination within the MEW regional groundwater contamination plume in accordance with EPA's 1989 ROD for the MEW Site. NASA, which signed its own FFA in 2014, also has responsibility for controlling and/or mitigating Vapor Intrusion.



Responsibility for Vapor Intrusion Response North of 101

The institutional controls selected for the vapor intrusion remedy are found in NASA's and Planetary Ventures' Environmental Issues Management Plans (EIMP), which applies to the NASA Research Park area and a portion of the Moffett Federal Airfield Leasehold by Planetary Ventures, a Google subsidiary. The EIMP requires all future construction overlying 5 parts per billion (ppb) of VOCs in the shallow groundwater to incorporate vapor intrusion mitigation either with a sub-slab depressurization system (SSDS) or an indoor air mechanical ventilation

system that maintains positive pressure. After mitigation measures are implemented, the EIMP requires ongoing monitoring of contaminants and remedial measures.

In addition, planned development projects at the southern part of Moffett are expected to demolish most of the buildings in this area.

The Vapor Intrusion ROD Amendment of 2010

Vapor intrusion is the upward migration of gases from soil and groundwater into overlying buildings. At the time of the 1989 ROD for the site, little was understood about this contaminant pathway. Beginning 2002 EPA requested the Potentially Responsible Parties (PRPs) for the MEW groundwater contamination—the MEW Companies, U.S. Navy, and NASA—to evaluate the investigate potential vapor intrusion pathway throughout the regional plume. During 2003 through 2008, the MEW Companies, NASA, U.S. Navy, and EPA collected over 3,000 air samples from 47 commercial buildings and 20 residences within the Vapor Intrusion Study Area, an area just larger than the delineated shallow TCE plume.

In August 2010, EPA issued the Record of Decision Amendment for the Vapor Intrusion Pathway. It stated, “The maximum TCE indoor air concentrations found in existing residential and commercial buildings overlying the shallow groundwater contamination (within the Vapor Intrusion Study Area) are 490 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) in the MEW Area and 176 $\mu\text{g}/\text{m}^3$ in the Moffett Field Area.”

EPA established site-specific indoor air cleanup levels for TCE of 1.0 and 5.0 $\mu\text{g}/\text{m}^3$ for residential and commercial building, respectively. Later EPA set slightly higher *short-term* exposure standards based upon the risk of fetal heart defects during the first trimester of pregnancy.

The ROD Amendment lays out two remedial action objectives (RAOs) for the MEW Site.

- 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 exceed indoor air cleanup levels for long-term exposure.
- 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.

Only the first objective is directly addressed in the ROD amendment. The second was deferred to a Supplemental Site-wide Groundwater Feasibility Study, which has not yet been completed.

Buildings overlying elevated groundwater concentrations are more likely to have indoor air TCE concentrations exceeding the TCE action level. Actual indoor air concentrations are also dependent on other factors, such as ventilation system operations, building configuration, and preferential pathways into the building.

The highest TCE indoor air concentrations at MEW were found in a building with a basement, where there was direct contact with groundwater (644 National Avenue in the MEW Area). Significantly elevated concentrations were also found in a NASA building North of Highway 101, where the ventilation system introduced air from beneath the raised floor into the building (N210).

There are three elements to the remedy selected in this ROD Amendment to address the potential long-term exposure risks from vapor intrusion: engineering controls, institutional controls, and indoor air sampling.

Engineering controls are the most aggressive method of limiting human exposure to toxic vapor. They usually require the installation of some type of sub-slab depressurization system (SSDS) or other means of regulating pressure within structures. Regulating the heating, ventilation, and air conditioning system (HVAC) can also be used to control pressure, although this method is not widely used because it depends on building operators ensuring that HVAC systems are functioning at all times when there are humans present. Existing buildings are also inspected for potential vapor entry points (e.g., utility and plumbing connections) and sealed where appropriate. All new buildings in the vapor intrusion study area must be constructed with a vapor barrier and a passive sub-slab depressurization system with the ability to make it active (through installation of a fan).

Institutional Controls (ICs) are non-engineered remedy components—essentially paperwork—that are part of each of the remedial alternatives. ICs are used to ensure ongoing operation of engineering controls, to require that controls be designed into new buildings, and to provide information about the vapor intrusion remedy to the public and prospective property owners and tenants.

Additionally, ongoing monitoring of ICs is necessary to ensure that the remedy is effective over the long term. Therefore, EPA plans to develop Institutional Controls Implementation Plans to serve as the design documents for IC management. This is done in Remedial Design phase of building-specific remedy implementation. At this time, EPA does not have a Site-wide Institutional Controls Implementation Plan.

