Lockheed Martin Corporation
6801 Rockledge Drive MP: CCT-246
Bethesda, MD 20817
Telephone 301-548-2209

LOCKHEED MARTIN

October 12, 2021 **VIA EMAIL AND PRIVATE CARRIER**

Gary Schold, Project Manager
Land Restoration Program
Land and Materials Administration
Maryland Department of the Environment
1800 Washington Boulevard, Suite 625
Baltimore, Maryland 21230

Subject: 100% Design Sub-Slab Depressurization Systems-
Drop Hammer Building, Building A, Building C
Lockheed Martin Corporation – Middle River Complex
2323 Eastern Boulevard, Middle River, Baltimore County, Maryland

Dear Mr. Schold,
For your information, please find enclosed two hard copies with a CD of the above-referenced documents. These documents were prepared to describe the proposed installation of sub-slab depressurization systems in the Drop Hammer Building, Building A and Building C of the Middle River Complex in Middle River, Maryland.

Please let me know if you have any questions. My office phone is (301) 548-2209.

Sincerely,

Thomas D. Blackman
Project Lead, Environmental Remediation

cc: (via email without enclosure)

Anuradha Mohanty, MDE
Mark Mank, MDE
Christine Kline, Lockheed Martin
Mary Morningstar, Lockheed Martin
Tom Green, LMCPI
James Damm, LMCPI
Michael Martin, Tetra Tech
Cannon Silver, CDM Smith

cc: (via Box)
Jann Richardson, Lockheed Martin
Scott Heinlein, LMCPI
Christopher Keller, LMCPI
Glen Harriel, LMCPI
Rina Scales, LMCPI

cc: (via mail with enclosure)
Budd Zahn, MRAS

100% DESIGN
SUB-SLAB DEPRESSURIZATION SYSTEM
THIRD-PHASE EXPANSION – BUILDING C
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
2323 EASTERN BOULEVARD
MIDDLE RIVER, MARYLAND

Prepared for:
Lockheed Martin Corporation

Prepared by:
Tetra Tech, Inc.

October 2021

Revision: 0

Michael Martin, P.G.
Regional Manager

Peter A. Rich, P.E.
Principal Engineer

TABLE OF CONTENTS

APPENDICES

ACRONYMS

ºF	degrees Fahrenheit
µg/m3	microgram(s) per cubic meter
%	Percent
cis-1,2-DCE	cis-1,2-dichloroethene
BTU	British thermal unit
COMAR	Code of Maryland Regulations
CPVC	chlorinated polyvinyl chloride
GAC	granular activated carbon
HP	Horsepower
HVAC	heating, ventilation, and air-conditioning
Lbs	Pounds
lbs/day	pounds per day
lbs/hr	pounds per hour
L/min	liters per minute
Lockheed Martin	Lockheed Martin Corporation
MDE	Maryland Department of the Environment
PCE	tetrachloroethene
PID	photoionization detector
PPZ	potassium permanganate zeolite
Psi	pounds per square inch
PVC	polyvinyl chloride
SSD	sub-slab depressurization
SCFM	standard cubic feet per minute
SV	sub-slab vapor
TBE	threaded on both ends
TCE	trichloroethene
Tetra Tech	Tetra Tech, Inc.
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WC	water column

SECTION 1
INTRODUCTION

Tetra Tech, Inc. (Tetra Tech) has prepared this 100% design package on behalf of Lockheed Martin Corporation (Lockheed Martin) to describe the proposed third-phase expansion of the sub-slab depressurization system currently operating in Building C at the Middle River Complex in Middle River, Maryland. The third-phase expansion will include installation of one soil vapor extraction point in the vicinity of vapor monitoring point SV-102-C, and installing overhead piping to connect the new extraction point to the system.

This 100% design package is organized as follows:

Section 2—Background: Briefly describes the history of the system.

Section 3—Basis of Design: Presents the technical approach used to determine the location of the expansion.

Section 4—100 Percent Design: Describes the components of the third-phase system expansion.

Section 5—Performance Monitoring: Explains system startup, operation, and monitoring and proposed project schedule.

Section 6—References: Lists the references used in this design document.

SECTION 2
BACKGROUND

The sub-slab depressurization (SSD) system in Building C has been operating since its installation in March 2008. The SSD system applies vacuum under the concrete foundation in areas in the middle and southern portion of the Building C basement where elevated volatile organic compounds (VOCs) are known to be present in the soil gas. The application of a sub-slab vacuum draws VOCs from the extraction points, maintains a negative pressure below the slab relative to the room space, and prevents migration to indoor air.

The original system consisted of two vapor-extraction wells in the basement (SV-21-C and SV-23-C), several sub-slab vapor monitoring points, two three-horsepower (HP) AMETEK® regenerative blowers in parallel, one moisture separator, two 200-pound granular activated carbon (GAC) units, and an exhaust stack that extends above the roof of the building. The GAC units and stack are located outdoors near the southern wall of Building C.

A first-phase system expansion was completed in October 2012 with the installation of four additional vapor-extraction wells (SV-26-C to SV-29-C), larger (replacement) 400-pound GAC units and a 600-pound potassium permanganate zeolite (PPZ) unit to address a larger area of the sub-slab with elevated VOCs delineated in the middle of the Building C basement, while continuing to address the southern basement area (with SV-21-C and SV-23-C).

A second-phase system expansion was completed in May 2013 to (more) efficiently prevent soil vapor intrusion into the building interior based on the lessons learned from the first-phase expansion. The second-phase expansion components included :

- Installing five additional extraction points designated SV-30-C, SV-31-C, SV-32-C, SV-33-C, and SV-34-C
- Replacing the two original regenerative blowers (rated for 60 standard cubic feet per minute [SCFM] suction at 40 inches of water column [WC] each) with a single larger unit (Rotron DR858AY72W rated for 220 SCFM suction at 55 inches WC) to accommodate the flow from 11 extraction points
- Replacing the in-line filter, dilution valve, and relief valve and updating the control panel as needed as part of the blower replacement

- Moving the blower skid, GAC and PPZ units to an indoor location approximately 75 feet northwest of the former system location

- Adding a heat exchanger (20,667 British thermal units per hour [BTU]/hour) for reducing 250 SCFM exhaust vapor temperature by 77ºF, as needed, to below about 125ºF, prior to GAC treatment

- Adding moisture separation (the separator is rated for up to 1200 SCFM)/collection and mist elimination for exhaust vapor to remove condensate prior to GAC and PPZ treatment and prevent stained condensate mist (if any) from discharging from the exhaust stack

- Relocating the exhaust stack condensate sump indoors to eliminate freezing concerns

- Adding appropriate fail-safes including a second temperature switch to protect the blower and a second high-level switch for the pre-GAC exhaust moisture collection and tying them into the control panel

The purpose of the proposed third-phase system expansion is to prevent soil vapor intrusion in the area near SV-102-C, a location which has had elevated VOC concentrations in soil vapor during recent sampling rounds. The third-phase expansion components include:

- Installing one additional extraction well within 15 feet of existing vapor monitoring point SV-102-C

- Installing overhead piping to connect the new extraction well to the system

The treatment capacity of the SSD system is sufficient to address flow from the new extraction point; therefore, no modifications to the current system are required.

SECTION 3
BASIS OF DESIGN

The design objective for the proposed third-phase system expansion is to maintain a negative pressure of at least 0.01 inches water column (WC) in the area of vapor monitoring point SV-102-C at all times regardless of heating, ventilation, and air-conditioning (HVAC) operation or barometric conditions, and to prevent potential vapor migration in the middle basement target area of Building C. To achieve this design goal, one soil vapor extraction point will be installed in the location shown on Drawings G1 and G2 of Appendix A. The proposed vapor extraction point location was reviewed and confirmed with Mr. Bob Kuhn on August 5, 2021. The proposed location was then cleared by geophysical utility survey/investigation on August 9, 2021 by RETTEW Field Services, Inc. The utility clearance report dated August 16, 2021is included in Appendix B.

SECTION 4
100 PERCENT DESIGN

The third-phase expansion of the sub-slab depressurization (SSD) system at Building C will consist of installing one vertical sub-slab vapor extraction point and polyvinyl chloride (PVC) piping to connect the new point to the system.

4.1 VAPOR EXTRACTION POINT AND PIPING

The new sub-slab extraction point will be installed in the middle basement target area within 15 feet of vapor monitoring point (VMP) SV-102-C. The proposed location is shown on Drawings G1 and G2 of Appendix A. The point will be designated SV-35-C and will be comprised of a vertical 12-inch to 18-inch length of two-inch diameter, 0.020-inch slot, Schedule 40 PVC pipe in a four-inch-diameter borehole, with clean pea gravel filling the annular space. A bentonite grout seal will be placed above the screen and gravel to prevent short-circuiting. The new extraction point will be located immediately adjacent to column S20, to eliminate the need for cutting the concrete slab other than for coring at the extraction point. The coring will be performed close to the column so that the pipe can be away from traffic; a bollard will be installed to protect the pipe, if needed. The concrete will be finished in a manner equal or better than surrounding areas, as required by Lockheed Martin Corporation (Lockheed Martin).

A two-inch-diameter pipe from the new extraction point will be brought aboveground at column S20, as shown on Drawing G2 of Appendix A, and will be supported on the column by pipe supports spaced every three to five feet. The riser pipe will have a measuring point for sampling, and for flow and vacuum monitoring, and will contain a lockable diaphragm valve for throttling or shutting off flow. The pipe will be connected using a PVC saddle to the six-inch-diameter Schedule 40 PVC pipe header, which connects the existing middle basement extraction points to the SSD system. A cut sheet for the saddle and technical specifications for the work to be performed are in Appendix C.

All piping will be level or sloped back towards the extraction point or towards the header pipe condensate sumps, and to prevent condensate accumulation in low points in pipe runs. A bollard may be installed to protect the piping at the proposed extraction point if Lockheed Martin and Middle River Aircraft Systems agree it would be worthwhile.

The treatment capacity of the SSD system is sufficient to address flow from the new extraction point; therefore, no modifications to the current system are required. Recent system vapor flow rates are approximately 150 standard cubic feet per minute (SCFM) at approximately 65 inches WC vacuum from the ten active extraction points. After the third-phase system expansion is completed, a slightly increased vapor flow of approximately 165 SCFM at approximately 60 inches WC vacuum is expected.

The system vapor flow rate of 165 SCFM and up to 25 SCFM per extraction point produces minimal friction losses in both the individual extraction pipes and the main header line; friction losses per foot of pipe were calculated to be about 0.007 inches WC per foot in the two-inch-diameter extraction laterals, and less than 0.005 inches WC in the six-inch-diameter header. Under a worst-case scenario, the vacuum-side filter loss will be an estimated 18 inches WC, resulting in anticipated total losses of approximately 31 inches WC. The pressure-side head loss is less than 38 inches WC. These are acceptable levels for system performance.

Pressure loss calculations and pressure losses for system components are provided in Appendix D. Pressure losses for both new and dirty filters are also included in Appendix D.

