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May 17, 2019 **VIA PRIVATE CARRIER**

Mr. James R. Carroll
Program Administrator
Land Restoration Program
Land Management Administration
Maryland Department of the Environment
1800 Washington Boulevard, Suite 625
Baltimore, Maryland 21230

Subject: Transmittal of the 2019 Vapor Intrusion Management Plan
Lockheed Martin Corporation – Middle River Complex
2323 Eastern Boulevard, Middle River, Baltimore County, Maryland

Dear Mr. Carroll:

For your review please find enclosed two hard copies with a CD of the above-referenced document. This document was developed as an update to the previous Vapor Intrusion Management Plan(s). If possible, we respectfully request to receive MDE's document review comments by July 9, 2019. Once approved, this plan will replace and supersede earlier versions of the Vapor Intrusion Management Plan.

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2019

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chemicals should be included in any vapor intrusion investigation or program if they are known or reasonably assumed to have been used or released at a site. Typically, the potential for vapor intrusion is evaluated during a site investigation.

Potentially applicable responses to vapor intrusion into existing buildings include passive or active ventilation systems, floor .1 (l)-1.9 4 (bl)-22 and seals, etc. The potential for vapor intrusion in future structures should be addressed during design; any necessary measures to reduce vapor intrusion, including those associated with construction, should be included in the design. A typical approach for assessing risks posed by a possible vapor intrusion pathway, including its mitigation and remediation, is summarized below:

Evaluate whether exposure to vapors poses an acute (immediate) risk to building occupants. This can include both acute health risks and, in extreme cases, the risk of ignition or explosion. For acute risks, field instruments will be used, and results will be compared to federal Occupational Safety and Health Administration (OSHA) short-term and ceiling exposure levels (see Section 3.1 for a description of steps to manage acute risks). Although these levels are used to regulate worker exposure to chemicals in use at a facility, they can also be used to estimate potential acute health risks. If acute risks from vapor intrusion are identified, the affected area will be evacuated until the risks have been mitigated. If no acute risks are identified, a screening-level vapor intrusion evaluation may be conducted. The threat of an acute risk due to vapor intrusion at the Middle River Complex is unlikely, based on historical contamination and the high degree of investigation and remediation completed to date. Concentrations of trichloroethene in indoor air over the course of the investigation have exceeded screening levels

or more affected environmental media exceed risk-based screening values, then an indoor air investigation might be necessary.

Conduct a site-specific vapor intrusion pathway evaluation. Site-specific data, including sub-slab soil vapor and/or indoor air samples

former screening level (8,700 µg/m^3); since then, the United States Environmental Protection Agency has withdrawn the toxicity factors for cis- and trans-dichloroethene, and no currently applicable screenings levels are available for these compounds.

Results from the first three monitoring rounds led the project team to recommend mitigation for locations where chemicals in sub-slab vapor were detected at concentrations above risk-based screening levels. In response, two sub-slab vapor mitigation systems were designed and installed: one beneath the Building A former plating shop, and one beneath the southern end of the Building C basement, with full system startup on March 31, 2008. The project team also recommended additional indoor air and sub-slab vapor sampling to address the analytical variability identified during subsequent rounds of monitoring.

To date, appropriate response actions have been implemented at the site to mitigate these potential health risks. Among these actions were the installation of sub-slab depressurization systems (SSDS) in areas of Buildings A and C with elevated sub-slab vapor concentrations, and periodic sub-slab and indoor air monitoring rounds. The sub-slab depressurization systems extract vapor from the sub-slab area, reducing the pressure driving vapors into indoor spaces. The recovered vapor is treated, and the clean air is discharged to the atmosphere. Although some vapors are

assumptions for industrial workers. These analyses indicate that most volatile organic compounds detected in indoor air samples are probably not associated with sub-slab vapor intrusion, because they were detected either at concentrations less than screening levels or not at all in sub-slab vapor.

After the initial installation of the sub-slab vapor mitigation systems in Building A, three additional upgrades were installed:

- In October 2010, the sub-slab depressurization system in Building A was expanded to address elevated concentrations of sub-slab volatile organic compounds detected beneath the middle area of the Building A basement. During this first-phase expansion, two horizontal vapor-extraction trenches were installed, and the two existing 200-pound granular activated carbon (GAC) drums that removed volatiles from system exhaust gases were replaced with two 400-pound drums.