EPA's selected umbrella remedy to address the vapor intrusion pathway and ensure protection of human health of building occupants in the Vapor Intrusion Study Area 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.
- Alternative 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).
- Implementation of Institutional Controls (ICs) and Monitoring to Ensure the Long-term Effectiveness of the remedy.

Tiering

The ROD uses a tiering framework, based on indoor air sampling results, to determine the appropriate remedy for each building. While the tiers are well established, the assignment of buildings to tiers is clouded. The MEW Companies report they have not received EPA approval of the Revised Tiering Work Plan that were submitted as far back as 2013. In 2020 (2019 Annual Report), they explained that they would nevertheless assign tiers to buildings within their area of responsibility, with no assurance of EPA agreement. However, in some cases, the responsible parties have not assigned a tier, and thus a remedy to a building. For those buildings, the “VI Remedy” column in Table 1 is blank.

In brief, the Tiers for existing buildings are as follows:

- Buildings are classified as Tier 1 if the indoor air concentrations for any of the seven chemicals of concern exceed both the nearby outdoor air concentrations and the indoor air cleanup levels for buildings without engineering controls in place. Tier 1 buildings need an appropriate engineering control plus governmental, proprietary, and informational ICs as needed.
- Buildings are classified as Tier 2 if indoor air concentrations are below EPA’s indoor air cleanup levels only with an engineering control in place or in operation. Long-term monitoring and ICs need to be implemented.
- A building is classified as Tier 3A, if, with no engineering controls, indoor air concentrations are below EPA’s indoor air cleanup levels, but they exceed outdoor air concentrations.
- A building is classified as 3B if the indoor air concentrations are at or below the approximate nearby outdoor air concentrations as well as indoor air cleanup levels. In this case, governmental ICs are implemented.
- Buildings are classified as Tier 4 when converging lines of evidence demonstrate that there is no longer the potential for indoor vapors to exceed the EPA’s indoor air cleanup levels.

New buildings are divided into two categories:

- New buildings are classified as Tier A where lines of evidence indicate a potential for vapor intrusion. They must implement engineering control, confirm effectiveness with indoor air sampling after construction, implement ICs, and recategorize the property as Tier 2.
- New buildings are classified as Tier B where lines of evidence indicate there is no potential for VI. If confirmed by indoor air testing after construction, no action is necessary.

Buildings are evaluated using results from building surveys, walk-throughs, interviews, inspections, indoor air sampling, subsurface sampling, and other lines of evidence. Sampling and Analysis Plans require that the indoor air in each existing building in the Vapor Intrusion Study Area be sampled to determine the appropriate response action. Where buildings have a mechanical ventilation system (HVAC), sampling should be done with both the system turned on

and off. Once a building has gone through this process, the selected response action for a building is implemented. Additional lines of evidence may be collected and evaluated at any time to determine whether a change is appropriate. Recently, in areas of high groundwater contamination, EPA began to require soil gas analysis.

Even if a new building site is planning to put in an active SSDS system, high soil-gas levels may require additional response measures. For example, EPA required that soil-gas analysis be undertaken at 277 Fairchild Ave. where the residential developer had already planned to put in an SSDS. Because EPA believed that the SSDS might not be sufficient to mitigate potential human-health risks, the agency required that additional groundwater and soil gas cleanup be initiated. At this site, the project developer conducted *in situ* bioremediation and soil vapor extraction to knock down the high levels of TCE before breaking ground. We expect that when the Supplemental Site-wide Groundwater Feasibility Study is completed, EPA will require soil-gas analysis. It will also require additional subsurface remediation if soil gas levels exceed a trigger level that EPA might set at 20,000 $\mu\text{g}/\text{m}^3$.

Findings

I. Of the 141 buildings found in **Table 1**:

- 8 buildings exceed EPA cleanup standards. All are recommended for mitigation.
- 28 buildings either had or were in the process of implementing mitigation measures that included engineering controls.
- 21 buildings had no information on results of sampling.
- 28 buildings are in the southern part of Moffett Field planned for redevelopment by Mountain View Homes and the University of California Berkeley. All or most of these buildings are designated for demolition.
- 34 additional buildings had indoor sampling results that exceeded background levels. In this category:
 - 21 buildings had no information on whether the exceedance was with the HVAC on or off.
 - 10 buildings indicated that the exceedance was with HVAC off.
 - 1 building indicated that the exceedance was with HVAC on.
 - 4 buildings had no HVAC
 - 4 buildings were scheduled for demolition
- 29 buildings had no information at all. These could be inactive or demolished.

