Vapor-Intrusion Management Plan
Lockheed Martin Middle River Complex
2323 Eastern Boulevard
Middle River, Maryland

Prepared for:

Lockheed Martin Corporation

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ACRONYMS

µg/m^3	micrograms per cubic meter
AF	attenuation factor
atm-m^3/mol	atmospheres per cubic meter/mole
ca	carcinogenic
DTSC	California Department of Toxic Substances Control
ESH	environment, safety, and health
FID	flame-ionization detectors
HQ	hazard quotient
HVAC	heating, ventilation, and air conditioning

Introduction

Vapor intrusion (VI) is the migration of volatile chemicals from the subsurface into the indoor air of buildings above the location of chemical contamination. This document was developed as a resource for personnel at the Lockheed Martin Middle River Complex (MRC) who that need to manage known VI pathways and/or investigate as yet unknown potential VI pathways at the site that may adversely affect facility indoor air quality (IAQ). This document provides a general framework for addressing VI from a program management, technical management, and risk management perspective.

VI should be evaluated as a potential human exposure pathway whenever volatile chemicals are present in soil, soil gas, or groundwater underlying existing structures or has the potential to underlie future buildings. The physical properties of volatile chemicals can result in their migration through unsaturated soil into the indoor air of buildings near zones of subsurface contamination. The United States Environmental Protection Agency (USEPA) defines a chemical as volatile if its Henry's Law constant is 1×10^{-5} atmospheres per cubic meter/mole (atm-m^3/mol) or greater (USEPA, 2002). (Henry's Law constants are calculated to characterize the equilibrium distribution of concentrations of volatile, soluble chemicals between gas and liquid;b8Mm89us4ysical 95 7

use-controls may also be an option to control exposure. Remediation treats and removes chemicals from contaminated subsurface media, such as soil and groundwater. Common remediation options include soil removal, soil gas extraction, and groundwater treatment. Mitigation and remediation may be performed concurrently or individually, depending on site needs.

Section 2
Program Management

As part of VI management at the Middle River Complex, Tetra Tech developed VI-specific action levels and policies/protocols. Similar policies/protocols may already be in effect at the MRC that can be modified or adapted to meet VI management needs. These steps can then be integrated into the facility-level operations program and policies**.**

2.1 SITE VI MANAGER

An on-site person will be assigned as the VI manager at the MRC and provided with sufficient authority to implement the comprehensive VI management plan. Appropriate training and other steps will ensure that the VI manager is familiar with the principles of VI, IAQ, and the elements of the VI management plan. The VI manager will be responsible for the following:

- ensuring that building drawings and records are up to date
- training staff, as necessary
- coordinating monthly building walk-through with tenants
- reviewing with tenants, before work begins, any maintenance and housekeeping plans for their potential VI effects
- reviewing contracts and negotiations with contractors for anything that might increase potential VI, such as drilling through the slab, ventilation changes, and running of conduit from basement locations
- communicating with tenants/occupants about building activities and occupant/tenant responsibilities in managing VI

Key Lockheed Martin personnel, as well as tenant staff, should be identified and assigned clearly defined VI responsibilities. We recommend that each tenant identify their own VI manager(s) so the site VI manager will have specific individuals within the tenant organization to coordinate and communicate. All personnel associated with VI management should understand the fundamentals of both VI and indoor air quality, and be trained as necessary to incorporate management thereof as part of their daily responsibilities. Key Lockheed Martin and tenant personnel who may assist with VI management may include the following parties:

- building managers
- building engineers
- environmental, health, and safety personnel
- heating, ventilation, and air conditioning (HVAC) personnel
- building maintenance personnel

All contractors working on-site will have their proposed work evaluated by VI management personnel at least one month in advance to assess how their proposed tasks might affect potential VI.

2.2 RECORDS

An organized system should be developed to collect and maintain the following building records:

- "as built" blueprints, including modifications to reflect current conditions
- up-to-date drawings of all tenants' build outs and interior renovations
- records of major changes in space use not reflected in original design
- drawings of pressure relationships (i.e. pressurized versus non-pressurized areas)
- operating and maintenance plans and schedules
- inventory of any products or materials

2.3 SITE WALKS AND THE BASELINE BUILDING AUDIT

As part of VI management, baseline building conditions will be documented, and these records will be updated periodically. A whole-building walk through will be conducted by the site VI manager and tenant representatives to record the status of existing, as well as potential, conduits for sub-slab vapor. Simple measurements of pressure relationships and airflow patterns may help identify locations that may be more susceptible to VI. These measurements will be recorded and kept as a baseline for future comparison. If appropriate, areas where more detailed information may be needed to complete the basic profile can be identified and placed in the baseline audit at a later date. The basic conditions of the building exterior, its mechanical systems, the HVAC design, and occupied spaces will be documented.

Potential problems identified in the baseline audit that might facilitate VI should be rectified as soon as possible (see Section 3). The site VI manager will ask Lockheed Martin to issue appropriate work orders so that the problems can be corrected. Managers should plan and budget for the remediation of major problems requiring significant expenditure. Site walks and audits will be repeated monthly and the results recorded. Any changes in the facility that may affect VI,

2.5.3 Feedback

To coordinate and cooperate with tenant operations, tenants will receive advance notice of any VI activities that may occur on-site. These include on-site sampling of environmental media, or the assessment, installation, or expansion of the existing VI-mitigation systems. This advance notice will allow the tenant to shift on-site processes to other locations, to minimize disruption of overall site operations and production.