- In January 2015, three stand-alone indoor-air filters were installed in the southeastern corner of the Building A basement. These filters operate continuously to address intermittent trichloroethene concentrations above the indoor-air screening level.

- A second-phase system expansion was installed in Building A in February 2016 to address areas along the building's eastern side, where elevated concentrations of volatile organic compounds were detected in the sub-slab in 2014 and 2015. The system now includes two parallel trains of two 400-pound granular activated-carbon drums. The additional drums were added to reduce the number of changeouts needed for the expanded system and to relieve back-pressure that may have led to blower failure issues after the second-phase expansion.

- In May 2017, three additional air-purifying filters were installed in the Building A basement as an interim measure to target floor features (e.g., drains and sumps) that had shown elevated trichloroethene concentrations. A continuous air-monitoring survey identified significant sources of indoor air contamination in the basement at sumps associated with former heater rooms. In the summer of 2017, a closed-circuit television (CCTV) camera survey of floor features conducted in Building A basement determined that the underground network of floor drains, pipes, and manholes/sumps are interconnected in some circumstances.

- As part of the 2017 third-phase expansion, one vertical vapor-extraction point and one vapor-monitoring point (VMP) were installed in June 2017, a second moisture separator was added to the system's equipment skid, and the system's extraction piping was extended

in the basement to extract vapor from sump HRS and other to-be-determined sumps or extraction points

Following the startup of the sub-slab depressurization system in the southern end of the Building C basement, subsequent monitoring of the Building C basement identified an area beneath the east central part of the basement with sub-slab vapor contamination. This contamination is believed to be associated with the former Patriot missile canister plating, painting, and manufacturing operation. With the identification of this contamination, the sub-slab depressurization system in Building C was expanded.

- The first-phase expansion of the sub-slab depressurization system was completed in October 2012 to address the middle area of the Building C basement and to continue to address the southern portion of the basement. The phase one expansion installed four additional vapor extraction wells, replaced the granular activated carbon drums with larger vessels (and updated associated piping, fittings, and appurtenances) for removal of trichloroethene and other volatile organic vapor, and installed one potassium permanganate zeolite (PPZ) drum for removal of vinyl chloride vapor
- The second-phase system expansion, completed in May 2013, more thoroughly addressed sampling results obtained over time from the middle area of Building C basement. Five additional vapor extraction wells were installed, the system equipment skid was replaced and relocated, a heat exchanger and post-heat-exchanger moisture separator was added, a mist-eliminator pad was installed in the exhaust stack, and the vapor treatment drums were relocated to the approved indoor location.

Periodic combined rounds of indoor air and sub-slab vapor monitoring continue to investigate possible sources of sub-slab vapor, evaluate the performance of the sub-slab depressurization systems, and provide ongoing protection of worker health and safety with respect to possible vapor intrusion. The current monitoring program includes sampling twice annually, targeting both winter (February) and summer (August) conditions.

SECTION 2

SCREENING LEVELS,

mitigation might be needed or can be discontinued. Trigger levels are intended to be used as a guide to determine:

- whether additional indoor air (IA) and sub-slab vapor (SV) monitoring are needed
- whether mitigationn8[(s)(r)5 (0 Ty)44.5 c.i0 Ty a0i c.i0 Ty0 r0 whe(r)3 TJ 0 Tt3 (TJ 0 Tr (a)4/3

Risk Characterization

The decision matrix in

trigger levels, decisions regarding stopping the SSD or modifying active and passive mitigation methods can be made. Cessation may be warranted, because, as stated earlier, the trigger levels incorporate conservative safety factors.

