Vapor Intrusion Mitigation Design, Implementation, and OM&M

Matthew Williams
Volatilization to Indoor Air Specialist
Remediation and Redevelopment Division EGLE
517-881-8641
williamsm13@michigan.gov

Paul French
Sr. Hydrogeologist
fishbeck
Engineers | Architects | Scientists | Constructors
w: 269.544.6958 c: 269.365.7060
pfrench@fishbeck.com

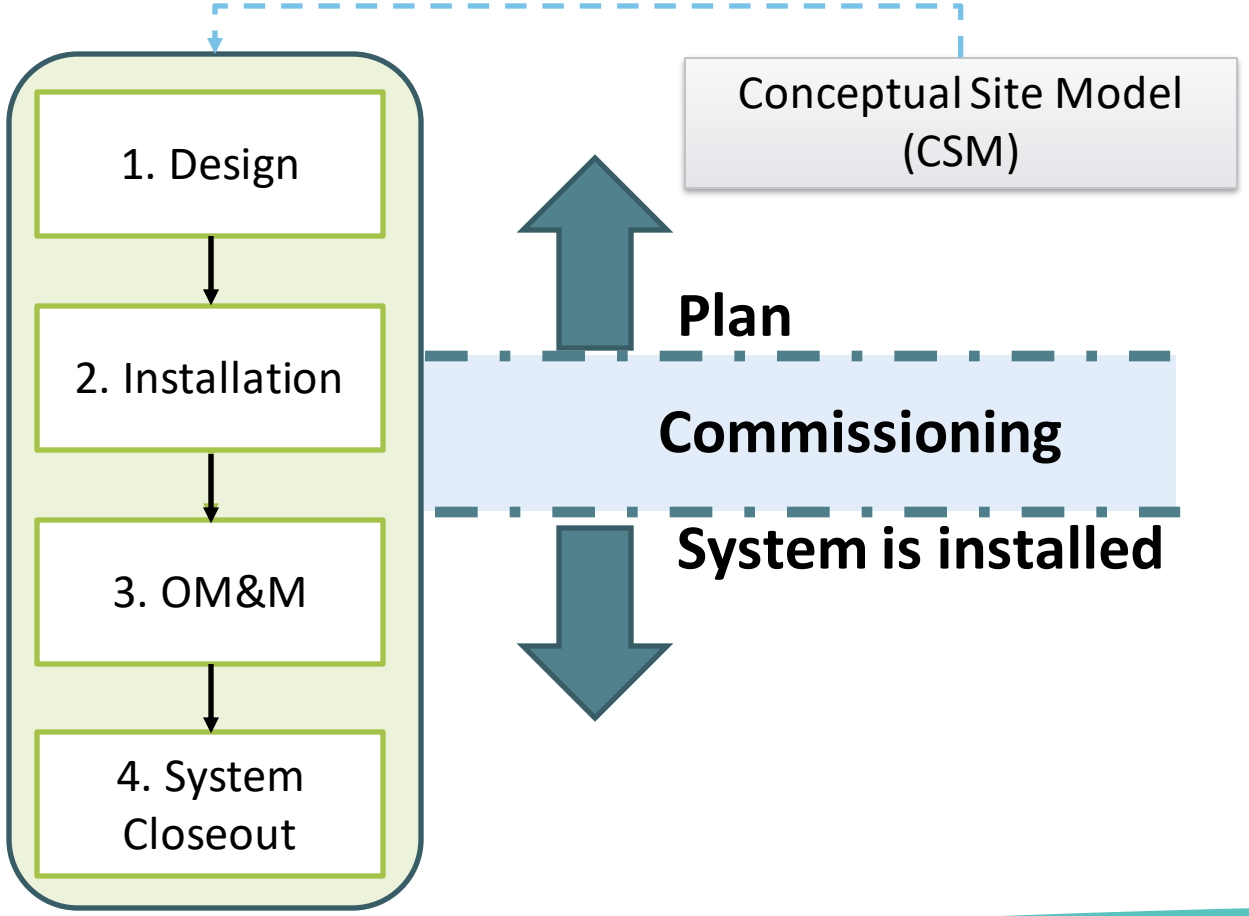
Today

- Background
- Table of Contents for Active and Passive Vapor Mitigation Systems (VMS)
- Case Study