4.2 ESTIMATED EMISSIONS AND PERMITS

Current volatile organic compound (VOC) mass removal rates of the Building C SSD system are approximately 0.001 pounds per day (lbs/day). Using the February 2021 total VOC concentration of 10,330 $\mu g/m^3$ at SV-102-C and an estimated maximum extraction rate of 25 SCFM, an additional 0.023 lbs/day will be removed initially. Based on the previous system expansions, the VOC concentration at the proposed extraction point is expected to decrease by approximately 90% during the first month of operation. Therefore, an increase in the very low current mass removal may be seen initially but may not be noticeable thereafter. Vapor sampling at the Building C system will continue per current (every four months) protocol (Tetra Tech, 2021a).

Even without granular activated carbon (GAC) and potassium permanganate zeolite (PPZ) treatment, the anticipated system emission rates are below the Maryland Department of the Environment (MDE) guidance for Title 5 emissions (25 tons VOCs per year) found in Code of Maryland Regulations (COMAR) 26.11.02.01C. Based on telephone communication with the MDE Air Quality Permits section when the existing SSD system was proposed in November 2007, no air permit is required for these emission rates. This was re-confirmed via telephone communication with George Beerli with the MDE Air Quality Permits section on August 2, 2012 in preparation for the first-phase expansion.

4.3 FAILURE-MODE AND EFFECTS ANALYSIS

Tetra Tech, Lockheed Martin, and its remedial technical operations (RTO) contractor conducted a failure mode and effects analysis (FMEA) on August 26, 2021 via a virtual (online) meeting. The purpose of the FMEA is to examine work for single or multiple point failures that could cause a release of untreated soil vapors to the environment or cause damage to the SSD system. The results of the FMEA have been incorporated into the design document. FMEA documentation is in Appendix E.

4.4 WORK PLANS AND PROPOSED CONSTRUCTION SCHEDULE

Construction work plans have been prepared by Tetra Tech to guide the construction of the system expansion and include a construction quality control plan (CQCP) (Tetra Tech, 2021b), a site and temporary facilities plan (Tetra Tech, 2021c), and project-specific health and safety plan (HASP) that includes an emergency response plan (Tetra Tech, 2021d). The wastes to be generated during the construction of the system expansion will be managed in accordance with the facility's current investigation–derived waste management plan (WMP) (CDM Smith, 2021). The construction work plans are provided under separate cover.

The CQCP presents the approach for confirming that the system is installed consistent with the design intent. The site and temporary facilities plan details the temporary facilities required to advance work and the best management practices that will be used to limit impact to building tenants and operations. The HASP includes procedures used to protect workers and the public from potential hazards during construction. The emergency response plan, included in the HASP, outlines emergency procedures.

The third-phase SSD system expansion is anticipated to be completed in the fall of 2021 following approval of the 100% design documents. Construction of the system expansion is expected to last less than one week.

SECTION 5
PERFORMANCE MONITORING

5.1 SYSTEM STARTUP AND OPERATION

Following construction of the third-phase system expansion, the system will be balanced by taking vacuum and flow rate measurements from each extraction point and each induced vacuum monitoring point, and adjusting the diaphragm throttling valve to pull between 15 and 25 standard cubic feet per minute (SCFM) from the new extraction point, thus achieving the design criteria of a vacuum of 0.01 inches water column (WC) or greater at SV-102-C, the VMP within the radius of influence of the new extraction point, when possible.

System checks and process vapor sampling will be conducted per the current system operation and maintenance manual and the current schedule (Tetra Tech, 2021a). System checks will include readings of induced vacuum, applied vacuum, and flow rate.

5.2 SYSTEM MONITORING

The system checks will continue to include the following steps:

1. Record the vacuum and flow velocity from each extraction point and adjust as needed.
2. Record effluent blower temperature and pressure.
3. Check induced vacuum at monitoring points including SV-102-C.
4. Empty condensate in moisture separators and sumps into properly-labeled transportable drum, as needed.
5. Check vacuum gauges, pressure gages, piping, and fittings for leaks and signs of heat stress.

The Building C sub-slab depressurization (SSD) system checklist has been updated to include monitoring at the new extraction point SV-35-C; a copy of the updated system checklist and a pre-startup checklist are in Appendix F.

5.3 INDUCED VACUUM MONITORING

During startup of the new extraction point, induced vacuum will be monitored at nearby vapor monitoring points by collecting single, instantaneous readings with a manometer. Extraction point flow rates will be adjusted to maximize vacuum influence within the target area and to achieve the design criteria, if possible. The slab will be checked for short-circuiting at joints and perforations, and any pathways will be sealed.

Monitoring in the south basement target area will continue at 001-C-SV, SV-3-C, SV-4-C, SV-2C, SV-22-C, SV-24-C and SV-25-C. Monitoring in the middle basement area will continue at 050-C, 060-C, newly added 102-C, 111-C, 113-C, 126-C, 127-C, 133-C, 135-C, 141-C, 149-C,150-C, 151-C, 152-C 153-C, 154-C, 155-C, 156-C, 157-C, 158-C, and 159-C. Monitoring points will be removed from the program if they are not useful.

SECTION 6
REFERENCES

Maryland Department of the Environment (MDE), 2007. Telephone communication between Dave Mummert of Air Quality Permits section and Tetra Tech, Inc. regarding the anticipated volume of emissions at site not requiring an air permit. November.

Maryland Department of the Environment (MDE), 2012. Telephone communication between George Beerli of Air Quality Permits section and Tetra Tech, Inc. regarding the anticipated volume of emissions at site not requiring an air permit. August.

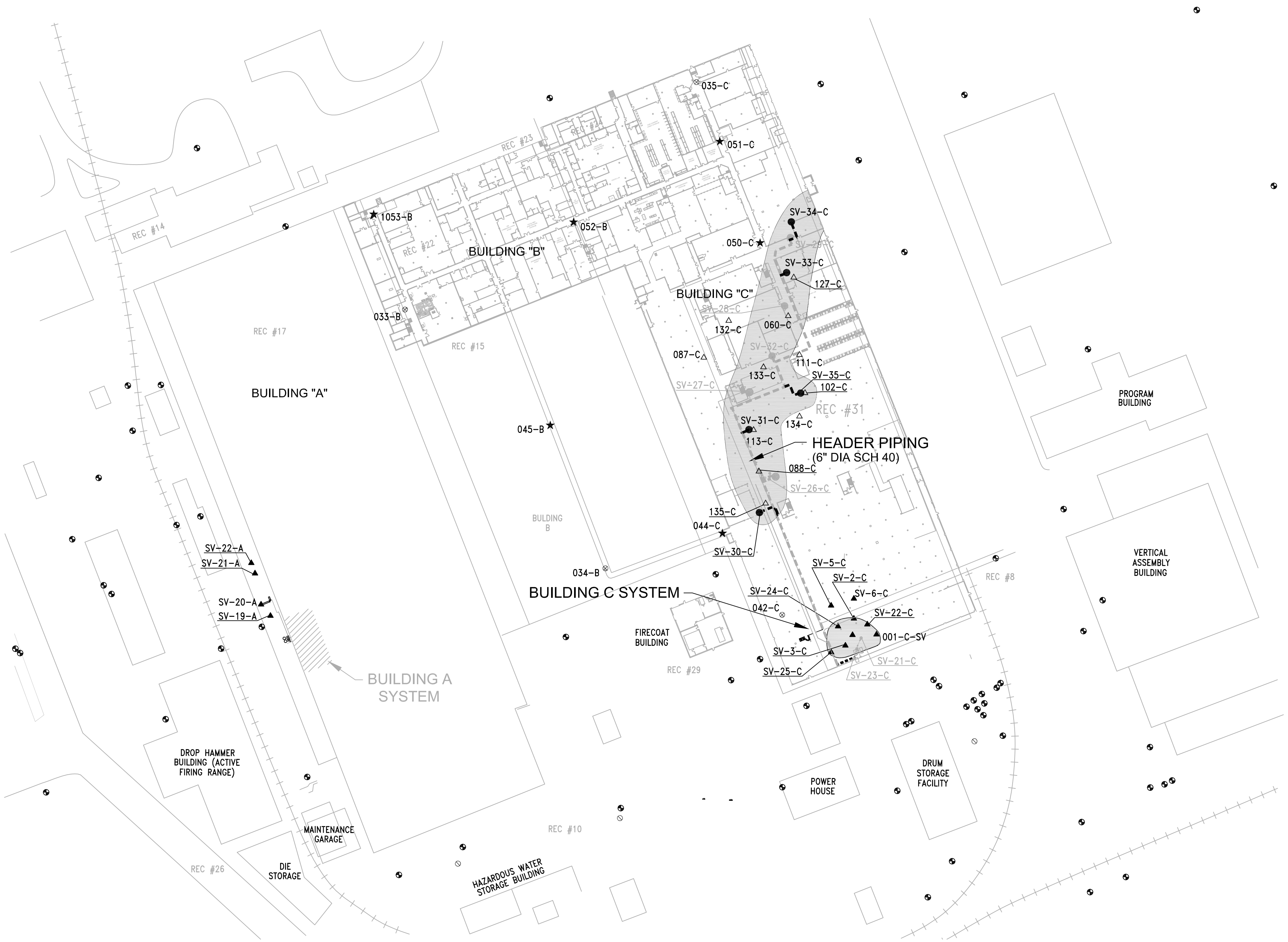
Tetra Tech, Inc. (Tetra Tech), 2021a. *Operation, Maintenance, and Monitoring Manual, Sub-Slab Depressurization System – Building C, Lockheed Martin Middle River Complex, 2323 Eastern Boulevard Middle River, Maryland*. July.

Tetra Tech, 2021b. *Construction Quality Control Plan, Sub-Slab Depressurization System Third-Phase Expansion – Building C, Lockheed Martin Middle River Complex, 2323 Eastern Boulevard Middle River, Maryland*. September.

Tetra Tech, 2021c. *Site and Temporary Facilities Plan, Sub-Slab Depressurization System Construction-Drop Hammer Building*, Lockheed Martin Middle River Complex, 2323 Eastern Boulevard Middle River, Maryland. September.

Tetra Tech, 2021d. *Site-Specific Health and Safety Plan for Construction, Expansion, Operation, Maintenance, and Monitoring of Sub-Slab Depressurization Systems, Lockheed Martin Middle River Complex, 2323 Eastern Boulevard Middle River, Maryland*. September.