A procedure to keep the tenant informed of work associated with VI-related activities will be developed. It should describe the activity and the area in which it will be performed. Contact persons and their telephone numbers, as well as the names and phone numbers of individuals to call for more detailed information, will be provided. Progress and the expected length of any on-site work should be identified and included in the notification.

in 1,000,000), carcinogenic risk is evaluated at the 1×10^{-5} risk level at this site in accordance with MDE requirements. For TCE, MDE has specified a screening level of 25 $\mu g/m^3$, at a risk level of 1×10^{-5} (MDE, 2009). A summary of the indoor air screening levels used at this site is presented in Table 3-2.

In the past, these default screening values were used to evaluate historical data collected as part of ongoing investigations at Block I. Sub-slab vapor sampling results were compared to sub-slab vapor screening values, which were derived in accordance with methods discussed in Appendix D of USEPA, 2002. SV screening values were calculated by dividing the default indoor air screening levels (Table 3-2) by a conservative attenuation factor (AF) of 0.1, obtained from USEPA, 2002. An AF represents the factor by which subsurface-vapor concentrations migrating into indoor air spaces are reduced due to diffusive, advective, and/or other attenuating mechanisms.

Exceedance of a screening level indicates a potential risk from VI and that further evaluation is needed. Sub-slab vapor screening values may not reflect actual site conditions because they are based on a default attenuation factor. Site-specific attenuation factors may be higher or lower, which in turn may overestimate or underestimate potential risks. To address this uncertainty and provide the site VI manager with a tool to address potential VI before it reaches levels of potentially regulatorily unacceptable risk, new site-specific action levels for the MRC were developed.

These new action levels incorporate site-specific factors that the existing screening levels lacked. They reflect site conditions at the MRC, since they are based on co-located sub-slab vapor and IAQ sampling data. Where these data are adequate, the new action levels incorporate attenuation factors derived from the co-located data. These site-specific attenuation factors reflect both the characteristics of the chemicals that affect potential VI (i.e., vapor pressure, molecular weight, Henry's Law constant, etc.), as well as the particular building characteristics, such as slab thickness, porosity, ventilation, etc. To calculate the new site-specific action levels for the MRC, EPA and MDE screening values were used in conjunction with chemical- and site-specific attenuation factors. Note that the new action levels are specific to the MRC, and may not be applicable at other locations due to differences in geology, hydrogeology, building characteristics, etc.

3.2.1 Attenuation Factor Calculations

To calculate site-specific action levels for sub-slab vapor and indoor air at the MRC, site-specific attenuation factors (AFs) were calculated (where possible). AFs were calculated using chemical concentrations measured in co-located sub-slab vapor and indoor air samples from the first three rounds of sampling at the MRC. This sample set represents conditions at the MRC before activation of the SSD systems. Since the action levels will ultimately be used to determine whether to shut down the SSD system (and then whether it needs to be reactivated), AFs should represent the site without the influence of a mitigation system. AFs are valid only when migration from SV to indoor air is occurring. An SSD system is designed to minimize this migration.

AFs were calculated by dividing the measured indoor air concentration by the sub-slab vapor concentration for each co-located sample in sampling rounds 1–3. The data sets for all buildings were combined to provide as large a data set as possible to determine site-specific AFs. Table 3-1 presents a summary of the AFs for each chemical. Figure 3-1 includes a flow chart illustrating AF calculation.

The data set from sa

while the SSD system was operational. Although rounds 6–8 had considerably more data, concentrations in the sub-slab vapor were generally several orders of magnitude lower than those observed in sampling rounds 1–3 because the SSD system was operating. The indoor air concentrations measured in rounds 6–8, however, were generally one to two orders of magnitude lower than those measured in rounds 1–3. This resulted in higher AFs (greater than 0.1) for most chemicals. These AFs are not considered representative of vapor intrusion from sub-slab vapor to indoor air, since operation of the SSD system may be influencing the measured concentrations; therefore, data from rounds 6–8 were not used in the site-specific AF calculations.

Results from sampling rounds 1–3 data (Table 3-3) provided sufficient data (i.e., a minimum of five AFs less than 1) to calculate site-specific AFs for only four chemicals: *cis*-1,2-dichloroethene, tetrachloroethene (PCE), TCE, and toluene. Five AFs less than 1 was considered a reasonable minimum number to perform statistical calculations, as fewer AFs would likely result in no differences between the percentiles of the calculated AFs for each chemical. Cumulative distribution functions of the AFs for these chemicals are provided in Appendix A. The 90th percentile AF was selected to calculate the site-specific SV action levels for this site.

For the remaining chemicals, the absence of adequate co-located data (non-detected, blank contaminated, estimated below detection-limits) or other uncertainties and/or lack of quantification in the data set prevented calculation of a site-specific AF. A default AF of 0.01 was assigned to these chemicals. This is a conservative assumption, as an AF of 0.01 is the maximum AF recommended by California Department of Toxic Substances Control (DTSC) (2005) (representing sub-slab to basement uncertainty exists in determining a specific correlation between the sub-slab vapor data set and the indoor air data set. Nevertheless, a relationship is expected to exist between the two, since for chemicals such as TCE and cis-1,2-DCE, no other indoor air sources (other than sub-slab vapor intrusion) are known, and because these chemicals appear above detection limits in both media. However, any relationship between SV and IAQ concentrations would be mathematically complex due to the variety of contributing factors; the observed range of ratios between the co-located sub-slab and indoor air samples is consistent with this observation.

To address this inherent variability, the 90th percentile AF was selected for chemicals where the database was considered adequate for such calculations. Using conservative factors to offset uncertainty is a standard practice in risk assessment and risk based decision-making, where assurances that potential risks will not be underestimated are necessary. Notably, the AF selected for TCE (0.008) is essentially comparable to the default value (0.01) selected for evaluating other chemicals for which data are insufficient to allow calculation of site-specific AFs. Consequently, this determination supports the health-protective nature of using an upper percentile of the calculated site-specific AFs.