II. There was little or no information on residential buildings. Where sampled, the locations are not identified due to privacy concerns. Moreover, in OU3, which is largely residential, there are no data on the number of buildings tested or even the number of buildings comprising OU3. Most commercial buildings, as well as homes near known hot spots, within this area have been tested

III. EPA does not have a central data base providing all indoor air test results. The Navy has a table for its sites, but neither NASA nor the MEW Companies publish their data. This report is compiled from the Responsible Parties' annual vapor intrusion reports.

- IV. If the indoor air concentrations in a building are below cleanup standards but above outdoor background levels, EPA requires a long-term monitoring plan (LTMP), in addition to implementing ICs. However, if a building is 'at or within' background with HVAC off, it does not have to develop an LTMP. In a May 26, 2020 e-mail, EPA stated, "Currently the only buildings/properties with long-term operations, maintenance, and monitoring plans are the ones with vapor intrusion control systems."
- V. The responsible parties have submitted to EPA proposed tier designations for most buildings, some almost 10 years ago. As far as one can tell from the Annual Reports, EPA has not acted upon them.
- VI. The ROD Amendment states that "As part of Remedial Design, EPA will develop an Institutional Controls Implementation Plan ('ICIP') that will serve as the design document for implementation and ongoing ICs management." No site-wide IC implementation plan has been completed.
- VII. The second RAO is not addressed by this vapor intrusion remedy; instead, it is being addressed by the soil and groundwater remedy being implemented under the 1989 ROD. It will be further evaluated in a separate Supplemental Site-wide Shallow Groundwater Focused Feasibility Study. Any resulting subsurface remediation requirements will be documented in future ROD Amendment.
- VIII. The 2019 *Fourth Five-Year Review Report for Middlefield-Ellis-Whisman (MEW) Superfund Study Area* stated:

TCE groundwater concentrations have decreased over the years; and analysis of monitoring data indicates that TCE concentration in the groundwater plume are levelling off at concentrations above the cleanup level. The declining efficiency of the operations of the current groundwater remedy indicates that groundwater cleanup levels will not be achieved in shallow groundwater for many decades. This length of time is inconsistent with the vapor intrusion remedy 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.
- IX. Most properties within the Vapor Intrusion Study Area establish outdoor background concentrations based on real-time sampling results. Others rely on a level, $0.4 \mu\text{g}/\text{m}^3$, that EPA described as typical in the 2010 ROD Amendment, even though there is no instruction to use that for comparative background.

Based on a survey of Navy sampling results, background levels are almost always lower than the EPA default number. For the 19 buildings that have data, the average highest background near each building was $0.24 \mu\text{g}/\text{m}^3$. This is based on the highest readings for each building, disregarding three anomalous readings. Many samples were much less. If one averages the background readings for each building, disregarding the three outliers and all estimated and/or non-detected results (signified by J and U in data tables) background would be $0.09 \mu\text{g}/\text{m}^3$.

Furthermore, the Navy was originally going to classify nine of these buildings below EPA background (but above building-specific background data) as needing an LTMP. However, it decided to go back and use the EPA default value for background so that it wasn't required to undertake long-term monitoring.

Recommendations

- I. EPA should prepare and share its Supplemental Site-wide Groundwater Feasibility Study. Accelerated subsurface remediation remains the best way to reduce long-term risk and the ongoing need for vapor intrusion mitigation, institutional controls, and long-term monitoring. This study, and the resulting Proposed Plan and ROD Amendment, can build upon pilot projects and optimization studies already underway or completed.
- II. All commercial buildings with HVAC systems should be sampled with HVAC on and HVAC off. This approach, already encouraged by U.S. EPA, provides information on what one would expect from both normal HVAC operations and worst-case scenarios—for example, should the HVAC system malfunction. EPA should promptly identify those buildings that have not tested indoor air with the HVAC system both on and off.
- III. EPA should make formal decisions on Tiering assignment proposals within a year of submission so remedies, including the implementation of long-term management plans, can be carried out. Within six months, EPA should also make decisions on those buildings where proposals were submitted over one year ago.
- IV. Background levels for each building should be based on outdoor sampling adjacent to each building, preferably at the same time as indoor air sampling.
- V. EPA requires that all owners of buildings *where TCE indoor air concentrations are above building-specific background levels but below action levels* develop a long-term management plan. If building-specific data is used rather than the EPA default level, this would increase the number of buildings requiring long-term monitoring plans. Furthermore, indoor air sampling for these buildings should be performed at least once every two years, in winter months. At buildings where indoor air samples repeatedly exceed background levels, EPA should notify building occupants. This would give people—such as pregnant women—the opportunity to make personal risk management decisions. EPA should also consider requiring the operation of engineering controls.
- VI. EPA should create a public data base compiling all indoor air test results. It is currently burdensome to find and compare historic air monitoring results. All results for buildings with HVAC systems should indicate which samples were taken with HVAC on and which were taken with HVAC off.
- VII. EPA should identify and explain the 29 buildings with no information as well as the 21 buildings with no sampling results.
- VIII. EPA should complete a site-wide Institutional Control Implementation Plan. As noted, this Plan was to be developed as part of the remedial design phase. The ROD Amendment was signed 12 years ago, so the site-wide remedial design and ICIP are long overdue.