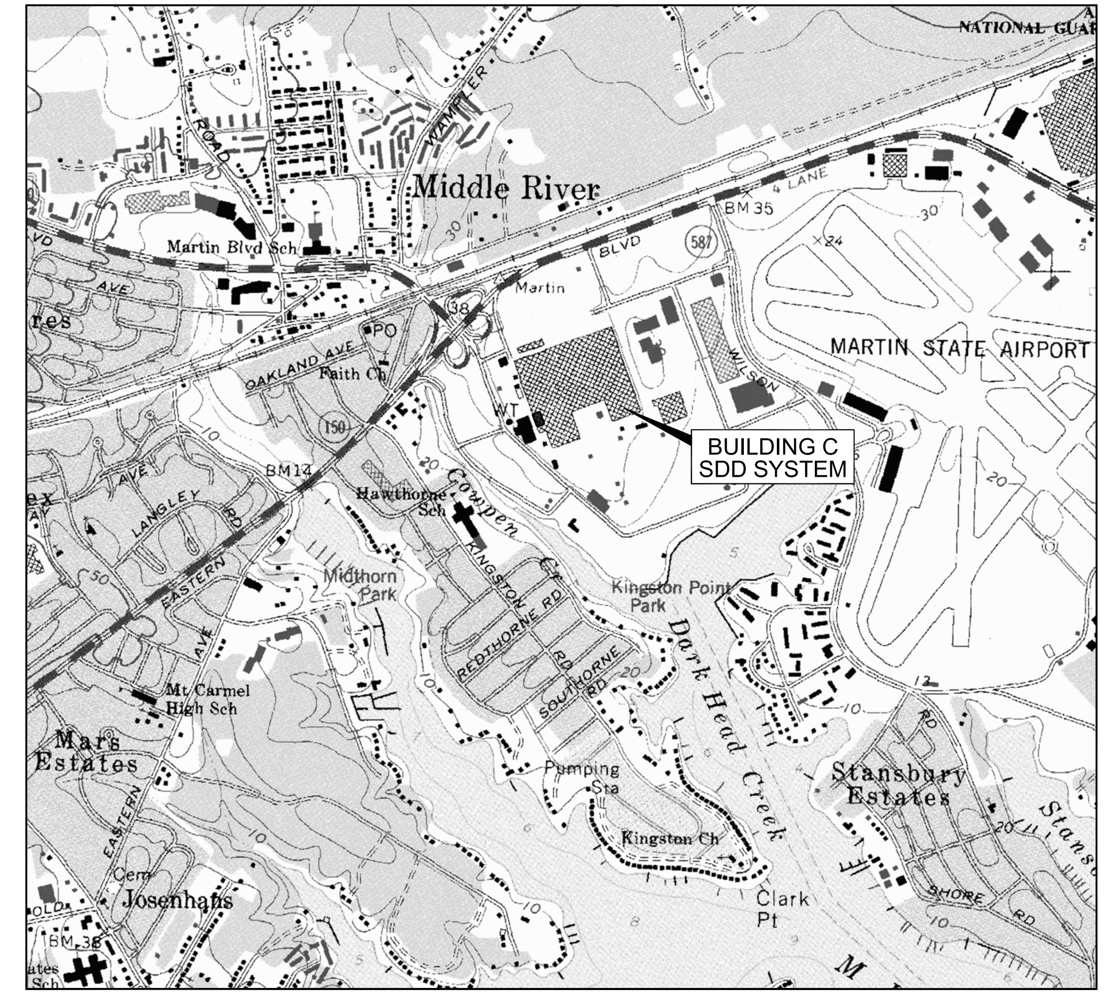
APPENDIX A—DESIGN DRAWINGS



LEGEND	
SUBSLAB VAPOR EXTRACTION POINT INSTALLED MARCH 2008	
GROUNDWATER MONITORING WELL	
SUBSLAB VAPOR MONITORING POINT	
MONITORING POINT INSTALLED JANUARY 2010	
PROPOSED SUBSLAB VAPOR EXTRACTION POINT	
TARGET OF OPPORTUNITY	
INDOOR AIR SAMPLE	
ABANDONED WELL BORING	
SUBSLAB VAPOR EXTRACTION POINT INSTALLED OCTOBER 2012	
SSD	SUBSLAB DEPRESSURIZATION
	SYSTEM PIPING
	PROPOSED PIPE EXTENSION (OVERHEAD)
	TARGET AREA FOR INDUCED VACUUM

0 100 200 300
SCALE IN FEET

N



SITE LOCATION MAP

0 1000 2000 3000
SCALE IN FEET

APPROVED BY:	DATE	REVISION	APRVD.

TITLE:
100% DESIGN
PLAN OVERVIEW
SSD SYSTEM THIRD-PHASE EXPANSION - BUILDING C

LOCATION:
LMC Middle River Complex
Middle River, Maryland

TETRA TECH

APPROVED	PAR
DRAFTED	CMP
PROJECT#	117-0512524
DATE	09-02-21

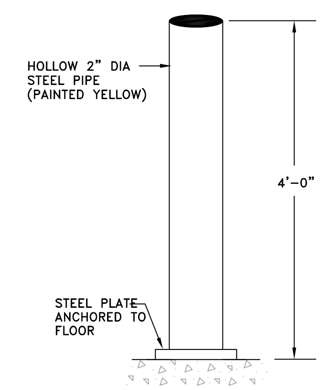
DRAWING: G1

WASHED PEA GRAVEL GRADATION	
SIEVE SIZE	PERCENT PASSING
1/2"	100%
3/8"	85 TO 100%
#4 (4.75MM)	10 TO 30%
#8 (2.36MM)	< 5%
#20 (0.85MM)	< 2%

NOTES:

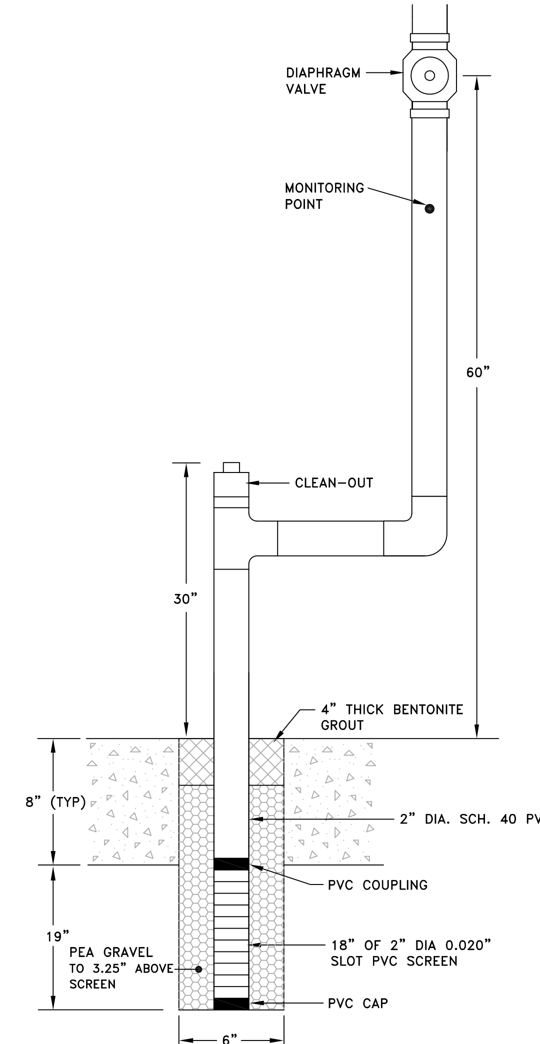
A. GRAVEL MATERIAL SHALL CONFORM TO ASTM C-33 SPECIFICATIONS FOR 3/8"AGGREGATE.

B. GRAVEL SHALL BE SEMI-ROUND AND FREE OF ORGANIC MATERIAL.



PIPE BOLLARD DETAIL (PLACED AS NEEDED)

NOT TO SCALE



EXTRACTION POINT DETAIL (TYP)

NOT TO SCALE

LEGEND

- GROUNDWATER MONITORING WELL
- ▲ SUBSLAB VAPOR MONITORING POINT
- △ MONITORING POINT TO BE INSTALLED FEBRUARY 2013
- ● PROPOSED SUBSLAB VAPOR EXTRACTION POINT
- SUBSLAB VAPOR EXTRACTION POINT
- ● PS-1 PIPE SUMP
- HEADER PIPE (6" DIA. SCH 40)
- PROPOSED PIPE EXTENSION (2", 3", 4" OR 6" DIA. SCH 40)

NOTES:

1. PIPE HANGERS PLACED NEXT TO EXISTING SUPPORT BRACKETS FOR STEEL PIPING IN CEILING APPROX. 6-12 FT APART.
2. EXTRACTION POINT PIPING SUPPORTED ON WALL OR COLUMN WITH PIPE SUPPORTS.

APPROVED BY:	DATE	REVISION	APRVD.

TITLE:

100% DESIGN
PIPING LAYOUT AND DETAILS
SSD SYSTEM THIRD-PHASE EXPANSION - BUILDING C

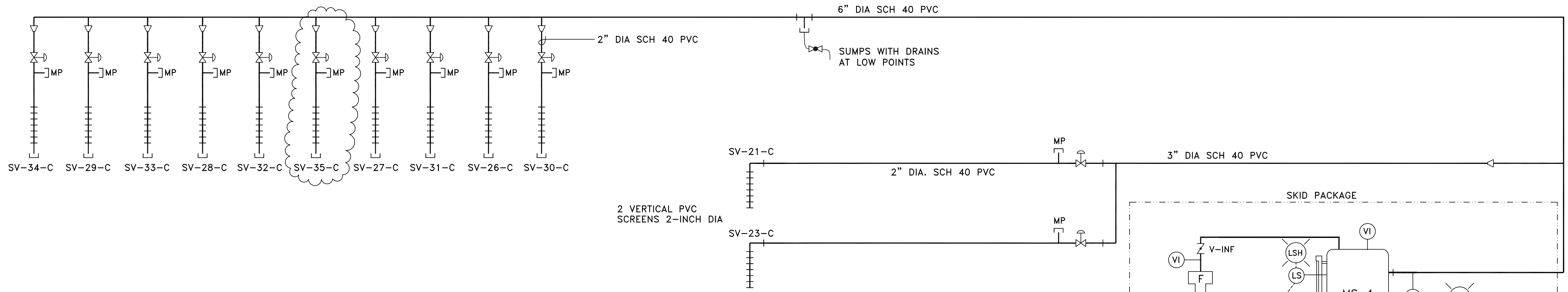
LOCATION:

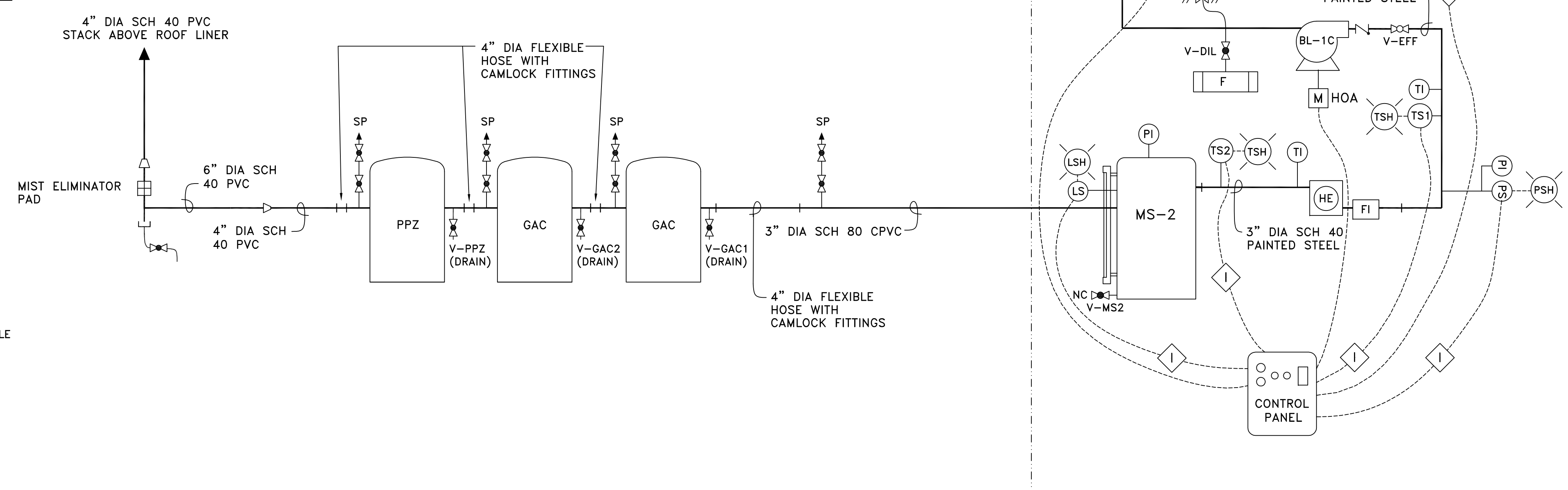
LMC Middle River Complex
Middle River, Maryland