2.3 SSD SYSTEM SHUTDOWN

Once an SSDS has reduced SV contaminant concentrations below the previously discussed SV trigger levels, Lockheed Martin can evaluate SSDS shutdown. To be eligible for shutdown, a system should demonstrate consistent reduction of SV and IA contaminant concentrations within its radius of influence. SV contaminant concentrations must remain below the trigger levels for at least one year (or for two consecutive semi-annual sampling rounds) before system shutdown can be considered. After system shutdown, rebound testing will check SV concentrations and compare them to historical elevated SV concentrations and to trigger levels equal to MDE "Commercial Tier 1 Soil Vapor" screening levels (MDE, 2012). A rebound testing plan will be submitted to

SECTION 3
MANAGEMENT OF POSSIBLE VAPOR INTRUSION RISKS

If calculated health risks associated with exposure via vapor intrusion (VI) from chemicals of concern (COC) exceed target risk levels, that risk must be appropriately managed. Early planning will assist site management to make informed decisions. To manage possible VI risk, the results of indoor air (IA) and sub-slab vapor (SV) investigations are integrated with other considerations to identify the need for mitigation, remedial action, or other risk reduction activities. Additional factors, such as regulatory requirements, technical implementability, potential liability, and employee/tenant acceptance must also be considered when making risk management decisions.

This section addresses management of acute and chronic risks associated with exposure to volatile organic compounds (VOCs) due to vapor intrusion. The section also addresses increased soil vapor concentrations resulting from sub-slab depressurization system (SSDS) shutdowns due to power failures or mechanical problems. Events triggering the communication of risks and investigation results to building occupants, management, and regulatory agencies are also discussed. Finally, this section provides exit strategies for SSDS shutdown or for terminating the VI monitoring program.

As discussed in this section,

- Remediation refers to the treatment, removal, and reduction in contaminant mass at a site.
- Mitigation means taking measures to minimize or reduce contaminant exposure due to current site conditions.

Mitigation, by itself, usually does not directly affect the contaminant source area. The Middle River Complex (MRC) sub-slab depressurization (SSD) and treatment system is a mitigation measure. This was demonstrated by the D /TM8pt,a.,o0.5fon(n)-8 ( )BDC 0.02 Tc -[(V0.5f)5OCw b

sub-slab after the planned shutdown of the Building A SSD system in March 2013. If the source contamination could be located and were remedied instead, rapid rebound would not be expected.

3.1 MANAGEMENT OF POSSIBLE ACUTE RISKS

The procedures presented in Section 3.1. apply if the performing contractor is on site and is responsible for managing the acute risk. If the incident was caused by others, the performing contractor may be requested or contracted to respond and assist in monitoring.

Acute risks are those that could immediately produce harmful effects. At the MRC, acute VI risks might be i(w)2 (aea3.9 Td [(m)-62 (t3 a1 ntaea3) -0.00 (corl)0-2a)4.7 (orpb ()or (ae 4Tw a2.Bt)r-T(ae 10 Tw t(vicdiie)-2 2.Bo9:200.0

exists, facility security, facility firefighting, the local fire department, and appropriate regulators should be alerted, per the site crisis and emergency plan (Tetra Tech, 2018).

Monitoring programs to manage potential acute risks will rely on direct-reading field instruments

reducing SV and IA contaminant concentrations to regulatorily acceptable levels, remediation of affected media will be required.

Removing the source of vapors is often the preferred remediation strategy at vapor intrusion sites; however, this may not be an easy option at MRC. Feasibility is low given the size of the building footprints (80 acres), the scant knowledge of soil and groundwater contamination and of the nature and extent of vapor sources beneath the buildings, and the infeasibility of complete exploration of sub-slab conditions in buildings with active industrial operations. Short-term effects may be realized with soil removal and SV extraction, as these remediation actions either eliminate or

groundwater contaminant concentrations are high, remediation measures should be instituted before building construction. Remediation measures are currently underway at three groundwater plume locations (Block E, Block G, and Block I) with elevated trichloroethene concentrations.

Institutional and land use controls are common measures for limiting access and/or development to prevent and mitigate exposure to site contaminants. Institutional controls may be applied at undeveloped sites or at sites where land use may change in the future. Institutional controls might be necessary at MRC to ensure that the VI pathway is effectively addressed in the future. Institutional controls could include requirements to install engineering controls on buildings to mitigate possible VI pathways and to limit certain kinds of land use (such as residential use) that might pose regulatorily unacceptable health risks.