3.2.2 Sub-Slab Vapor Action Level Calculations

Table 3-4 summarizes the sub-slab vapor action levels and indoor air action levels for all chemicals. Figure 3-1 illustrates the decision logic used to calculate action levels. The sub-slab vapor action levels were calculated by dividing the indoor air action level by the AF.

Site-specific indoor air action levels assume a regulatorily acceptable risk probability of 1×10^{-6} (one in 1,000,000) for carcinogens and a hazard quotient (HQ) of 0.1 for non-carcinogens. These action levels provide an order of magnitude safety factor below the basis on which current health-based screening values were derived (i.e., a factor of 10 below a risk probability of 1×10^{-5}, or a HQ of 1). Sub-slab vapor action levels for this site were determined conservatively by using the 90th percentile AF. This would, in turn, result in sub-slab vapor action levels equal to a regulatorily acceptable risk probability of 1×10^{-6} for carcinogens and a HQ of 0.1 for non-carcinogens. The intent is to calculate sub-slab vapor and indoor air screening values that are sufficiently low so that decisions regarding possible intervention can be made before concentrations reach regulatory thresholds.

contaminant concentration, as it is being drawn from all extraction points and is less likely to be biased by a sample with a highly elevated or highly depressed result. Influent samples may include ambient air, which could dilute contaminant concentrations in the system stream. Once the results of the influent monitoring and sub-slab vapor and IAQ sampling meet the action levels/performance criteria previously described, the system may be shut down to undergo rebound testing.

To perform a rebound test, the SSD system must be shut off and not turned on for a period of three to six months. The objective is to see whether sub-slab vapor and indoor air contaminant concentrations increase (i.e., rebound) after the system is turned off. The actual length of time the system remains dormant depends on site-specific conditions that might reduce the flow of vapor. Thus, at locations with high clay content or tight soils, a longer dormant period may be needed.

At the beginning of the test, samples of sub-slab vapor are collected from background air and from the permanent vapor-monitoring points, along with collection of their co-located IAQ samples. These samples document baseline conditions. After the system has remained off for the test period, samples of sub-slab vapor, indoor air, and background air are collected from the same locations.

If the concentrations of contaminants in sub-slab vapor and indoor air have not increased and are still below action levels, then a decision may be made to remove the system. If the

TABLE 3-1

INDOOR WORKER RISK-BASED SCREENING LEVELS FOR AMBIENT AIR
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Chemical	CAS Number	Inhalation Unit Risk $(ug/m3)^{-1}$	IUR Ref	Chronic RfC (mg/m^3)	RfC Ref	Carcinogenic SL TR=1.0E-6 (ug/m3)	Noncarcinogenic SL HI=1 (ug/m3)	Screening Level (ug/m^3)
Benzene	71-43-2	7.80E-06	I	3.00E-02	I	1.57E+00	1.31E+02	1.57E+00 ca*
Carbon Tetrachloride	56-23-5	6.00E-06	I	1.00E-01	I	2.04E+00	4.38E+02	2.04E+00 ca
Chlorodifluoromethane	75-45-6	-		5.00E+01	I	-	2.19E+05	2.19E+05 max
Chloroform	67-66-3	2.30E-05	I	9.77E-02	A	5.33E-01	4.28E+02	5.33E-01 ca
Dichlorodifluoromethane	75-71-8	-		2.00E-01	H	-	8.76E+02	8.76E+02 nc
Dichloroethane, 1,1-	75-34-3	1.60E-06	C	-		7.67E+00	-	7.67E+00 ca**
Dichloroethane, 1,2-	107-06-2	2.60E-05	I	2.43E+00	A	4.72E-01	1.06E+04	4.72E-01 ca

TABLE 3-2

INDOOR AIR SCREENING LEVELS FOR MRC
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Chemical	Screening Level (ug/m^3)	Source
Benzene	1.57E+01	EPA 2010, adjusted for 10^{-5} risk level
Carbon Tetrachloride	2.04E+01	EPA 2010, adjusted for 10^{-5} risk level
Chlorodifluoromethane	2.19E+05	EPA 2010
Chloroform	5.33E+00	EPA 2010, adjusted for 10^{-5} risk level
Dichlorodifluoromethane	8.76E+02	EPA 2010
Dichloroethane, 1,1-	7.67E+01	EPA 2010, adjusted for 10^{-5} risk level
Dichloroethane, 1,2-	4.72E+00	EPA 2010, adjusted for 10^{-5} risk level
Dichloroethylene, 1,1-	8.76E+02	EPA 2010
Dichloroethylene, 1,2-cis-	2.63E+02	Trans-1,2-dichloroethylene used as surrogate
Dichloroethylene, 1,2-trans-	2.63E+02	EPA 2010
Ethylbenzene	4.91E+01	EPA 2010, adjusted for 10^{-5} risk level
Methyl tert-Butyl Ether (MTBE)	4.72E+02	EPA 2010, adjusted for 10^{-5} risk level
Methylene Chloride	2.61E+02	EPA 2010, adjusted for 10^{-5} risk level
Naphthalene	3.61E+00	EPA 2010, adjusted for 10^{-5} risk level
Tetrachloroethylene	2.08E+01	EPA 2010, adjusted for 10^{-5} risk level
Toluene	2.19E+04	EPA 2010
Trichlorobenzene, 1,2,4-	8.76E+00	EPA 2010
Trichloroethane, 1,1,1-	2.19E+04	EPA 2010
Trichloroethane, 1,1,2-	7.67E+00	EPA 2010, adjusted for 10^{-5} risk level
Trichloroethylene	2.50E+01	EPA 2010
Vinyl Chloride	2.79E+01	EPA 2010, adjusted for 10^{-5} risk level
Xylene, P-	3.07E+03	EPA 2010
Xylene, m-	3.07E+03	EPA 2010
Xylene, o-	3.07E+03	EPA 2010