TETRA TECH

APPROVED	PAR
DRAFTED	CMP
PROJECT#	117-0512524
DATE	09-02-21

DRAWING: G2





PROCESS AND INSTRUMENTATION DIAGRAM NOTES

VI	VACUUM INDICATOR – 0–160" H_2O
MP	MEASURING POINT 1/4" MALE CONNECTOR WITH PLUG THREAD WITH TEFLON TAPE. FITTING MAY BE REMOVED FOR ANEMOMETER AND VACUUM READINGS PROVIDE 20" SOLID PIPE BOTH SIDES.
▽	REDUCER
	BUTTERFLY VALVE (LOCKABLE)
	BALL VALVE
	BALL VALVE – NORMALLY CLOSED
	DIAPHRAGM VALVE (LOCKABLE)
	CHECK VALVE
FI	FLOW INDICATOR (DIRECT 70–350 SCFM READING, ROTRON FM30C350Q)
F	INLET AIR FILTER
HE	HEAT EXCHANGER (XCHANGER AA–250)
MS	MOISTURE SEPARATOR WITH 30 GALLON CAPACITY, SIGHT TUBE, REMOVABLE TOP, DRAIN VALVE
LS	LEVEL SWITCH
VRV	VACUUM RELIEF VALVE
SP	SAMPLE PORT 1/4" DIAMETER
BL	ROTRON DR858, 7.5 HP MOTOR, 220 SCFM @ 55" H_2O
PI	PRESSURE INDICATOR 0–160" H_2O
TS1	TEMPERATURE SWITCH, 215° F SETTING
TS2	TEMPERATURE SWITCH, 140° F SETTING
GAC	GRANULAR ACTIVATED CARBON VAPOR TREATMENT (SIEMENS VENT-SCRUB® VSC400, VOCARB® 48C) OPERATED IN UPFLOW MODE
PPZ	POTASSIUM PERMANGANATE ZEOLITE MEDIA (SIEMENS VENT-SCRUB® VSC400, KMN2000) OPERATED IN UPFLOW MODE
TI	TEMPERATURE INDICATOR 0–250° F
PS	PRESSURE SWITCH (HIGH)
VS	VACUUM SWITCH (LOW)
V-MS1	PROCESS VALVE LABELS
HOA	PANEL MOUNTED HAND/OFF/AUTO SWITCH FOR BLOWER
◇ I	INTERLOCK BLOWER SHUTDOWN
○	LOCALLY MOUNTED INSTRUMENT
	PANEL ALARM LIGHT
H	HIGH
L	LOW

CONNECT ONE (1) NEW SUBSLAB VAPOR EXTRACTION POINTS.

APPROVED BY:	DATE	REVISION	APRVD.

TITLE: 100% DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM
SSD SYSTEM THIRD-PHASE EXPANSION - BUILDING C

LOCATION: LMC Middle River Complex
Middle River, Maryland

TETRA TECH

APPROVED	PAR	DRAWING:
DRAFTED	CMP	G3
PROJECT#	117-0512524	
DATE	09-02-21	

APPENDIX B— GEOPHYSICAL UTILITY INVESTIGATION REPORT

SUBSURFACE UTILITY ENGINEERING PROJECT COMPLETION REPORT

RETTEW

TO: Andrew Smith, Tetra Tech	
FROM: Bill Steinhart, RETTEW Field Services, Inc.	
CC: John B. Stipe III, RETTEW Associates, Inc.	
DATE: August 16, 2021	
CLIENT: Tetra Tech	PROJECT LOCATION: Middle River Complex Middle River, MD
PROJECT NO: 019872029	
PROJECT NAME: Tetra Tech QLB Drop Hammer Building	
TECHNICIANS: Daniel Hinton	
UTILITIES DESIGNATED:	**EQUIPMENT:**
• **Water line** • **Electric Conduit**	☒ EM Locator (RD8000/Metrotech) ☒ Ground Penetrating Radar (GPR) ☐ TW-6 (metal detector) ☒ C.A.T. Passive Locator ☐ Acoustic Leak Detector ☐ Magnetometer ☐ Integrity Assessment Camera ☐ Traceable Rodder ☒ Concrete GPR

SCOPE OF WORK

RETTEW completed a Subsurface Utility Engineering (SUE) survey to identify and designate utilities at seven proposed soil vapor point locations within the Drop Hammer Building, and one proposed soil vapor point location within Building C.

METHODOLOGIES

RETTEW first traced utilities with visible surface features (i.e. manhole covers, valves, utility poles, hydrants) utilizing the EM locator. RETTEW then searched the site for unknown utilities with GPR, the concrete GPR, and the passive utility locator.

RESULTS/CONCLUSIONS

On August 9, 2021, Daniel Hinton of RETTEW and Andrew Smith of Tetra Tech arrived on-site. Together they identified the proposed soil vapor point locations. The Drop Hammer Building had a reinforced concrete floor. Instruments utilized within the Drop Hammer Building were the EM locator and the concrete GPR. The soil vapor testing, proposed by Tetra Tech, requires a small penetration through the concrete. At each soil vapor point location, a small area clear of utilities was marked on the floor or asphalt. The soil vapor test locations are depicted below. Two water lines were marked on the concrete floor for the vapor point location in Building C. Rebar in concrete was marked at all vapor point locations. The soil vapor points are depicted below. Several of the points in the Drop Hammer Building were moved to avoid obstructions.

Enclosures: Client-provided schematics are included as **Attachment A**. Photos taken at the site are included in **Attachment B**.

RETTEW strives to provide quality and accurate locating services to all of its clients, but due to the nature of underground facilities, RETTEW will not be held liable for any damaged facilities. All clients are advised that they are required to follow their state's One-Call-Law before beginning excavation. The marks placed during this investigation are temporary markings for utility mapping purposes. The marks are not intended, nor should they be used, for construction; legal and/or recommended construction tolerance zones associated with the identified utilities were not marked by RETTEW. Prior to construction activities, RETTEW should be contacted for re-marking of the utilities and construction tolerance zones.

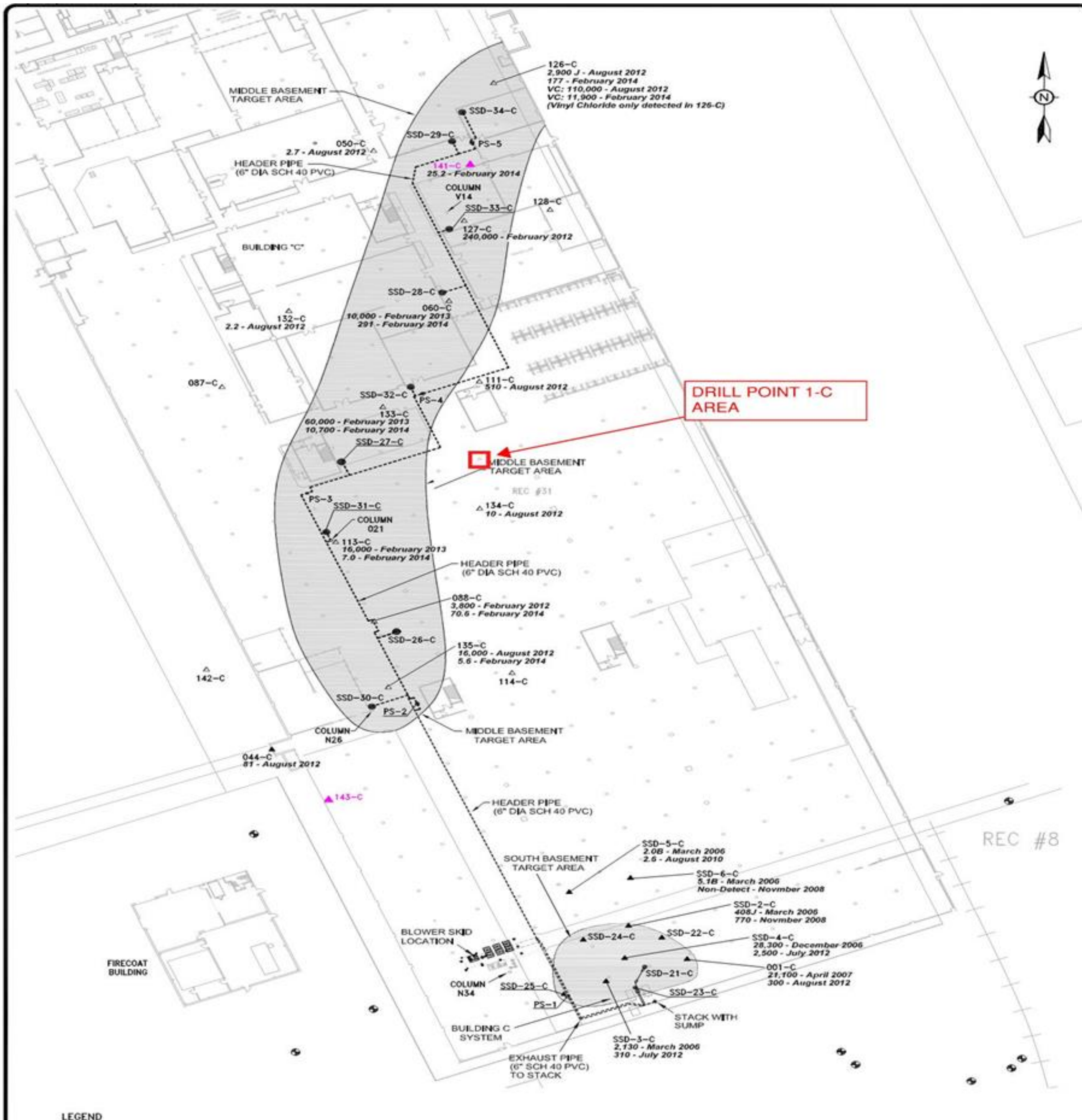
RETTEW will not guarantee the longevity of utility markings, due to activities on site that may destroy, or otherwise alter, the markings that were placed on the ground by RETTEW. If the marks have been altered or destroyed, the client is advised to contact RETTEW for re-markings. Any electronically determined depths provided to the client are estimates only, and due to equipment limitations, cannot be guaranteed. The client acknowledges that due to the limitations of the equipment used, safe exposure and measurements are the only methods which can precisely determine location and depth of structures marked.