3.3 SSD SYSTEM FAILURES

SSD systems in Buildings A and C have operated since March 31, 2008 to maintain a vapor migration barrier. The SSD systems have removed VOCs from [illegible]

ensure that workers are protected. Events that would trigger communication to stakeholders include:

x e

Lockheed Martin will continue to attend tenant meetings, conduct monthly inspections to look for changes that may potentially result in exceedance of trigger levels, and consider yearly monitoring.

The SSDS exit strategy will incorporate the previously discussed trigger

Eastern Boulevard, Middle River, Maryland. epared by Tetra Tech, Inc., Germantown, Maryland for Lockheed Martin Corporation, Bethesda, Maryland. March.

United States Environmental Protection Agency (USEPA), 2011a. Toxicological Review of Dichloromethane (Methylene Chloride). EPA/635/R-10/003F. November.

United States Environmental Protection Agency (USEPA), 2011b. Toxicological Review of Trichloroethylene. EPA/635/R-09/011F. September.

United States Environmental Protection Agency (USEPA), 2012a. ection Age

FIGURES

Figure 2-1 Trigger-Level Decision Matrix

Figure 2-2 SSD System Exit Strategy Decision Matrix

Figure 2-1

Trigger-Level Decision Matrix
Lockheed Martin Middle River Complex
Middle River, Maryland

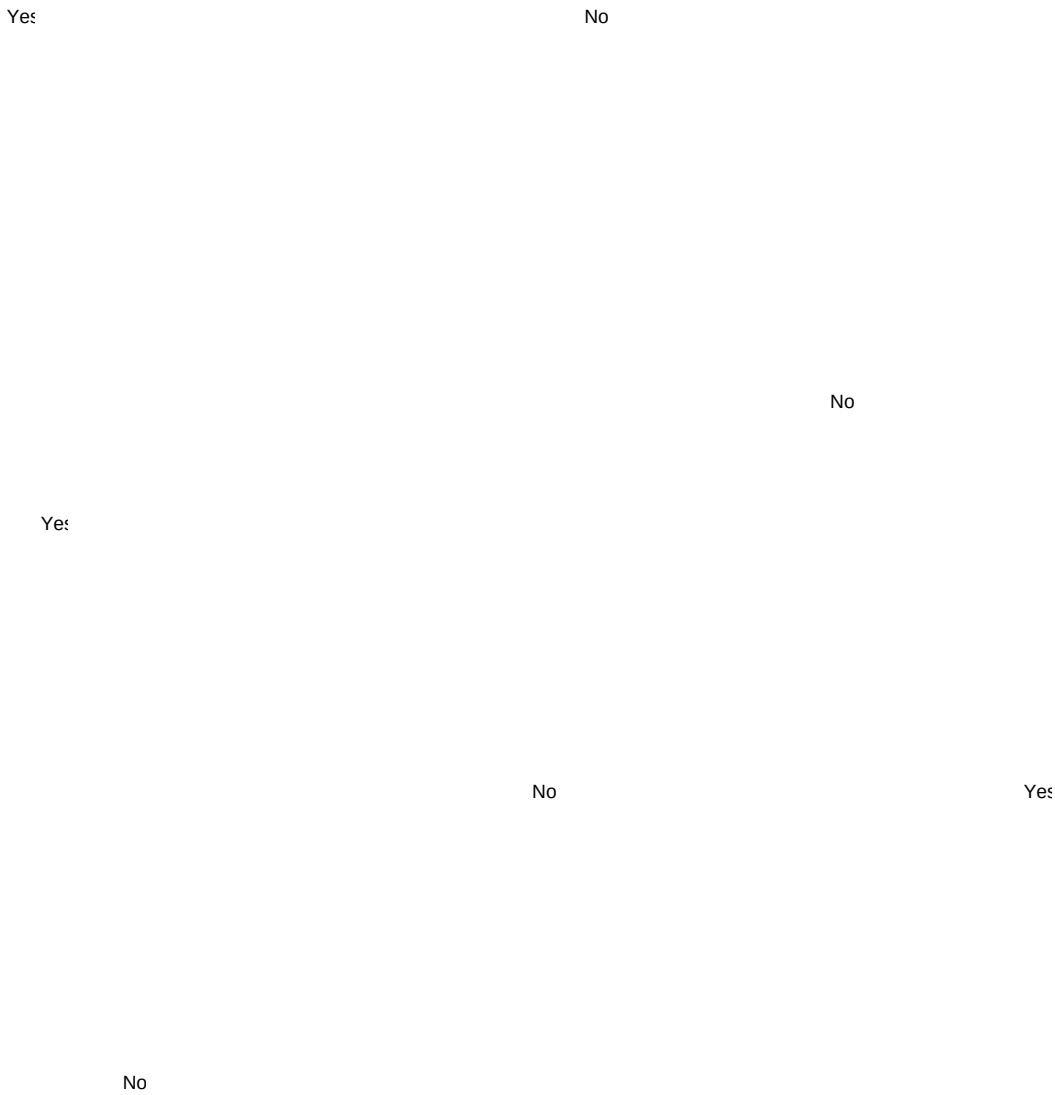
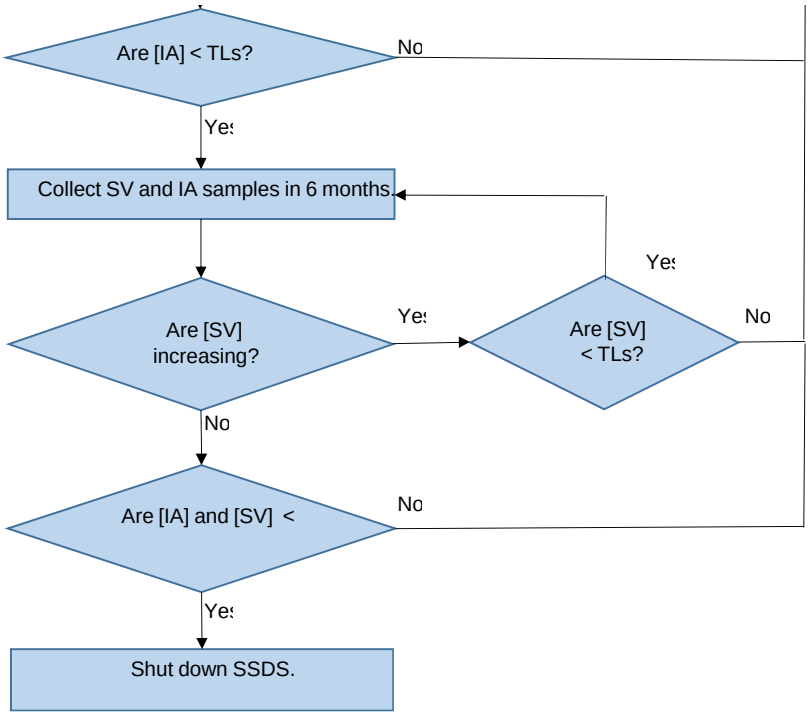