TABLE 3-3

SUMMARY OF ATTENUATION FACTORS BASED ON CO-LOCATED SAMPLING ROUNDS 1-3 (PRE-SSD)[1]
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

		Min	Max	50th percentile	90th percentile		Notes
Benzene	6	0.034	0.044	0.041	0.043	3	

TABLE 3-4

SUMMARY OF ACTION LEVELS
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Chemical	Attenuation Factor (AF)	Sub-Slab Vapor Action Level (ug/m^3)	Indoor Air Action Level (ug/m^3)	Basis for Attenuation Factor
Benzene	0.01	157	1.57	Default
Carbon tetrachloride	0.01	204	2.04	Default
Chlorodifluoromethane	0.01	2,190,000	21,900	Default
Chloroform	0.01	53.3	0.53	Default
Dichlorodifluoromethane	0.01	8,760	87.6	Default
1,1-Dichloroethane	0.01	767	7.67	Default
1,1-Dichloroethene	0.01	47.2	0.47	Default
1,2-Dichloroethane	0.01	8,760	87.6	Default
cis-1,2-Dichloroethene	1.68E-04	156,717	26.3	90th percentile AF from Sampling Rounds 1-3 Data
Trans-1,2-Dichloroethene	0.01	2,630	26.3	Default
Ethylbenzene	0.01	491	4.91	Default
MTBE	0.01	4,720	47.2	Default
Methylene chloride	0.01	2,610	26.1	Default
Naphthalene	0.01	36.1	0.36	Default
Tetrachloroethene	0.07	29.7	2.08	90th percentile AF from Sampling Rounds 1-3 Data
Toluene	0.23	9,522	2,190	90th percentile AF from Sampling Rounds 1-3 Data
1,2,4-Trichlorobenzene	0.01	87.6	0.88	Default
1,1,1-Trichloroethane	0.01	219,000	2,190	Default
1,1,2-Trichloroethane	0.01	76.7	0.77	Default
Trichloroethene	8.05E-03	310	2.50	90th percentile AF from Sampling Rounds 1-3 Data
Vinyl chloride	0.01	279	2.79	Default
Total Xylenes	0.01	30,700	eS	

TABLE 3 5 -

ACTION LEVEL DECISION MATRIX
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Indoor Air Sampling Results		Sub Slab Vapor Sampling Results	Response	Activities
	AND			
	OR			
	OR			

Figure 3-1

Action Level Calculation Flow Chart

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facility security, facility firefighting, the local fire department, and/or regulatory authorities should be alerted.

Monitoring programs to manage potential acute risks will rely on direct reading instruments such as photoionization detectors (PIDs) and/or flame ionization detectors (FIDs). (If a PID is used, make sure that a lamp of appropriate photon energy is selected for the sub-slab vapor and indoor air chemicals of concern.) The direct reading instruments cited have varying degrees of response to different chemicals, so action levels must be developed accordingly based on instrument response.

Table 4-1 contains action levels to be used during acute events. These levels are based on federal Occupational Safety and Health Administration (OSHA) short-term exposure limits (STELs) and 8-hour time-weighted averages (TWAs), which are more appropriate for screening acute exposures than the EPA screening levels, which are based on chronic exposure scenarios. (Note that the units in Table 4-1 are in parts per million [ppm] and not micrograms per cubic meter as ppm is the concentration unit most commonly used in field instruments.)

The location(s) where the slab has been compromised should be monitored to identify whether sub-slab contamination is migrating into the occupied space. The occupied space should also be monitored to assess airborne (breathing zone) concentrations of sub-slab vapor contaminants. If action levels are exceeded, then the area will need to be vacated until mitigation measures (localized ventilation) are implemented.

4.2 MANAGEMENT OF POTENTIAL CHRONIC RISKS

If the results of sub-slab vapor and/or indoor air monitoring indicates that potential chronic risks

these potential risk. S20081 thOt ma

- ***Sealing and venting groundwater sumps:*** Many buildings with basements have sumps intended to capture any unexpected water release (flooding, burst hose, etc.). These sumps are dug into the ground below the rest of the foundation and may serve as an easy access point for vapors. Sealing and venting them maintains their function while preventing VI.

- ***Vapor barriers beneath the building:*** Vapor barriers can be plastic or geotextile sheeting or perhaps a sealant applied directly to the foundation or basement wall. Barriers are more easily installed during building construction than during a retrofit. This technique is often used in conjunction with active mitigation systems at sites with known contamination. Damage to even a small portion of the barrier during installation can result in significant leakage across the barrier.

- ***Reducing basement depressurization by ducting in outside air for furnace combustion:*** For furnaces in basements, bringing outside air into the furnace decreases the pressure differential across the slab. Lowering the pressure in a basement lessens the pull on subsurface vapors.

- ***Over-pressurization of the building using air/air heat exchangers:*** This technique creates a positive pressure in the building by supplying more outdoor air to the inside than the amount of air exhausted. To work effectively, buildings should be tightly sealed and have a ventilation system capable of producing the output needed to maintain the pressure differential. This may only be viable for limited portions of the Block I at the MRC due to the high use of natural ventilation through open doors and bays.