PREPARED BY:	RECEIVED BY:
Daniel Hinton – Utility Locator	
______________________________	______________________________ (Name and Title)

ENCLOSURES

ATTACHMENT A

CLIENT-PROVIDED SCHEMATICS



LEGEND

- GROUNDWATER MONITORING WELL
- ▲ SUBSLAB VAPOR MONITORING POINT
- △ SUBSLAB VAPOR MONITORING POINT INSTALLED JANUARY 2010
- ▲ SUBSLAB VAPOR MONITORING POINT INSTALLED FEBRUARY 2013
- ● SUBSLAB VAPOR EXTRACTION WELLS
- • SUMP

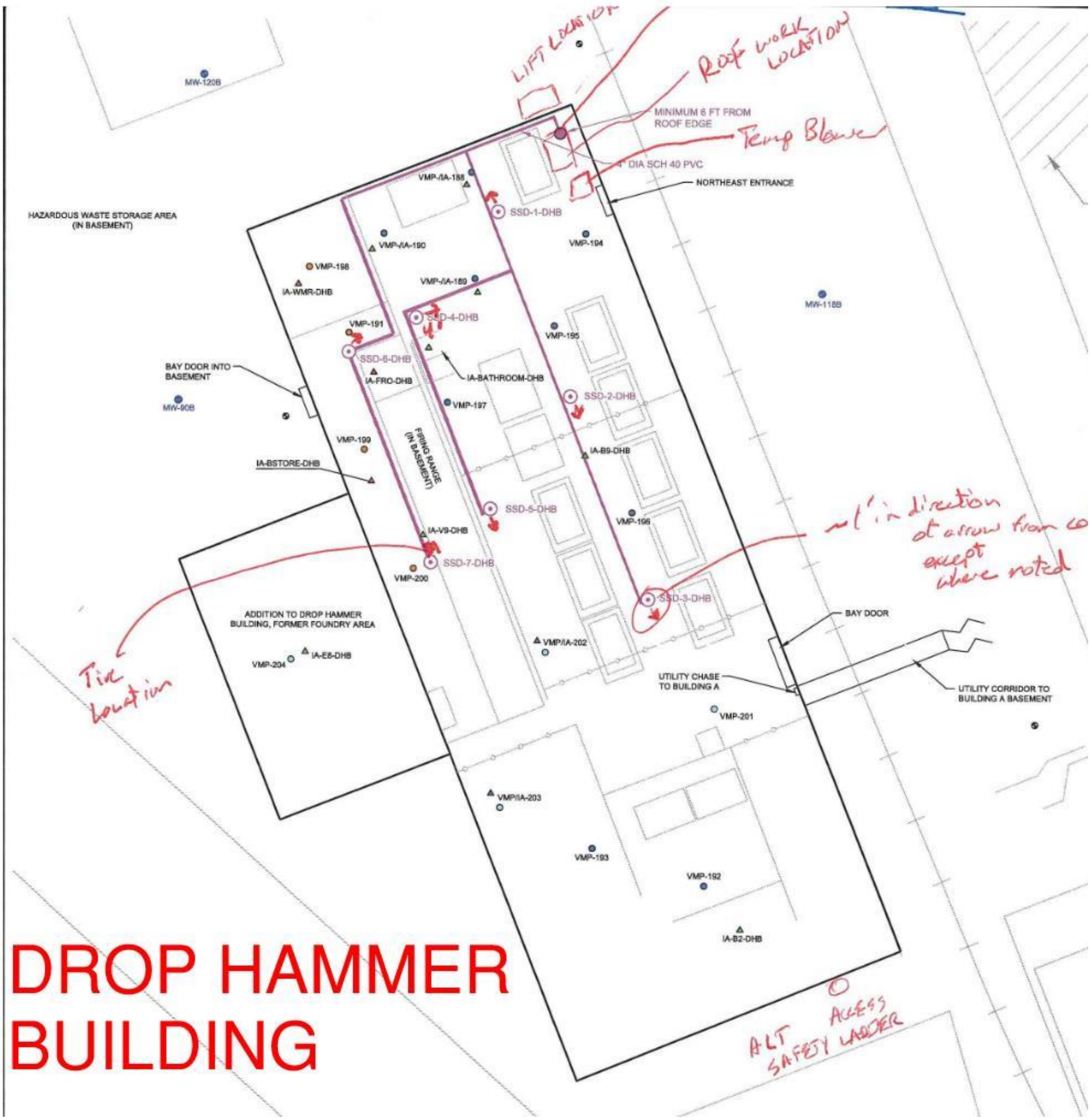
2,100	HIGHEST TCE CONCENTRATION ($\mu g/m^3$) PRE-SSDS AND MOST RECENT TCE CONCENTRATION POST-SSDS OPERATION
----	HEADER PIPE (2", 3" OR 6" DIA. SCH 40)
SSD	SUBSLAB DEPRESSURIZATION
2,900 J	ESTIMATED TCE CONCENTRATION
B	DETECTED IN LAB BLANK

TITLE: **BUILDING C SSD SYSTEM LAYOUT**

LOCATION: **Middle River, Maryland**

TETRA TECH

APPROVED	PR	FIGURE
DRAFTED	CP	2
PROJECT#	117-0507599	
DATE	9-19-14	



DROP HAMMER BUILDING
MW-120B
LIFT LOCATION
ROOF WORK LOCATION
MINIMUM 6 FT FROM ROOF EDGE
Temp Blower
4" DIA SCH 40 PVC
NORTHEAST ENTRANCE
HAZARDOUS WASTE STORAGE AREA (IN BASEMENT)
VMP-/IA-188
SSD-1-DHB
VMP-/IA-190
VMP-194
VMP-198
IA-WMR-DHB
VMP-/IA-189
MW-118B
SSD-4-DHB
VMP-191
VMP-195
SSD-6-DHB
BAY DOOR INTO BASEMENT
IA-FRO-DHB
IA-BATHROOM-DHB
MW-90B
VMP-197
SSD-2-DHB
VMP-199
FIRING RANGE (IN BASEMENT)
IA-B9-DHB
IA-BSTORE-DHB
SSD-5-DHB
VMP-196
IA-V9-DHB
SSD-7-DHB
VMP-200
SSD-3-DHB
BAY DOOR
ADDITION TO DROP HAMMER BUILDING, FORMER FOUNDRY AREA
VMP/IA-202
VMP-204
IA-E8-DHB
UTILITY CHASE TO BUILDING A
UTILITY CORRIDOR TO BUILDING A BASEMENT
Fire Location
VMP-201
VMP/IA-203
VMP-193
VMP-192
IA-B2-DHB
ALT SAFETY ACCESS LADDER