Figure 2-2

SSD System Exit-Strategy Decision Matrix
Lockeed Martin Middle River Complex
Middle River, Maryland



IA	indoor air	SV	sub-slab vapor
[IA]	indoor air concentration	[SV	sub-slab vapor concentration
RO	radius of influence	[SV Influent]	sub-slab vapor influent concentration
SSD	sub-slab depressurization	TL	trigger level
SSD	sub-slab depressurization system	VMP	vapor monitoring point

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Table 2-1 Indoor Air and Sub-Slab Vapor Risk-Based Screening Levels for Indoor Workers

Table 2-2 Summary of Vapor-Intrusion Trigger Levels

Table 3-1 Possible System Failures and Troubleshooting Matrix, Buildings A and C Sub-Slab Depressurization Systems

Table 2-1

Indoor Air and Sub-Slab Vapor
Risk-Based Screening Levels for Indoor Workers
Lockheed Martin Middle River Complex
Middle River, Maryland

Chemical	10 x Carcinogenic Industrial Air USEPA RSL[1] ($\mu g/m^3$)	Noncarcinogenic Industrial Air USEPA RSL[2] ($\mu g/m^3$)	Indoor Air Screening Level[3] ($\mu g/m^3$)	Sub-Slab Screening Level[4] ($\mu g/m^3$)	
Benzene	1.6E+01	1.3E+02	1.6E+01	5.3E+02	Carcinogenic RSL (10^{-5} risk level)
Carbon tetrachloride	2.0E+01	4.4E+02	2.0E+01	6.7E+02	Carcinogenic RSL (10^{-5} risk level)
Chlorodifluoromethane	NA	2.2E+05	2.2E+05	7.3E+06	Noncarcinogenic RSL
Chloroform	5.3E+00	4.3E+02	5.3E+00	1.8E+02	Carcinogenic RSL (10^{-5} risk level)
Dichlorodifluoromethane	NA	4.4E+02	4.4E+02	1.5E+04	Noncarcinogenic RSL
1,1-Dichloroethane	7.7E+01	NA	7.7E+01	2.6E+03	Carcinogenic RSL (10^{-5} risk level)
1,2-Dichloroethane	4.7E+00	3.1E+01	4.7E+00	1.6E+02	Carcinogenic RSL (10^{-5} risk level)
1,1-Dichloroethene	NA	8.8E+02	8.8E+02	2.9E+04	Noncarcinogenic RSL
cis- 1,2-Dichloroethene[5]	NA	NA	NA	NA	*trans*- 1,2-dichloroethene used as surrogate
trans- 1,2-Dichloroethene[5]	NA	NA	NA	NA	USEPA withdrew reference concentration (2014).
Ethylbenzene	4.9E+01	4.4E+03	4.9E+01	1.6E+03	Carcinogenic RSL (10^{-5} risk level)
Methyl tert-Butyl Ether	4.7E+02	1.3E+04	4.7E+02	1.6E+04	Carcinogenic RSL (10^{-5} risk level)
Methylene chloride	1.2E+04	2.6E+03	2.6E+03	8.7E+04	Noncarcinogenic RSL
Naphthalene	3.6E+00	1.3E+01	3.6E+00	1.2E+02	Carcinogenic RSL (10^{-5} risk level)
Tetrachloroethene	4.7E+02	1.8E+02	1.8E+02	6.0E+03	Noncarcinogenic RSL
Toluene	NA	2.2E+04	2.2E+04	7.3E+05	Noncarcinogenic RSL
1,2,4-Trichlorobenzene	NA	8.8E+00	8.8E+00	2.9E+02	Noncarcinogenic RSL
1,1,1-Trichloroethane	NA	2.2E+04	2.2E+04	7.3E+05	Noncarcinogenic RSL
1,1,2-Trichloroethane	7.7E+00	8.8E-01	8.8E-01	2.9E+01	Noncarcinogenic RSL
Trichloroethene[6]	3.0E+01	8.8E+00	8.8E+00	2.9E+02	Noncarcinogenic RSL
Vinyl chloride	2.8E+01	4.4E+02	2.8E+01	9.3E+02	Carcinogenic RSL (10^{-5} risk level)
Xylene, *p*-	NA	4.4E+02	4.4E+02	1.5E+04	Noncarcinogenic RSL
Xylene, *m*-	NA	4.4E+02	4.4E+02	1.5E+04	Noncarcinogenic RSL
Xylene, *o*-	NA	4.4E+02	4.4E+02	1.5E+04	Noncarcinogenic RSL

[1]Corresponds to a risk level of 1 x 10^{-5}. (10 times the carcinogenic RSL)

[2]Corresponds to a hazard quotient of 1.0

[3] Lesser of ten times the carcinogenic industrial air RSL (10^{-5} risk level) and the noncarcinogenic industrial air RSL

[4] Sub-slab screening level = indoor air screening level divided by an attenuation factor of 0.03

[5]The RSL for cis- and trans-1,2-dichloroethene were withdrawn in 2014 because the reference dose was withdrawn from IRIS.

[6]A site-specific screening level of 35 µ

Table 2-2

Summary of Vapor Intrusion Trigger Levels
Lockheed Martin Middle River Complex
Middle River, Maryland