- ***Passive or active sub-slab depressurization systems:*** This technique creates a relatively low pressure beneath the building foundation; this low pressure is greater in strength than the pressure differential that exists between the building and the soil. Low-pressure zones created beneath the slab reverse the flow direction so that air is drawn from inside the building and into the soil, thus preventing vapors from migrating into the structure. Passive and active systems are very similar in design; the only real difference is inclusion of a powered fan to create a low-pressure zone for the active system. A passive

affected individuals that can influence program success. Early involvement of workers and tenants is critical.

Too often, risk communication is seen as something that takes place after the fact, when all the important decisions have already been made. This approach often produces negative outcomes, because affected individuals feel that they were not informed and involved early on, and can create unnecessary difficulties in completing assessments and implementing solutions. If tenants and employees are not informed of the steps leading to conclusions, they are very likely to regard study conclusions skeptically, and trust and credibility will be lost.

Such a scenario may lead to protracted disagreement about what was done at the site, what the results mean, and the correct path forward. Corporate or outside communication staff shall be consulted before any meeting or presentation to facility employees or tenants. Educational materials that incorporate risk management principles may be generated by communications personnel to assist in delivering a consistent message and providing clear, effective responses to questions from interested parties.

TABLE 4-1

ACTION LEVELS FOR ACUTE EXPOSURE
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Chemical	CAS #	Occupational Exposure Limit (OEL)	OEL Reference	Can this chemical be monitored by a FID?	Can this chemical be monitored by a PID (RAE)?	Lamp strength for PID (eV)	# of Exposures allowed in any one work day	Time per Exposure (mins)	PID ACTION LEVEL/ INSTRUMENT READING (ppm)	FID ACTION LEVEL/ INSTRUMENT READING (ppm)
1,1,1-Trichloroethane	71-55-6	450	ACGIH 15 min STEL	yes	yes	11.7	1	3	2250	350
1,1-Dichloroethane	75-34-3	100	OSHA TWA8	yes	no	NA	1	3	NA	3750
1,1-Dichloroethene	75-35-4	5	ACGIH TWA8	yes	yes	10.6	1	3	650	45
1,2-Dichloroethane	107-06-2	100	OSHA Ceiling	yes	y					

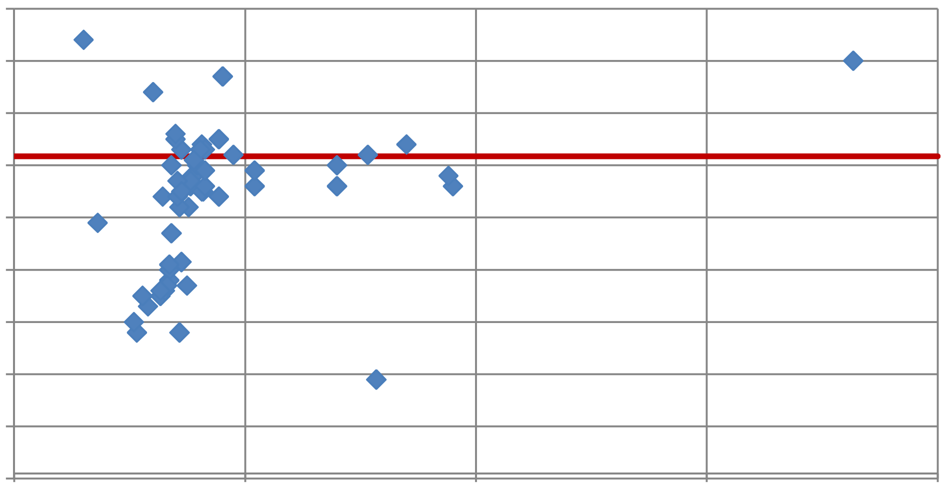
Section 5
References

1. MDE (Maryland Department of the Environment), 2009. Conversation among Mark Mank (MDE), Tetra Tech, and Lockheed Martin. June.

2. USEPA (United States Environmental Protection Agency), 2002. "Draft Guidance for Evaluating the VI to Indoor Air Pathway from Groundwater and Soils (Docket ID No. RCRA-2002-0033)," *Federal Register*: November 29, 2002 (Volume 67, Number 230).

3. USEPA (United States Environmental Protection Agency), 2010. *Regional Screening Levels for Chemical Contaminants at Superfund Sites*. EPA Office of Superfund and Oak Ridge National Laboratory. May.