- IX. We recommend that the Responsible Parties provide updated maps that indicate whether a building is vacant, is slated for demolition, or has already been demolished. Maps should include addresses in addition to building numbers for easier identification.
- X. At new buildings where soil gas or groundwater concentrations exceed trigger levels, such as those established by EPA for the 277 Fairchild Ave. development, EPA should consistently mandate additional subsurface remediation.

References

1. *Fourth Five-Year Review Report for Middlefield-Ellis-Whisman (MEW) Superfund Study Area*, U.S. EPA, September, 2019.
2. *Five-Year Review Report for IR Sites 26 and 28, NAS Moffett Field Superfund Site*, U.S. Navy, August, 2020
3. *EPA Third Five-Year Review Report for MEW Superfund Study Area*, September, 2014
4. *2021 Annual Vapor Intrusion Progress report: Fairchild and Regional Groundwater Remediation Programs, Middlefield-Ellis-Whisman (MEW) Vapor Intrusion Study Area*, prepared for Schlumberger Technology Corporation by Geosyntec, April, 2022
5. *2021 Annual Progress Report: Former Raytheon Facilities 350 Ellis Street Mountain View*, prepared for Raytheon by Haley-Aldrich, April, 2022
6. *2021 Annual Progress Report: Former Intel Mountain View Facilities*, 365 East Middlefield Road, prepared for Intel by Weiss and Associates, April, 2022
7. *Draft Addendum to the 2018 Building-Specific Vapor Intrusion Long-Term Monitoring Report 2020 Sampling Event*, prepared for NASA Ames Environmental Management, prepared by BB&E Consulting Engineers, July, 2020
8. *2021 Installation Restoration Site 28 Air Sampling and Vapor Intrusion Tier Response Evaluation Report Former Naval Air Station Moffett Field*, prepared for U.S. Navy by Titan Environmental Solutions, Inc., June, 2022
9. *Record of Decision Amendment for the Vapor Intrusion Pathway, MEW Superfund Study Area*, U.S. EPA, August, 2010
10. *2019 Annual Vapor Intrusion Progress Report MEW Area and Moffett Field*, prepared for Schlumberger Technology and Raytheon by Haley & Aldrich, Inc., April, 2020

Table 1: Vapor Sampling and Mitigation by Responsibility Area

Building	VI Remedy	Last Indoor Test	Below Action Level?	Indoor Above Outdoor?	Occupied Vacant Partial	HVAC	Notes
South of 101 Commercial							
350/370/380 Ellis	Active SSD, ICs	2016	Y		O	On/Off	Veritas constructed the current site facilities in 2000 with a passive SSV. Raytheon installed and continues to operate air purification units (APUs) in five utility rooms. In 2015, Raytheon voluntarily converted the passive system to an active sub-slab depressurization (SSD) system.
464 Ellis	ICs	2013	Y		P	On/Off	
466 Ellis	ICs	2013	Y		P	On/Off	
468 Ellis	ICs	2013	Y		P	On/Off	
480/488 Ellis	ICs	2014	Y		O	On/Off	
500 Ellis		2012	Y		O	On/Off	
515 Ellis	ICs	2014	Y		O	On/Off	
550 Ellis		2012	Y	Y	O	On/Off	Does not indicate whether air samples exceeded background with HVAC on or off
555 Ellis		2012	Y		O	On/Off	
605 Ellis		2012	Y	Y	O	On/Off	Does not indicate whether air samples exceeded background with HVAC on or off
625 Ellis		2012	Y	Y	O	On/Off	Does not indicate whether air samples exceeded background with HVAC on or off
636 Ellis/ 491 Fairchild		2012	Y	Y	O	On/Off	Does not indicate whether air samples exceeded background with HVAC on or off
645 Ellis		2012	Y	Y	O	On/Off	Does not indicate whether air samples exceeded background with HVAC on or off
277 Fairchild	Active SSD, vapor barrier, monitoring, and ICs	2020	Y		O		Construction complete
299 Fairchild		2012	Y	Y	O	On/Off	Does not indicate whether air samples exceeded background with HVAC on or off
313 Fairchild	Implement governmental ICs	2019	Y		O	On/Off	
323 Fairchild	Monitoring to be decided; Implement governmental ICs	2019	Y	Y	O	On/Off	Exceeded background with HVAC off. Tenant improvements concluded in 2021.
331 Fairchild	Passive SSV System, Vapor Barrier, Monitoring, and ICs	2013	Y		O		A passive sub-slab ventilation (SSV) system was installed beneath the building prior to building construction. Properties addressed as 644/660/670 National Ave. were consolidated and re-addressed as 331 Fairchild
411/415 Fairchild		2012-2014		Y	O	On/Off	2012 and 2014 sampling of Suites 411 and 415 indicated above background during normal occupancy.
465 Fairchild		2012	Y	Y	O	On/Off	A mitigation plan was submitted to EPA for a planned redevelopment of the property.
295 Middlefield		2012	Y		O	On	
325 Middlefield		2012	Y		O	On	
335 Middlefield	Monitoring, ICs	2017	Y	Y	O	On/Off	Does not indicate whether air samples exceeded background with HVAC on or off
340 Middlefield	Passive SSV, monitoring, ICs	2021	Y		O	N/A	The property was redeveloped and a SSV was installed. In 2021, the system was operating as designed.
345 Middlefield		2017	Y		O	On/Off	