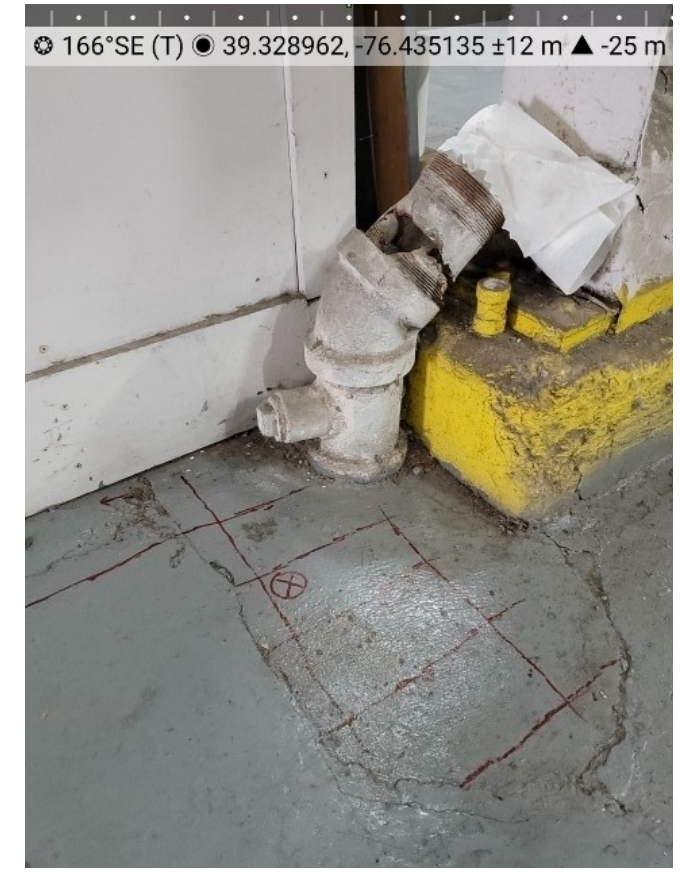
ATTACHMENT B

SITE PHOTOGRAPHS

Rebar locations at 1-DHB

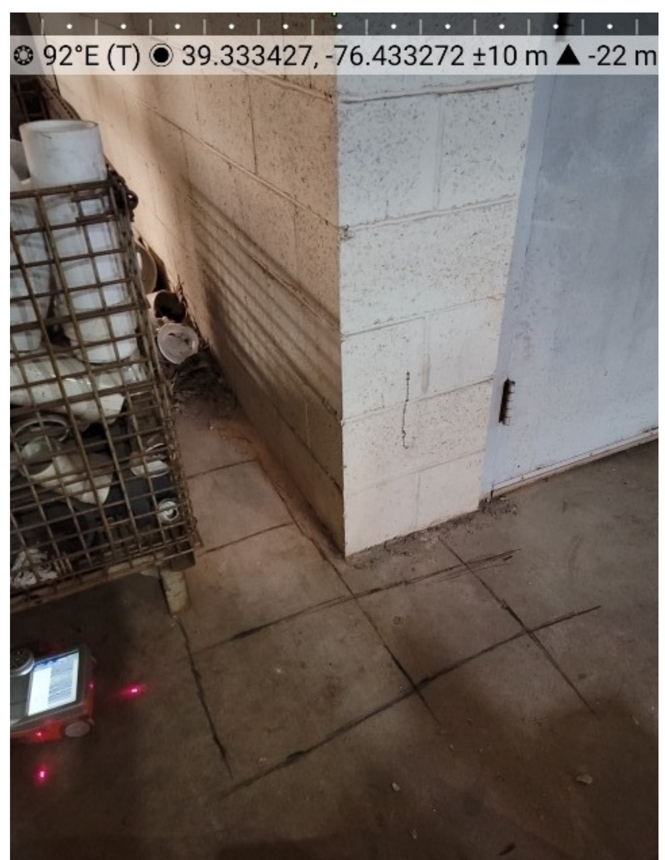
Rebar locations at 2-DHB

Rebar locations at 3-DHB

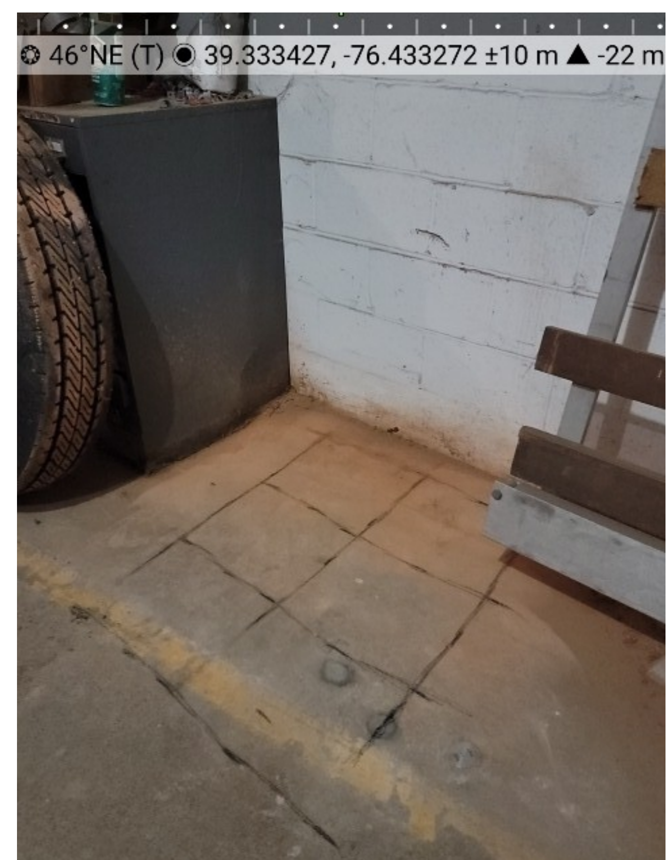


Rebar locations at 4-DHB

Rebar locations at 5-DHB



Rebar locations at 6-DHB



Rebar locations at 7-DHB

Rebar and water lines at 1-C

SURVEY DATE:	08/09/2021
PROJECT No.:	019872029
REVIEWED BY:	JBS
DRAWN BY:	DTH
DATE:	08/10/2021
SCALE:	—
FIGURE No.:	1OF 1

RETTEW℠
RETTEW Associates, Inc.
3020 Columbia Avenue, Lancaster, PA 17603
Phone (717) 394-3721 Fax (717) 394-1063

Baltimore County, MD

Attachment B: Site Photographs

Drop Hammer Building
103 Chesapeake park plaza
Middle River MD, 21220

Middle River

APPENDIX C—TECHNICAL SPECIFICATIONS AND EQUIPMENT LIST

[2" Pipe Plain End PVC Schedule 40 - Harrington Industrial Plastics (hipco.com)]

HARRINGTON
Process Solutions since 1959

PRODUCTS SOLUTIONS LOCATIONS RESOURCES ABOUT NEWSLETTER

2" Pipe Plain End PVC Schedule 40

Item #400-020

- Applications include transfer lines, plant service water, utility piping and potable water lines
- Material conforms to ASTM D- 1784
- Type 1, Grade 1, White PVC
- Meets or exceeds, ASTM D-2466 for socket-type PVC fittings
- Use with schedule 40 PVC pipe or IPS-sized class (SDR) pipe (Pressure-rated) systems
- Pressure rating of fittings is not the same as the pipe.
- IPS-sized (inches) 1/4-24"
- Schedule 40 pipe is not suitable for threading or grooving
- Pipe sizes 1/4" and 3/8" are grey in color; all other pipe is normally white
- Available in larger sizes on request
- Consult your sales person for size and pressure recommendation

Material
PVC

Category
Pipe

Size
2"

Pressure Rating
280 psi

Quantity: 1

Quote

Request Information

Schedule 40 PVC corrosion resistant pressure pipe, IPS sizes 1/8-24, is ideal for use in applications with temperatures up to and including 140 degrees F. Pressure rating (120 psi to 230 psi) varies with pipe size and temperature. It is generally resistant to most acids, bases, salts, aliphatic solutions, oxidants, and halogens. Chemical resistance data is available and should be referenced for proper material. Schedule 40 PVC pipe exhibits excellent physical properties and flammability characteristics. Typical applications include: chemical processing, plating, high-purity applications, potable water systems, water and wastewater treatment, irrigation and agriculture along with many other industrial applications involving corrosive fluid transfer. Schedule 40 pipe is not recommended for threading or grooving. If threading is required for the application, solvent-cemented male or female adapters should be utilized. If grooving is required, solvent-cemented grooved adapters are available in limited sizes.Do not test or use PVC piping for air or compressed gasses. Care should be taken to avoid ketones, chlorinated hydrocarbon, and aromatic solvents.

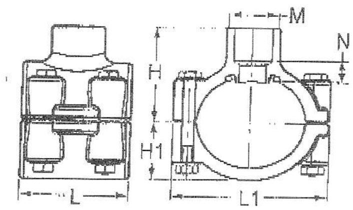
Category	Pipe
Material	PVC
PSI	280 psi
Size	2"
Sub Category 1	PVC Schedule 40

PVC WHITE SCHEDULE 40 FITTINGS UNIONS & SADDLES

CLAMP-ON SADDLE x SOCKET SINGLE OUTLET (continued)

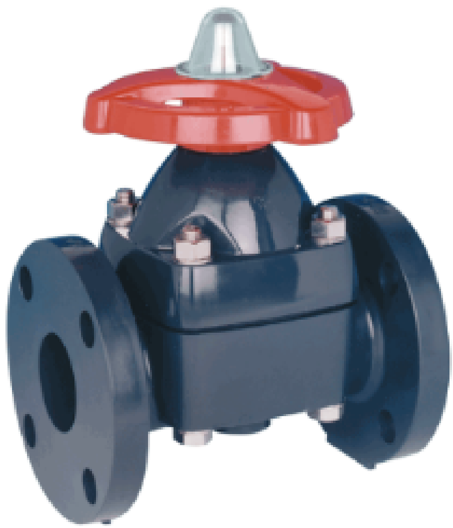
Dimensions Also Applicable to
466S-XXX 466E-XXX 466SE-XXX

Pressure Rating
2" - 4" 235 psi @ 73° F
6" 200 psi @ 73° F
8" - 12" 150 psi @ 73° F



Part Number	Size	H	H1	L	L1	M	N	Approx. Wt. (Lbs.)
466-336	3x1-1/4	4-1/32	2-1/16	4-3/32	4-5/8	3	1-1/32	1.47
466-337	3x1-1/2	4-1/32	2-1/16	4-3/32	4-5/8	3	29/32	1.41
466-338	3x2	3-5/8	2-1/16	4-3/32	4-5/8	3	3/8	1.25
466-415	4x1/2	4-3/32	2-5/8	3	5-9/16	2-3/8	31/32	1.31
466-416	4x3/4	4-3/32	2-5/8	3	5-9/16	2-3/8	27/32	1.28
466-417	4x1	3-13/16	2-5/8	3	5-5/8	1-11/16	7/16	1.24
466-418	4x1-1/4	4-13/32	2-5/8	4-3/32	5-5/8	2-3/8	29/32	1.70
466-419	4x1-1/2	4-1/8	2-5/8	4-3/32	5-9/16	2-3/8	1/2	1.63
466-420	4x2	4-3/16	2-5/8	4-1/8	5-5/8	3	7/16	1.70
466-421	4x2-1/2	5	2-5/8	5-7/16	5-23/32	4-9/32	3/4	2.82
466-422	4x3	4-5/8	2-19/32	5-7/16	5-11/16	4-1/4	1/2	2.41
466-523	6x1/2	5-13/32	3-7/8	3	7-3/4	1-11/16	1-7/32	2.35
466-524	6x3/4	5-7/16	3-7/8	3	7-3/4	1-11/16	1-1/8	2.33
466-525	6x1	5-1/8	3-7/8	3	7-15/16	1-11/16	11/16	2.29
466-526	6x1-1/4	5-15/16	3-7/8	4-1/8	7-3/4	3	1-3/8	3.26
466-527[1]	6x1-1/2	5-23/32	3-7/8	4-1/8	7-31/32	3	1-1/32	3.20
466-528	6x2	5-1/2	3-7/8	4-1/8	7-3/4	3	11/16	3.04
466-529	6x2-1/2	6-7/16	3-7/8	6	7-15/16	4-1/4	1-1/8	4.75
466-530	6x3	5-15/16	3-7/8	6	7-15/16	4-1/4	25/32	4.33
466-532	6x4	6	3-29/32	6	7-15/16	5-3/16	5/8	5.12
466-573	8x1/2	8-3/32	4-7/8	8-1/2	10-1/8	5-1/4	2-3/16	9.35
466-574	8x3/4	8-3/32	4-7/8	8-1/2	10-1/8	5-1/4	2-3/4	9.36
466-575	8x1	8-3/32	4-7/8	8-1/2	10-1/8	5-1/4	2-5/8	9.37
466-576	8x1-1/4	8-3/32	4-7/8	8-1/2	10-1/8	5-1/4	2-1/2	9.39
466-577	8x1-1/2	8-3/32	4-7/8	8-1/2	10-1/8	5-1/4	2-3/8	9.32
466-578	8x2	7-11/16	4-7/8	8-1/2	10-1/8	5-1/4	1-7/8	9.17
466-579	8x2-1/2	8-1/8	4-7/8	8-1/2	10-1/8	5-1/4	1-11/16	9.24
466-580	8x3	7-1/16	4-7/8	8-1/2	10-1/8	5-1/4	1-7/16	9.15

[1] Outlet sized with bushing



Asahi/America Type-14, 2" True Union Diaphragm Valve, PVC Body, EPDM Diaphragm, Socket Ends

Item #1526020

- True Union design permits installation or repairs without expanding pipeline
- Rugged square body and bonnet are of solid thermoplastic for maximum corrosion resistance
- Uniquely designed body and bonnet together with diaphragms of new sealing designs by the state-of-the-art computer aided analysis for superior sealing
- Weir design for excellent throttling
- Full vacuum rated
- Bubble-tight sealing, even in applications such as slurries or suspended particles
- Bonnet seals to protect internals from corrosive environments
- Adjustable travel stop to prevent diaphragm from being over-tightened
- Bayonet structure to connect compressor and diaphragm for quick maintenance
- Integrally molded bottom stand for simple yet firm panel mounting
- Indicator at the top for valve position
- PVDF gas barrier, which protects EPDM backing cushion from gas permeation, is standard for all valves with PTFE diaphragm
- Low profile

Type of product
True Union Diaphragm Valve

Series
Type-14

Manufacturer
Asahi/America

Connection Type
- - -

Quantity: 1

Quote

Request Information

sealing can be achieved even in tough applications containing suspended particles or slurrys. Asahi's Type-14 diaphragm valve features a layered EPDM/PTFE diaphragm which can accept the addition of a PVDF gas barrier for aggressive chemicals such as Sodium Hypochlorite. These aggressive chemicals produce an off-gas that can permeate the typical laminated PTFE layer and actually become delaminated in this highly corrosive environment leading to a potentially hazardous situation. The Type-14's 3-layer diaphragm which includes the gas barrier layer, prevents this from ever occurring. The Type-14 diaphragm valve body is of 1-piece molded construction and is not fabricated. For maximum corrosion resistance, the Type-14 diaphragm valve's rugged body and bonnet are manufactured of solid thermoplastic materials. The Type-14 diaphragm valve can be pneumatically or electrically actuated. Typical applications: Throttling, slurry lines, chemical processing, bleach plants, aquariums, mining, water treatment, landfills, swimming pools, semiconductor manufacturing.