APPENDIX A—SUPPORTING PLOTS FOR ATTENUATION FACTOR CALCULATIONS



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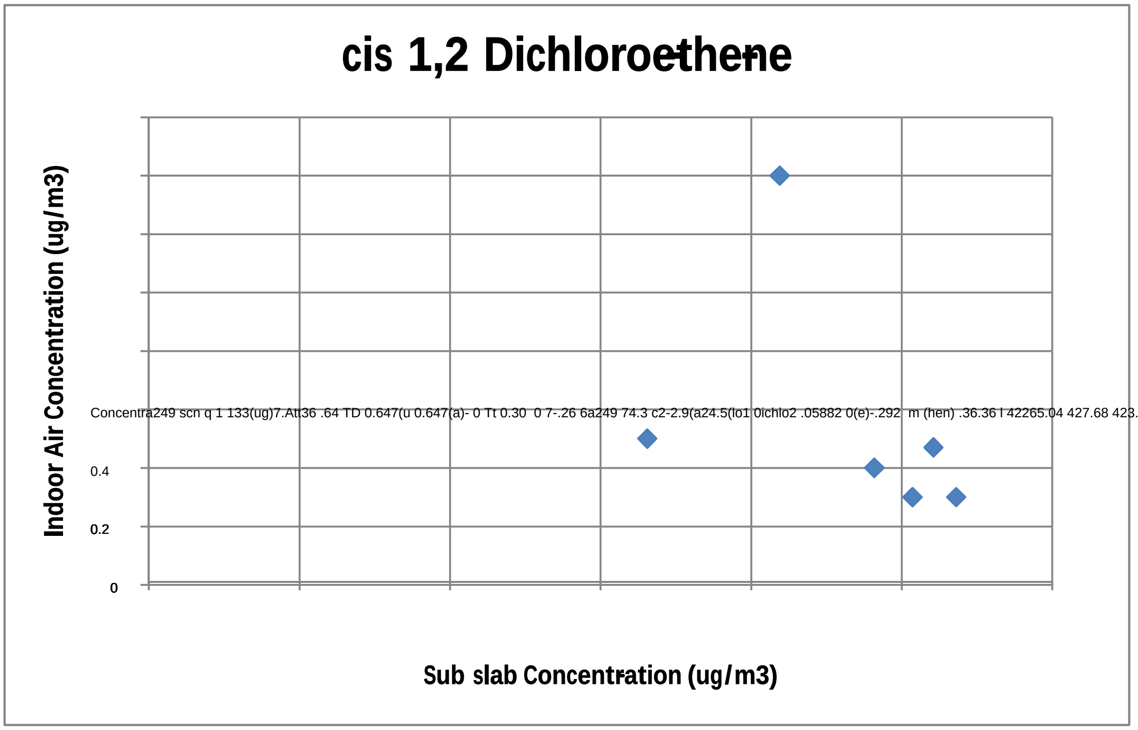
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Indoor Air Concentration (ug/m3)
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0.2
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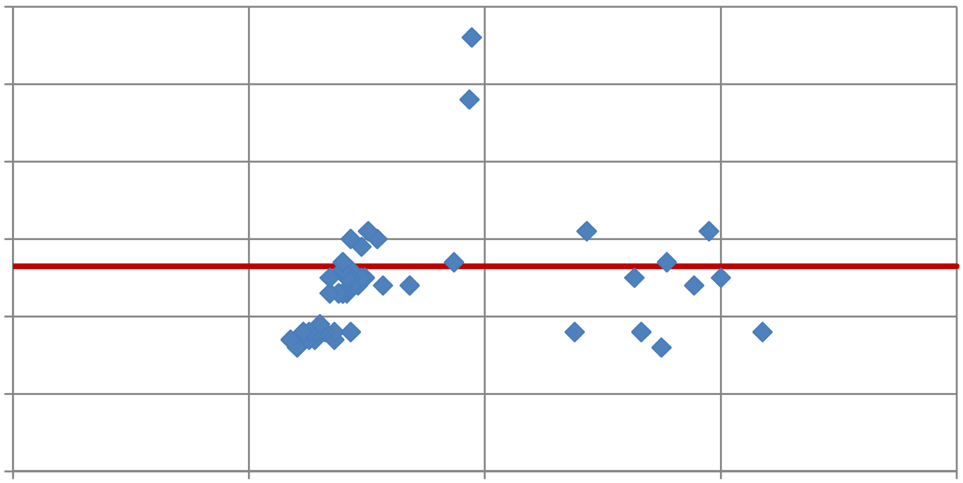
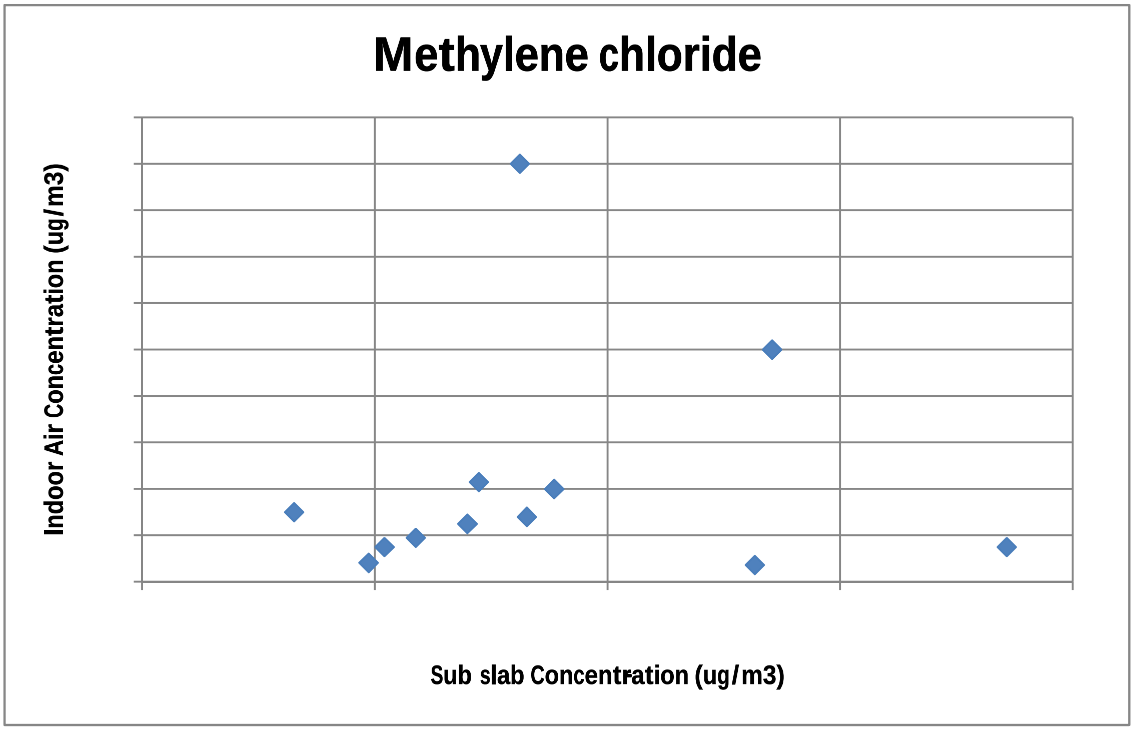
Sub slab Concentration (ug/m3)