Chemical	Indoor air trigger level ($\mu g/m^3$)	Sub-slab vapor trigger level ($\mu g/m^3$)
Benzene	1.6E+01	1.6E+03
Carbon tetrachloride	2.0E+01	2.0E+03
Chlorodifluoromethane	2.2E+05	2.2E+07
Chloroform	5.3E+00	5.3E+02
Dichlorodifluoromethane	4.4E+02	4.4E+04
1,1-Dichloroethane	7.7E+01	7.7E+03
1,1-Dichloroethene	4.7E+00	4.7E+02
1,2-Dichloroethane	8.8E+02	8.8E+04
cis-1,2-Dichloroethene	NA	NA
trans-1,2-Dichloroethene	NA	NA
Ethylbenzene	4.9E+01	4.9E+03
Methyl tert-Butyl Ether	4.7E+02	4.7E+04
Methylene chloride	2.6E+03	2.6E+05
Naphthalene	3.6E+00	3.6E+02
Tetrachloroethene	1.8E+02	1.8E+04
Toluene	2.2E+04	2.2E+06
1,2,4-Trichlorobenzene	8.8E+00	8.8E+02
1,1,1-Trichloroethane	2.2E+04	2.2E+06
1,1,2-Trichloroethane	8.8E-01	8.8E+01
Trichloroethene	8.8E+00	8.8E+02
Vinyl chloride	2.8E+01	2.8E+03
Xylenes, total	4.4E+02	4.4E+04

Table 3-1

Possible System Failures and Troubleshooting Matrix
Buildings A and C Sub-Slab-Depressurization Systems
Lockheed Martin Middle River Complex, Middle River, Maryland

Table 3-1

Possible System Failures and Troubleshooting Matrix
Buildings A and C Sub-Slab-Depressurization Systems
Lockheed Martin Middle River Complex, Middle River, Maryland

Issue	Possible causes	Possible remedies
High-pressure alarm[1,3]	x Granular activated-carbon drums are moist/wet. x Faulty pressure-switch. x Effluent pipe valve is partially closed.	x Replace carbon drum. x Check pressure switch; adjust, clean or replace if necessary. x Ensure that effluent pipe valve is fully open.
Low-pressure alarm (Building A) [1,3]	x Low or no flow due to closed/partially closed vapor extraction points. x Low or no flow due to water in the lines. x Faulty pressure-switch. x Pipe or hose disconnected or broken.	x Ensure that a sufficient number of vapor extraction points are open to allow enough flow. Check blower. x Check lines for water and drain if necessary. x Repair or replace switch. x Repair or replace pipe or hose.
Low-pressure alarm (Building C) [1,3]	x Low or no flow due to water in the lines. x Faulty pressure-switch x Pipe or hose disconnected or broken.	x Check lines for water and drain if necessary. x Repair or replace switch. x Repair or replace pipe or hose.

[1] Triggering any of the fail-safe alarms listed in the above table will also trigger the system auto-dialer to call the system operator and up to three backup personnel, until the alarm has been acknowledged (by pressing 555 on the phone's keypad). Tetra Tech, Inc. (Tetra Tech) will respond to the alarm and restart the system within four hours of notification during daylight hours, or the following morning if the alarm occurs overnight, if reasonably possible. Lockheed Martin Corporation (Lockheed Martin) will be notified within 24 hours if the system remains shut down for more than one day, and will be given a description of the cause(s) and actions taken to address the condition and restart the system.

[2] Note that at times of high precipitation, the SSD system extraction trenches in the Building A basement may be shut down until water levels decrease to avoid excessive water extraction by the system, as vapor cannot be effectively extracted under these conditions. Lockheed Martin will be notified if this action is required.

inTd [(2)-17Tw 9.5 ahesJ 0.003 .3 (,)-9s-2.5 (sh)-12.1 (u.3 (,)-94 Tw 22.vTc -0.00d)-12 -12u]TJ 0.00ll Tw -38.yl

APPENDICES

Appendix A—Spare Blower Installation and Operation

APPENDIX A

SPARE BLOWER INSTALLATION AND OPERATION
Sub-Slab Depressurization Systems
Lockheed Martin Middle River Complex
2323 Eastern Boulevard, Middle River, MD

1.0 INTRODUCTION AND PURPOSE

An AMETEK® Rotron® model DR858 blower was purchased in December 2016 to function as a spare blower if the blower in the sub-slab depressurization system (SSDS) operating in Building A or in the Building C SSDS becomes inoperable and needs to be removed for repair or replacement

2.0 REFERENCES

Tetra Tech, Inc. (Tetra Tech), 2019. Operation, Maintenance and Monitoring Manual, Sub-Slab