Body Material	PVC
Diaphragm Material	EPDM
End Connection	S
End Connection Type	Socket
Manufacturer	Asahi/America
Operator	Manual Handwheel
Seal Material	EPDM
Series	Type-14
Size	2"
Type	True Union Diaphragm Valve

Related Products

Item # 400-020

EQUIPMENT LIST

1. Slotted polyvinyl chloride (PVC) piping: 2 feet, 0.020-inch slot, schedule 40, 2-inch diameter
2. PVC piping:
   a. 100 feet, Schedule 40, 2-inch diameter
   b. One 6-inch by 2-inch PVC saddle or Tee
   c. Couplings, elbows, tees, caps, reducers
3. Diaphragm valve: 2-inch diameter construction PVC, 150 pounds per square inch (PSI) rating
4. Primer: PVC primer
5. Cement: heavy bodied universal cement

TECHNICAL SPECIFICATIONS

APPENDIX D—PRESSURE LOSS CALCULATIONS

HEAD LOSS FOR SYSTEM COMPONENTS (220 CFM)

Building C Sub-Slab Depressurization System Third-Phase Expansion
Lockheed Martin Corporation, Middle River Complex

Suction Side Loss for System Components

Component	**Loss (inches water column)**
PVC Pipe	< 3
Pipe at Blower	< 6
Moisture separator	< 1
Filter	18 (worst case scenario)
Miscellaneous	< 3
Total	**<31**

Pressure Side Loss for System Components

Component	**Loss (inches water column)**
PVC Pipe	< 4
Pipe at Blower	< 6
Heat Exchanger	< 5
Moisture Separator	< 1
Flow Meter	< 4
Granular activated carbon (2)	< 10
Potassium permanganate zeolite	< 5
Miscellaneous	< 3
Total	**<38**

APPENDIX E—FMEA DOCUMENTATION

Area	List Nbr	Item / Function	Potential Failure Mode(s)	Potential Effect(s) of Failure	Sev	Causes	Prob	Detection	Det	RPN
	47	DHB - Penetrations in the Roof or Walls	Asbestos Released from penetrations made in the roof or walls	Worker exposed to Asbestos from penetration on the roof	5	Penetrating into roof or walls where asbestos is present	5	None	5	**125**
	43	Stack Stability (change to taller stack)	New stack falls	Increased health risk to workers in the building	5	Exhaust is drawn back into building through windows or intakes	3	None	5	**75**
	48	DHB - Penetrations in the Roof or Walls	Asbestos Released from penetrations made in the roof or walls	Additional Costs for abatement / schedule delay, tests, etc.	3	Penetrating into roof or walls where asbestos is present	5	None	5	**75**
	44	Stack Stability (change to taller stack)	New stack falls	Stack could fall off of building (injury or damage to vehicle/property)	5	Weather conditions - High Winds	2	None	5	**50**
	46	Not in Current Design - Drop Hammer System Failure	System shuts off (> 5 days)	Loss of Treatment Tenant Complaints	4	Power Outage Mechanical Failure (Blower)	3	Monitoring inspections (2 Weeks)	4	**48**
	10	Not in Current Design Fail-Safe Alarms - Drop Hammer	Normally-open circuits do not close properly	System would be off/down for a longer period of time.	3	Power Outage	3	None besides knowing A and C buildings lost power Check every two weeks	5	**45**
	34	Safety	Installer falls during aboveground piping installation / Roof work	Personal Injury	5	Installer error/carelessness Lack of oversight Weather (high winds/storm)	2	Visual - immediate Oversight Installation procedures JHAs	4	**40**
	41	System operation without GAC treatment	Indoor air concentrations exceed acceptable levels	Potential for Increased health risk to workers in the building	5	Exhaust may be drawn back into building through windows or intakes	2	Indoor air Monitoring performed semi-annually in Drop Hammer Building and Building A basement; annually everywhere else	4	**40**
	2	Blower - Drop Hammer	Thermal Overload Switch fails	Potential to burn out the motor (system shut down)	4	Mechanical failure	2	Quarterly inspection and maintenance of blower/equipment	4	**32**
	3	Blower - Drop Hammer	Blower fails	System not operating, no suction	4	Mechanical failure	2	Quarterly inspection and maintenance of blower/equipment	4	**32**
	4	Blower - Drop Hammer	Motor fails	System shutdown	4	Mechanical failure	2	Quarterly inspection and maintenance of blower/equipment	4	**32**
	28	Piping - Installation overhead	Material / Tools fall from overhead	Injury - Workers or Tenant	5	Installation error / carelessness / accident	2	Tailgate Meetings JHAs Project Oversight	3	**30**

Area	List Nbr	Recommended Action(s)	Responsibility & Target Completion Date (Completion Date = Mid February unless otherwise specified)	Response	Actions Taken	New Sev	New Occ	New Det	New RPN
	47	1) Review facility assessment pertaining to Asbestos and update JHAs and Workplans accordingly 1) Contact Abatement Contractor to work with subcontractor for all penetration work 2) Ensure any Asbestos containing Material is disposed of at an LM Approved Asbestos disposal site (ex: Minerva, OH) 3) Complete an Alteration Request (from Rina) for roof work, asbestos abatement, and piping and submit to LMCPI prior to start of work	1) TT - Prior to 100% Final 2) TT - Ongoing 3) TT / LMC - Prior to 100% Final						
	43	Incorporate into 100% design - support for extended stack 10-ft above roof line	TT - Prior to 100% Design						
	48	1) Review facility assessment pertaining to Asbestos and update JHAs and Workplans accordingly 1) Contact Abatement Contractor to work with subcontractor for all penetration work 2) Ensure any Asbestos containing Material is disposed of at an LM Approved Asbestos disposal site (ex: Minerva, OH) 3) Complete an Alteration Request (from Rina) for roof work, asbestos abatement, and piping and submit to LMCPI prior to start of work	1) TT - Prior to 100% Final 2) TT - Ongoing 3) TT / LMC - Prior to 100% Final						
	44	Incorporate into 100% design - support for extended stack 10-ft above roof line							
	46	- Need to be aware of shutdown within 24 hours window - Evaluate costs and pros/cons of installation of a camera monitoring system vs equipment/ auto-dialer	TT - Prior to 100% Final						
	10	- Currently, DHB system has no fail safe alarms in design - Applies if a monitoring system (auto dialer, etc.) is incorporated in the Drop Hammer system design - Incorporate same alarm setting as A and C buildings (normally closed)	TT - Prior to 100% Final						
	34	- Include Chris Keller's evaluation of the safe roof access JHA and workplan for DHB roof work (follow EO-20 command media guidance) - Consider safety precautions for	TT - Prior to 100% Final (HASP)						
	41	- Consider conducting indoor air sampling in DHB after system startup in Nov/Dec 2021	TT - 1Q 2022						
	2	- Suggest having a spare blower on site - Update Operating Plan / Spare Parts List	TT - Prior to System Startup						
	3	- Suggest having a spare blower on site - Update Operating Plan / Spare Parts List	TT - Prior to System Startup						
	4	- Suggest having a spare blower on site - Update Operating Plan / Spare Parts List	TT - Prior to System Startup						32
	28	Add language to close off work areas in Specs and HASP during overhead installations	TT - Prior to 100% Final						

Area	List Nbr	Item / Function	Potential Failure Mode(s)	Potential Effect(s) of Failure	Sev	Causes	Prob	Detection	Det	RPN
	33	Power connection - DHB (Blower to power source)	Blower installed improperly	Roof damage / leak	4	Weather (heavy storms or high winds) seeping into the roof because of installation penetrations	2	Construction oversight / awareness	3	**24**
	39	Vacuum Relief Valve	Vacuum Relief Valve failed to open designed operating conditions	Thermal overload to the system and system shutdown	3	Mechanical failure	2	Bi-weekly inspections	4	**24**
	45	Waste Management	Waste Generated not disposed off at LM Approved facility or documented with a DD form	Violation of ESH-06 Potential violations of State or Federal Law	4	Inadequate planning	2	Verification with subcontractors and personnel that disposal facilities are in LM Approved list Overall sitewide waste management plan	3	**24**
	11	Not in Current Design Flow Indicator - Drop Hammer	Flow Indicator failure	Mass removal measurement will not be as accurate with the flow indicator measurement	2	Mechanical failure	2	Is not in current design Can Calculate flow in bi-weekly inspections	5	**20**
	18	Installation / Decomissioning of skid - DHB Temporary (1 month)	Improper removal / installation of electrical equipment	Severe Personal Injury/Electrical Shock	5	Not following LOTO Improper Training Worker carelessness	2	Electrical checks conducted during pre-work LOTO procedures Facility Communications / Input Tailgate Reminders prior to decomissioning / Installation	2	**20**
	30	Extraction points - installation	Utility damage while installing extraction points (drilling)	Personal Injury	5	Operator error Wrong Drilling Location Lack of oversight	2	Utility Clearance Facility Dig Permit	2	**20**
	19	Low Points Sumps - DHB	low point fills with water	system flow is reduced or eliminated from specific extraction points	3	Condensation of water from wells Heavy Rains	3	Inspection every two weeks. O&M Manual checklists will identify all checkpoints	2	**18**
	27	Piping from extraction points to system (above ground)	Pipe or joint failure	Loss of vacuum in extraction points	3	Material failure or physical damage	2	Inspection conducted every two week Tenant notification	3	**18**
	26	Piping	Utility damage while hanging pipe	Distruption of facility ops	4	Installer error/carelessness Lack of oversight	2	Visual - immediate Project oversight	2	**16**
	31	Extraction points - installation	Utility damage while installing extraction points (drilling)	Power / Utility Loss to Facility	4	Operator error Wrong Drilling Location Lack of oversight	2	Utility Clearance Facility Dig Permit	2	**16**
	35	Sample taps	Left open	release to environment	2	Operator error or occupant operator tampering	2	Every two weeks SSDS Inspection	4	**16**
	1	Balancing flow from extraction points	Reduced flow from individual points	Sub slab zone of influence could be inadequate or not according to design	3	Incorrect adjustment of valves Heterogeneity of subsurface Tubing/Piping failure (clogged, broken, etc.)	2	Flow-detectors at extraction and vapor monitoring points every 2 weeks Measuring points at each well Diaphragm valve for flow throttling	2	**12**
	5	Blower - Drop Hammer	Not getting vaccuum coverage under the building	Inadquate vaccuum at well	3	Blower undersized	2	Bi-weekly inspection of flow and vapor pin monitoring	2	**12**
	6	Dilution Filter - A / C Buildings	Valve to the dilution filter could be left open (blower ambient air valve)	Performance of system would be severely reduced due to suction through valve	3	Operator error or occupant operator bumping or tampering	2	Every two week inspection (confirmed close)	2	**12**
	7	Extraction points	Silt clogging of point	Loss of flow from these points	3	Native soil collecting into the extraction point	2	Inspection conducted every two week, flow measurement from each point, trends could detect.	2	**12**
	8	Extraction Points	Concrete Shrinkage and Cracks	Potential to have loss of vacuum and reduced capture of VOCs	3	Physical damage or intentional breach of concrete	2	- occupant contract requires notification of LMCPI to do building mods - Every two week inspection	2	**12**