0
0.2

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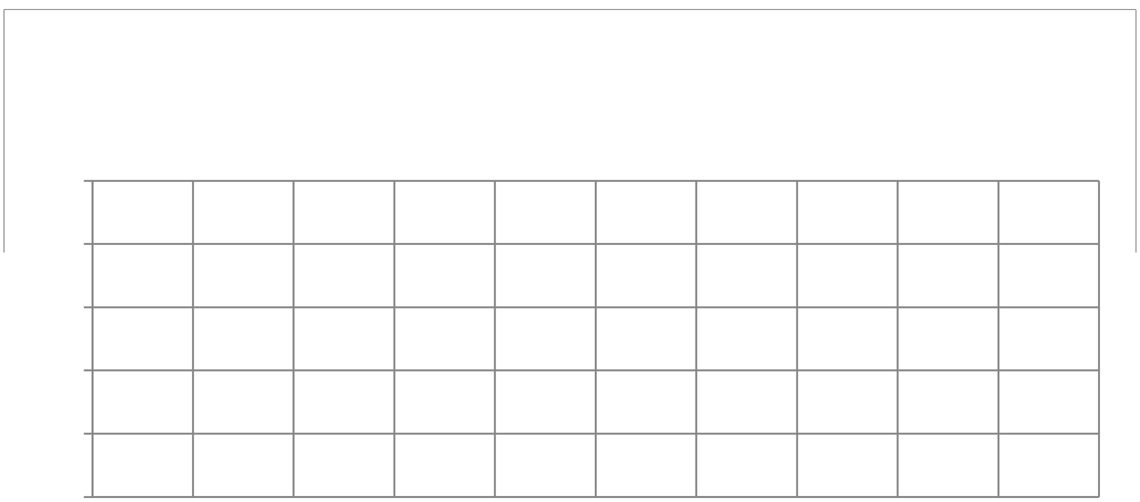
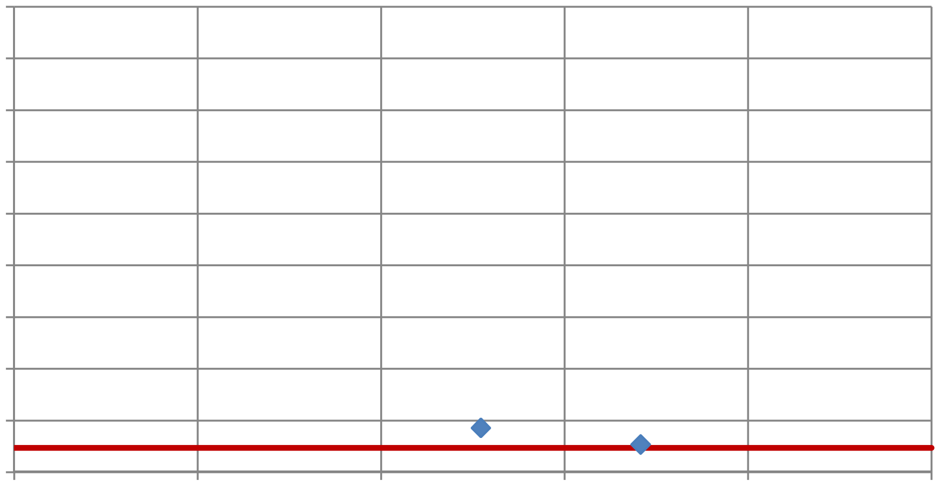
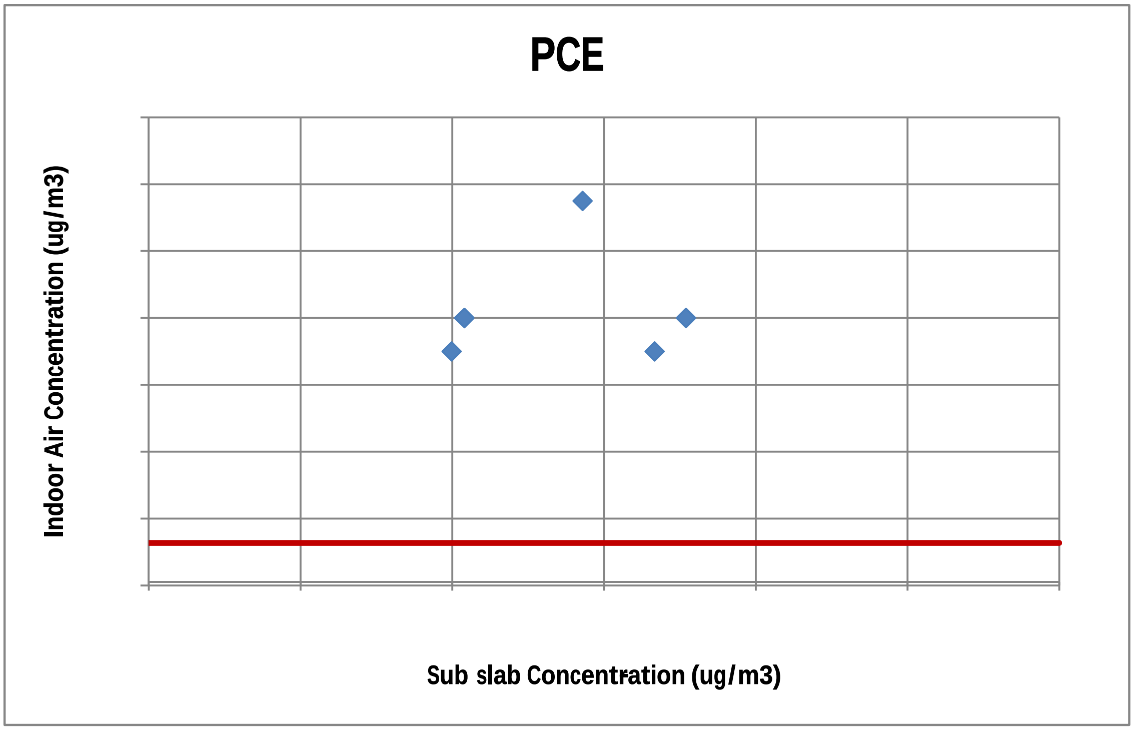
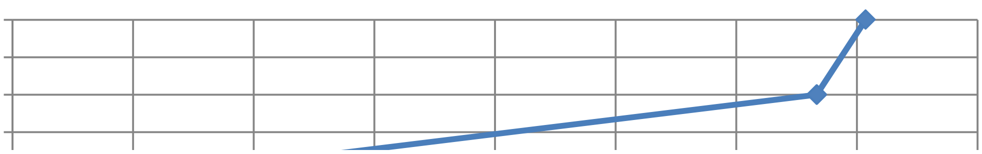
Indoor Air Concentration (ug/m3)
Sub slab Concentration (ug/m3)