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Building	VI Remedy	Last Indoor Test	Below Action Level?	Indoor Above Outdoor?	Occupied Vacant Partial	HVAC	Notes
355/365 Middlefield		2013	Y	Y	O	N/A	Residential development is planned. Soil gas for both TCE and PCE are in a range that EPA will require installation of a passive SSDS. Intel and Raytheon implemented enhance bioremediation to accelerate cleanup.
401 Middlefield		2013	Y	Y	O	N/A	Residential development is planned. Soil gas for both TCE and PCE are in a range that EPA will require installation of a passive SSDS. Intel and Raytheon implemented enhance bioremediation to accelerate cleanup.
440 Middlefield	Active SSV, monitoring, ICs. Semi-annual monitoring when occupied	2015	Y		V	N/A	
448/450 Middlefield		2012	Y		O		
460 Middlefield		2013	Y		O	On/Off	
490 Middlefield		2012	Y		O	On/Off	
401 National**	Open garage, implement ICs	N/A	N/A	N/A		N/A	The land is used as a parking garage.
450 National		2017	Y		O	On/Off	
455/465 National	HVAC, Monitoring, and ICs. Annual inspection	2013	Y		O		PCE exceeded EPA indoor standards with HVAC on and TCE exceeded the EPA clean-up level with HVAC off. In 2013 owners found that an SSD is not a feasible response action for this building. Adjusting the HVAC was determined to be an effective VI control remedy. In 2021, in preparation for occupancy, the HVAC system was modified to run at an exchange rate of 1.0 or greater.
615 National	Voluntary Active SSD System, Monitoring, and ICs		Y		O	On/Off	Voluntary SSD
620 National	Active SSD System, Monitoring, and ICs		Y		V		The property was redeveloped and an SSDS was required for the new building due to potential for vapor intrusion.
625/627 National		2012	Y		O	On/Off	
644 National***	Land is vacant. ICs	N/A			N/A	N/A	See 331 Fairchild
645 National		2012	Y		O	On/Off	
265/275 Whisman		2012	Y		V	On	
276 Whisman		2017	Y		O	On/Off	The building owner trenched through the concrete slab to perform emergency sewer repairs in January 2017.
301 Whisman		2012	Y		O	On/Off	
310 Whisman		2018	Y		O		Building was redeveloped in 2017, has submitted data indicating no action needed
369 Whisman	Active SSD System, Monitoring, and ICs	2013	Y		P	On/Off	In 2021, the Annual SSDS Operation, Maintenance, and Monitoring Report found that the systems were operating as designed.
379 Whisman	Active SSD System, Monitoring, and ICs	2013	Y		P	N/A	In 2021, the Annual SSDS Operation, Maintenance, and Monitoring Report found that the systems were operating as designed.
389 Whisman	Voluntary Active SSD System, Monitoring, and ICs	?	Y		O	On/Off	Owner installed a voluntary SSDS

Table 1: Vapor Sampling and Mitigation by Responsibility Area

Building	VI Remedy	Last Indoor Test	Below Action Level?	Indoor Above Outdoor?	Occupied Vacant: Partial	HVAC	Notes
399 Whisman	Voluntary Active SSD System, Monitoring, and ICs	?	Y		O	On/Off	Voluntary SSDS
425/495 Whisman		2012	Y		O	On/Off	Voluntary sub-slab pressurization system (SSP) prior to construction
515 Whisman	No Engineering Control, Monitoring TBD, ICs		Y	Y	P	On/Off	
545 Whisman	No Engineering Control, Monitoring TBD, ICs		Y	Y	P	On/Off	