Area	List Nbr	Recommended Action(s)	Responsibility & Target Completion Date (Completion Date = Mid February unless otherwise specified)	Response	Actions Taken	New Sev	New Occ	New Det	New RPN
	33	Suggest adding specifics to check roof penetrations post-construction - Update design specs	TT - Prior to 100% Final						
	39	- Add a vaccuum relief valve to design (DHB) - Update Operating Plan to include annual testing of relief valves	TT - prior to 100% Final						
	45	- Add languge to Construction Quality Control plan to ID potential waste streams and manage waste to Lockheed Martin Policy	TT - Prior to 100% Final						
	11	- Currently, DHB system has no flow indicator in design - Applies if a monitoring system (auto dialer, etc.) is incorporated in the Drop Hammer system design - Revisit if autodialer system is installed	TT - Prior to 100% Final						
	18	Confirm JHAs for specific activities reviewed prior to starting	TT - Temp System Startup and Switch to permanent System						
	30	Follow Standard procedure for facility	TT - ongoing						
	19	- Recommend inspection every week in the winter when A-Building inspections occur - Update Operating Plan	TT - Prior to 100% Final						
	27	- Install bollards per LM and tenant's preference - Evaluate scenario for pipe break / joint failure and no notification for 13 days - May need to perform indoor air sampling (SUMA canister) - Update O&M Manual as needed	TT - Prior to 100% Final						
	26	- Verify piping Run prior to installation - Tailgate discussions prior to activitiy	TT - ongoing						
	31	Follow Standard procedure for facility	TT - ongoing						
	35	None							
	1	Continue current frequency on monitoring	TT - ongoing						
	5	- During initial operations of full scale system, suggest more frequent monitoring (once a week) - Update start up plan	TT - Prior to System Startup						
	6	- Suggest exercising valve as part of annual inspection - Update Operating Plan	TT - 4Q 2021 Prior to system Startup						
	7	- Check bottom of well for material build up annually or biannually (depending on findings) - Update Operating Plan	TT - 4Q 2021 Prior to system Startup						
	8	-Based on observations recommend Use of a smoke pen to inspect cracks on the floor to detect movement of smoke in cracks to inspect how adequate the seal of the floor is (Annualy or as needed) - Communicate with occupant prior to conducting smoke pen inspection - Consider additional markings to label	TT - 4Q 2021 Prior to system Startup						

Area	List Nbr	Item / Function	Potential Failure Mode(s)	Potential Effect(s) of Failure	Sev	Causes	Prob	Detection	Det	RPN
	9	Extraction points	Water accumulation in the sub slab	Reduced capture of VOCs	3	High Groundwater, plant releasing water affecting subslab, storm	2	Measurement of Flow (every 2 weeks) and applied vaccuum at extraction points and checking condensate removed from piping system.	2	**12**
	12	GAC drums - DHB Temporary (1 month)	Carbon break through	release to environment	3	- Concentrations of VOCs in sub-slab-vapor higher than anticipated in design - Supplier provides off-spec carbon	2	Effluent sampling at end of 28-day start-up period Influent vapor samples on day 2 & 14	2	**12**
	32	Power connection - DHB (Blower to power source)	Blower fails	Damage to Blower	3	Weather (heavy storms or high winds)	2	NEMA rated cabinet Bi-weekly inspections	2	**12**
	37	Startup	Functional test results don't result as designed	Schedule delay - send back faulty equipment to vendor or vendor repair on-site	3	Faulty equipment provided by vendor	2	Visual during startup Equipment testing prior to startup	2	**12**
	38	Startup	Functional test results don't result as designed	Re-design / schedule delay / cost impacts	3	Error in Design	2	Performance Testing	2	**12**
	40	Vapor Transfer lines from new point to system	Water accumulation in the lines	Reduction of air flow Reduction of system performance	2	Condensation Weather conditions (Winter)	3	Inspection of sumps every two weeks or every week in winter	2	**12**
	25	Moisture Separator - DHB Temporary (1 Month)	Operator ergo injury draining water (gravity drain)	injury	5	location of drain valve	2	Oversight - Operator Awareness Operating Procedures / JHA	1	**10**
	42	System operation without GAC treatment	Permit limits are exceeded	Notice of violation	5	Extracted concentrations exceed expectatations (20 lb/day)	1	SSDS effluent concentrations measured [2 & 14 days during startup ; quarterly during normal operations]	2	**10**
	22	Moisture Separator - DHB Temporary (1 Month)	Level Switch High fails to indicate high water with MS (float switch)	Flood the blower (amperage overload on the blower) Shut system down	4	Mechanical failure	2	- Testing and Visual inspection at startup - Weekly visual inspection (sight glass)	1	**8**
	36	Skid - DHB Temporary (1 month)	Damaging new skid during unloading/installation	Possible repair work for skid Schedule delay (~1 wk)	2	Loading equipment not suited for purpose Operator error	2	Visual inspection of skid pre/during unloading/installation Project oversight Qualified Operator requirement	2	**8**
	13	GAC drums - DHB Temporary (1 month)	Seal on the rim fails	release to environment	3	Manufacturer defect (not sealed properly)	2	- Drum inspection prior to startup (soap test) - Weekly visual inspection	1	**6**
	14	Hose to GAC - DHB Temporary (1 month)	Hose failure (crack or fatigue)	release of untreated air to environment	3	stress points (short radius bends)	2	- Soap test and connections to fittings at Startup - Visual inspection at startup and every two weeks	1	**6**
	15	Hose to GAC - DHB Temporary (1 month)	Camlock connection fails	release of untreated air to environment	3	Operator error or occupant operator tampering	2	- Testing and visual inspection at startup - Cotter Pins to ensure camlocks are in place. - Zip ties installed to prevent tampering)	1	**6**
	16	Hose to GAC - DHB Temporary (1 month)	Camlock barb and hose joint failure	release of untreated air to environment	3	wear or over tightening	2	- Testing and Visual inspection at startup - Weekly visual inspection - Hoses replaced as necessary	1	**6**
	17	Hose to GAC - DHB Temporary (1 month)	Material incompatibility between PVC, CPVC and aluminum fittings	release of untreated air to environment	3	wear or over tightening	2	- Testing (soap) and Visual inspection at startup - Weekly visual inspection - Hoses / piping replaced as necessary	1	**6**

Area	List Nbr	Recommended Action(s)	Responsibility & Target Completion Date (Completion Date = Mid February unless otherwise specified)	Response	Actions Taken	New Sev	New Occ	New Det	New RPN
	9	Continue current frequency of flow monitoring for the new system	TT - ongoing						
	12	- Suggest additional effluent sampling on day 14 in addition to day 28 - Update Start up Plan	TT - Prior to 100% Final						
	32	None							
	37	None							
	38	None							
	40	None							
	25	Reminders and JHAs Review prior to activity	TT - ongoing						
	42	None							
	22	None							
	36	None							
	13	- Ensure project team is following startup plan and all testing and visual inspection	TT - System Startup						
	14	- Ensure project team is following startup plan and all testing and visual inspection	TT - System Startup						
	15	- Ensure project team is following startup plan and all testing and visual inspection	TT - System Startup						
	16	- Ensure project team is following startup plan and all testing and visual inspection	TT - System Startup						
	17	- Ensure project team is following startup plan and all testing and visual inspection	TT - System Startup						

Area	List Nbr	Item / Function	Potential Failure Mode(s)	Potential Effect(s) of Failure	Sev	Causes	Prob	Detection	Det	RPN
	20	Measurement Vacuum Suction - DHB	Faulty gauge used for Vacuum Measurement (weekly)	Incorrect adjustments to the system (area of influence would potentially be set incorrectly)	3	Mechanical failure	2	Multiple measurement points for gauge. Historical Data for comparison Operator should know that gauge is faulty	1	**6**
	21	Moisture Separator - DHB Temporary (1 Month)	Drain Valve on Moisture Separator left open	potential to release contaminated air and water to environment	3	Operator error or occupant employee tampering	2	- Testing and Visual inspection at startup - Weekly visual inspection	1	**6**
	23	Moisture Separator - DHB Temporary (1 Month)	Break of sight glass on Moisture Separator	potential to release contaminated air and water to environment	3	Operator error or occupant operator tampering or accident	2	Weekly Inspections Communications to Emlpoyees in area	1	**6**
	29	Piping from point to system	Inadvertent closing of the valve	No suction and removal of sub slab VOCs (ineffective system)	3	Operator error or occupant tampering	1	Inspection conducted every two week Locked valve	2	**6**
	24	Moisture Separator - DHB Temporary (1 Month)	MS water stored in 5 gallon pail could get knocked over	Release of potentially contaminated water to environment	2	Operator error or occupant operator tampering	2	Operating Procedures	1	**4**

Area	List Nbr	Recommended Action(s)	Responsibility & Target Completion Date (Completion Date = Mid February unless otherwise specified)	Response	Actions Taken	New Sev	New Occ	New Det	New RPN
	20	- Have access to spare gauge as necessary	TT - Prior to Inspections						
	21	None							
	23	Suggest whatever best orientation is to keep away from traffic	TT - prior to startup						
	29	None							
	24	None							

APPENDIX F—BUILDING C SSD SYSTEM CHECKLISTS

PRE-STARTUP EQUIPMENT INSPECTION CHECKLIST

SUB-SLAB DEPRESSURIZATION SYSTEM THIRD-PHASE EXPANSION

Building C, Middle River Complex, Middle River, Maryland

ITEM	YES/NO/NA	COMMENTS
Extraction Wells and Piping		
Piping installed as required? *(2-inch PVC for SV-35-C*)		
Pipe supports installed as required? *(Spaced every 3 to 5 feet for wall piping; every 6-8 feet for ceilling piping)*		
Valves installed as required and operational? *(2" diameter Diaphragm valves; 150 psi rating)*		
Valve locks installed as required? *(Master Lock 6 ft. adjustable cable lockout device or similar)*		
Sample/Measuring points installed as required? *(Below diaphragm valves at each extraction well; 1/4" NPT with Teflon tape)*		
Extraction well labeled appropriately? *(SV-35-C; self-adhesive labels)*		
Header piping labeled appropriately? *(self-adhesive "vacuum" labels approx. every 50 feet)*		
Extraction well piping properly tied into header pipe? *(PVC Saddles, Schedule 40 clamp-on saddle x socket single outlet type)*		

ITEM	YES/NO/NA	COMMENTS
Miscellaneous		
As-Built Drawings submitted?		
Bollard installed as required by the facility? *(2-inch dia., Schedule 40 welded and seamless steel pipe, 1/4-inch steel diamond plate - anchor type, painted yellow)*		
Summa canisters on-site for process vapor sampling if required per current system sampling schedule? *(One, 1-liter canister for TO-15 analysis of influent sample)*		

Tetra Tech Rep: Name ___________________________ Signature _____________________________ Date _______

S&S Tech Rep: Name ___________________________ Signature _____________________________ Date _______