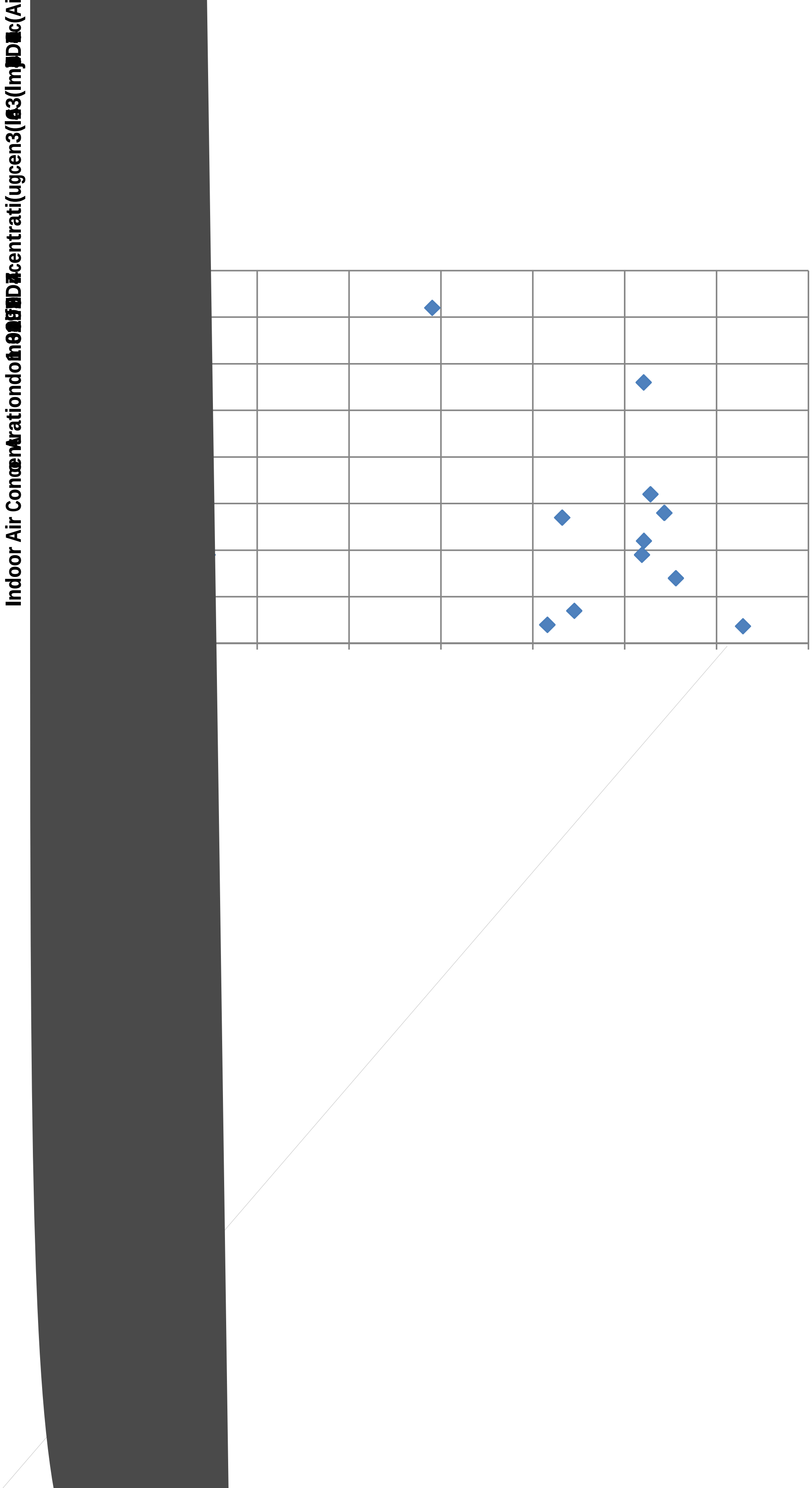





PCE
Indoor Air Concentration (ug/m3)
Sub slab Concentration (ug/m3)

CDF of 0 2 3 .

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