Table 1: Vapor Sampling and Mitigation by Responsibility Area

Building	VI Remedy	Last Indoor Test	Below Action Level?	Indoor Above Outdoor?	Occupied Vacant Partial	HVAC	Notes
MEW Companies' Responsibility at Moffett Field							
#17		2003	Y		P	Off	
#18		2008	Y		P	Off	
#19		2007	Y		O	Off	
#20	Active Basement Ventilation System, Monitoring, and ICs	2015	Y		O	Off	
#21****							
#22****							
#23		2011	Y		O	On	
#25****							
#48		2011	Y		O	On	
#109		2015	Y		P	Off	
#111****							
#146		2011	Y		P	Off	Demolition
#148****							Demolition
#149****							
#159****							Demolition
#151****							Demolition
#152		2016	Y	Y	V	On/Off	Demolition
#153		2015	Y	Y	V	Off	Demolition
#154		2012	Y	Y	V	Off	Demolition
#155****							Demolition
#156		2015	Y	Y	O	Off	Demolition
#184****							Demolition
#476****							
#503		2017	Y		O	Off	
#512A****							Demolition
#512B****							Demolition
#512C****							Demolition
#543		2011	Y		O	On	Demolition
#544							Demolition
#547B		2015	Y		P	Off	Demolition
#547C****							Demolition
#547D		2015	Y		V	Off	Demolition
#547E****							Demolition
#554		2011	Y		O	Off	
#556		2016/2020	Y			On/Off	
#569			Y		P	Off	
#572			Y	Y	P	Off	
#574							Demolition
#583A		2011	Y		V	Off	
#583B		2011	Y		V	Off	
#583C		2011	Y		V	On	
#596		2011	Y		O	On	
#944		2011	Y		P	On	
#945		2015	Y		P	Off	
#950****							Demolition
#951****							Demolition
N206****							
N207****							
N237****		2009	Y		O	On	

Table 1: Vapor Sampling and Mitigation by Responsibility Area

Building	VI Remedy	Last Indoor Test	Below Action Level?	Indoor Above Outdoor?	Occupied Vacant Partial	HVAC	Notes
Navy Responsibility							
#2—Gymnasium*****	No mitigation	2019	Y		O	N/A	No HVAC. EPA has asked the Navy to sample during the next annual sampling event in 2022. In 2013, outdoor air was 0.09 µg/m ³ .
#3—Conference Center/Cafeteria	Sealing cracks, recommended to install a SSDS, and continued monitoring	2021	N		O	On/Off	Outdoor air was measured at 0.24 µg/m ³ in 2012; however, it was measured at 2.3 µg/m ³ in 2018. This sample appears to be anomalous as it an order of magnitude higher than other samples.
#10—Storage/Former Boiler	Removal of temporary vapor abatement system, installation of a sub-slab depressurization system and confirmation sampling	2021	N	Y	V	N/A	No HVAC, sampling took place with a blower on. Utility tunnel connects to Hangar 1. Interim mitigation measures have been installed cutting off direct pathway. Outdoor air was 0.26 µg/m ³ in 2019
#12—Commissary		2019	Y		O	On/Off	Previous samples detected indoor air above outdoor air. However, 2019 samples did not detect this. Highest outdoor level was 0.097 µg/m ³
#13-Commissary Warehouse*****		2017	Y			N/A	No HVAC, previous samples detected indoor air above outdoor air. However, used EPA default background to adjust this. Highest outdoor was measured at 0.066 µg/m ³ .
#14—Offices/Storage		2021	Y	Y		On/Off	TCE, PCE, and 1,1-DCE exceeded outdoor values. Highest outdoor level was 0.038 µg/m ³ .
#15—NASA Security	Mitigation recommended, currently adjusting HVAC to increase air flow.	2021	N	Y	O	On/Off	Highest outdoor air was 0.085 µg/m ³ .
#16-Maintenance Contractor Office and Shops	Mitigation recommended, currently adjusting HVAC to increase air flow.	2021	N		O	On/Off	Sub-slab soil gas exceeded project screening levels for TCE and PCE. Highest outdoor level was 0.44 µg/m ³ .
#29—Bicycle Shop*****		2019	Y		O	N/A	No HVAC. Highest outdoor level was 0.15 µg/m ³ .
#45—Unmanned Aerial Testing Facility	Mitigation recommended. Interim measures included sealing cracks, and filled a sump with slurry and continued monitoring.	2021	Y	Y	O	N/A	No HVAC. Outdoor level was 0.78 µg/m ³ .
#67—Post Office*****		2019	Y		O	N/A	No HVAC. EPA's default outdoor air concentration was used. However, highest outdoor level was 0.055 µg/m ³ .
#76—Locksmith Shop*****	Due to renovations, confirmation samples recommended for 2022.	2019	Y		O	N/A	No HVAC. Outdoor air was not measured.

Table 1: Vapor Sampling and Mitigation by Responsibility Area

Building	VI Remedy	Last Indoor Test	Below Action Level?	Indoor Above Outdoor?	Occupied Vacant Partial	HVAC	Notes
#107-Construction Office*****		2019	Y	Y	O	On/Off	Though not shown in the Navy's table, previous samples detected indoor air above outdoor air. However, using EPA default outdoor air concentration, this was changed.
#126—Historical Museum	Recommended installing a SSDS. Interim measure adjusted HVAC.	2021	N	Y	O	On/Off	Exceeded outdoor air for PCE and DCE with HVAC off. Outdoor TCE was measured at 0.44 µg/m ³ . One sample was reported as 1.3 µg/m ³ . This appears to be anomalous as it an order of magnitude higher than other samples.
#510—Maintenance Offices		2019	Y	Y	O	On/Off	Previous samples detected indoor air above outdoor air. However, using EPA's default outdoor air concentration, this was changed. Ambient was measured at 0.36 µg/m ³ .
#555—Tenant Offices	Continue monitoring	2021	Y	Y	O	On/Off	Does not indicate whether air samples exceeded background with HVAC on or off. Outdoor was measured at 0.23 µg/m ³ .
#566—Tenant Offices*****		2019	Y	Y	O	On/Off	One previous sample detected indoor air above outdoor air. However, using EPA default outdoor air concentration, this was changed. No data available in Navy table.
#567— Warehouse and Machine Shop	Recommended mitigation	2021	N	Y		N/A	No HVAC. Sub-slab soil gas exceeded project screening levels for TCE, PCE, and 1,1-DCA. Highest outdoor level was 0.11 µg/m ³
N210—Offices and Storage	Recommended active mitigation. Interim measures included adjusting HVAC.	2021	N		O	Off	Mitigation system was off when sampled. Highest outdoor level was at 0.084 µg/m ³ .
N239—Life Sciences	Sealing cracks, continued monitoring, mitigation recommended	2021	N	Y	O	On/Off	Grab sample in elevator shaft detected TCE, PCE, cis-1,2-DCE, and trans-1,2 DCE above outdoor air. Outdoor air was measured as high as 1.2 µg/m ³ , but this sample appears to be anomalous as it an order of magnitude higher than other samples. The Highest other outdoor sample was 0.087 µg/m ³ .
N239A—Offices and Centrifuges	Recommended mitigation	2021	N	Y	O	On/Off	Outdoor was measured at 0.024 J µg/m ³ .
N243—Flight Guidance and Simulation Lab		2020/2022	Y	Y	O	On/Off	Does not indicate whether air samples exceeded background with HVAC on or off. Highest outdoor air was 0.19 µg/m ³ .
N243A—Welding and Machine Shop*****		2021	Y		O	On/Off	Outdoor concentration adjusted to EPA default, but was measured at 0.16 µg/m ³

Table 1: Vapor Sampling and Mitigation by Responsibility Area

Building	VI Remedy	Last Indoor Test	Below Action Level?	Indoor Above Outdoor?	Occupied Vacant: Partial	HVAC	Notes
NASA Responsibility							
Hangar One							This structure is currently open to the elements.
N144—Former FEMA Warehouse		2020	Y	Y			The northern portion of the warehouse does not have a central HVAC system. However, several rooms have individual wall-mounted air conditioning units. The southern portion of Building N144 does have a central HVAC system. All samples were below EPA cleanup levels but above outdoor air levels.
N211			Y				
N212			Y				
N213—Facilities Engineering		2020	Y	Y	O	On/Off	
N240—Airborne Missions and Life Sciences		2020	Y	Y		On/Off	
N242****							
N245			Y				
N256****							
T6-B****							
T6-D****							
T20-F****							
T20-G			Y				

Table 1: Vapor Sampling and Mitigation by Responsibility Area

Building	VI Remedy	Last Indoor Test	Below Action Level?	Indoor Above Outdoor?	Occupied Vacant: Partial	HVAC	Notes
Residential							
4-R	Earthen cellar ventilation system, monitoring, and ICs	2003	Y		O	N/A	
38-R		2012	Y		O		
156-R		2018	Y		O		Property was redeveloped. Testing of sub-slab soil, soil vapor and preoccupancy indoor results supported no action. EPA must confirm.
Private	No Action	2019	Y		O		
Private		2019					Scheduled redevelopment. Testing of soil and soil vapor
159A/159B-R	Passive SSV System, Vapor Barrier, Monitoring, and ICs	2019	Y		O		Property was redeveloped.

** Properties located at 401 National Avenue, 612/614/616/618/620 National Avenue, 630/634 National Avenue, and 640 National Avenue have been consolidated into a single parcel and re-addressed to 620 National Avenue. There is now a parking garage on the former 401 National Avenue parcel.

*** Properties located at 644/660/670 National Avenue have been consolidated into a single parcel and re-addressed to 331 Fairchild Drive. The former 644 National Avenue parcel is currently a parking lot.

**** These buildings are identified as MEW and NASA responsibility by the Navy. There is no data in the 2021 MEW annual report or the Navy tiering evaluation pertaining to these buildings.

***** These buildings were not sampled in 2021 because the Navy decided to use EPA's default background of 0.44 µg/m³ rather than the building's lower background levels ranging from 0.06 µg/m³ to 0.36 µg/m³.

Table Abbreviations:

HVAC - Heating, Ventilation, and Air Conditioning

ICs - Institutional Controls

PCE - tetrachloroethylene

SSD - Sub-slab depressurization

SSV - Sub-slab ventilation

TCE - trichloroethylene

Table 2: Response Action Tiering System for Existing Commercial and Residential Buildings in Vapor Intrusion Study Area (Sampled with Passive or Active Engineering Control in Place or Operating)

Tier	Description	Response Action
Tier 1	Building with indoor air concentrations greater than outdoor (background)* air concentrations and indoor air cleanup level.	Implement selected remedy (appropriate engineering control) to meet indoor air cleanup levels. Once indoor air cleanup level achieved and confirmed, building recategorized as Tier 2. Implement governmental, proprietary, and informational ICs (see Table 8).
Tier 2	Building with indoor air concentrations below the indoor air cleanup levels. Former Tier 1 existing building and Tier A future (new) building that confirmed indoor air concentrations are below the indoor air cleanup levels.	Ensure continued operation and maintenance of active ventilation system or other selected engineered remedy to meet RAOs. Develop and implement long-term monitoring and ICs implementation plan. Implement governmental, proprietary, and informational ICs (see Table 8). Where remedy is achieved through operation of an active ventilation system, agreement of property owner must be contained in a recorded agreement.

Table 3: Response Action Tiering System for Existing Commercial and Residential Buildings in Vapor Intrusion Study Area (Sampled with No Engineering Control in Place or Operating)

Tier	Description	Response Action
Tier 1	Building with indoor air concentrations greater than outdoor (background)* air concentrations and indoor air cleanup level.	Implement selected remedy (appropriate engineering control) to meet indoor air cleanup levels. Once indoor air cleanup level achieved and confirmed, building recategorized as Tier 2. Implement governmental, proprietary, and informational ICs (see Table 8).
Tier 3A	Building with indoor air concentrations below indoor air cleanup levels, but greater than outdoor (background) concentrations.	No engineered remedy required. Develop and implement long-term monitoring plan. Implement governmental ICs (see Table 8).
Tier 3B	Building with indoor air concentrations at or within outdoor air (background)* concentrations.	No engineered remedy nor long-term monitoring required. Implement governmental ICs (see Table 8)
Tier 4	Buildings where converging lines of evidence demonstrate that there is no longer the potential for vapor intrusion into the building exceeding indoor air cleanup levels.	No action required after performance of all necessary confirmation sampling and documentation approved by EPA that no action is necessary.

* Outdoor concentrations of TCE typically range from below laboratory analytical detection limits to 0.4 µg/m³.

Table 4: Response Action Tiering System for Future Commercial and Residential Buildings in Vapor Intrusion Study Area*

Tier	Description	Response Action
Tier A	Future (new) building on property where lines of evidence (soil gas, sub-slab soil gas, crawlspace) indicate that there is the potential for vapor intrusion into the new building above indoor air cleanup levels.	Implement selected remedy to meet RAOs. Perform indoor air sampling after construction to confirm remedial action is effective.
		Implement governmental and proprietary ICs (see Table 8).
		Re-categorize as Tier 2 Existing Building.
Tier B	Future (new) buildings on properties where lines of evidence indicate there is no potential for vapor intrusion into the building exceeding EPA's indoor air cleanup levels.	Perform indoor air sampling after building is constructed to confirm that there is no potential vapor intrusion risk and indoor air cleanup levels are met.
		If confirmed with EPA approval, then no action is required.
<p>* Commercial or multi-family residential buildings constructed with aboveground raised foundations typically would be separated from the ground by a parking garage, which would allow adequate ventilation to prevent vapor intrusion into the occupied spaces. For this construction, perform targeted confirmation air sampling after building is constructed to verify absence of preferred pathways into building and to confirm indoor air cleanup levels are met.</p> <p>Site-specific soil gas screening levels may also be developed.</p>		