Background and History

- Multiple stakeholder groups approach EGLE to modify the review process
  - Time consuming
  - Inconsistent reviews and feedback
  - Kept undergoing a stacking effect
- EGLE needed a process to:
  - Get more staff involved with the process and able to make consistent decisions
  - Better inform on what information should be contained in a submittal

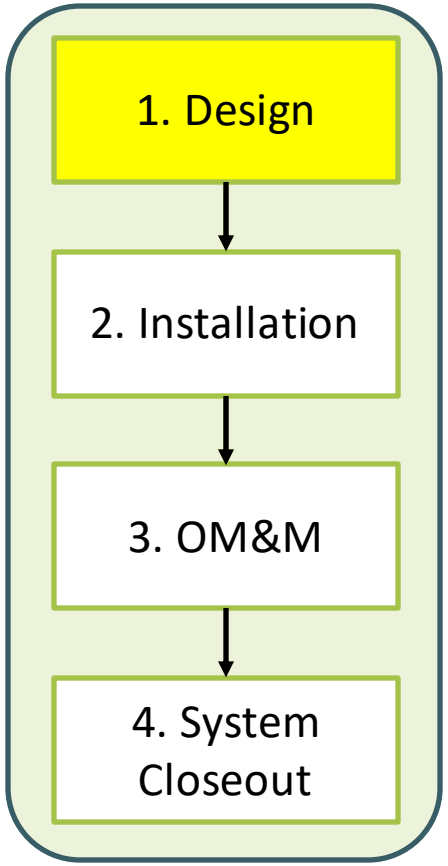
Identifying the Major Points/Steps of a Vapor Mitigation System (VMS)



Mitigation Installation and Commissioning

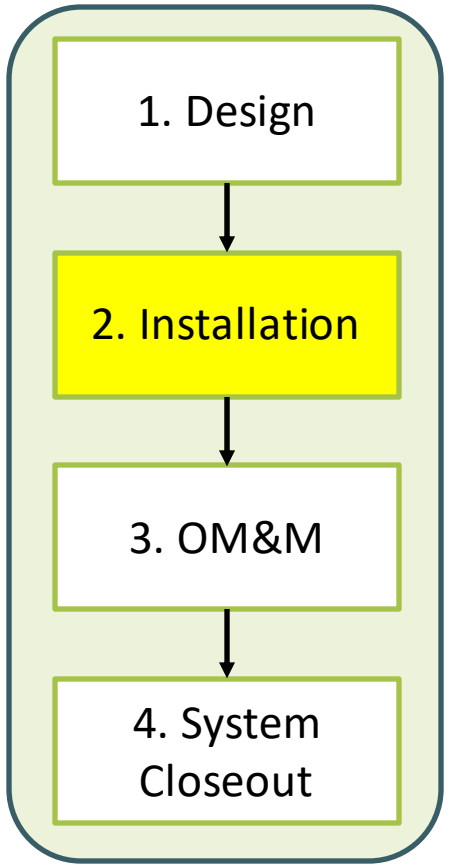
- Not installed until after it goes through "commissioning"
  - Additional changes and modifications occur
  - Some changes can be major
- Must be completed prior to OM&M

Design of a VMS



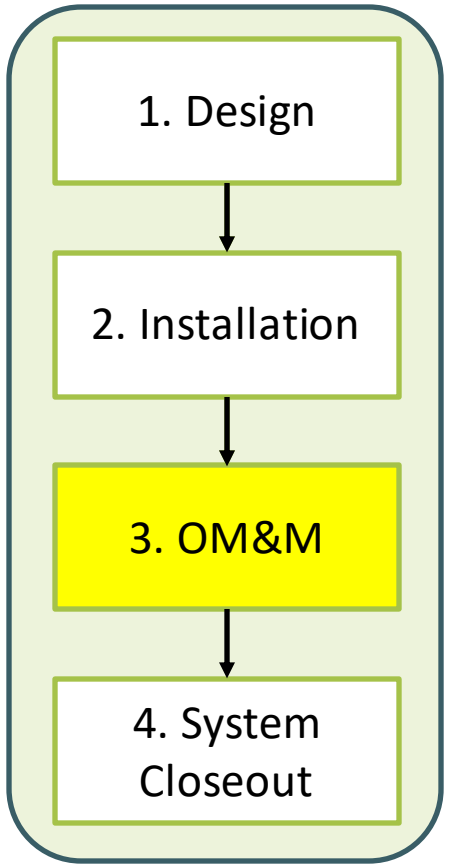
- Information necessary to ensure the proposed system has a reasonable potential of mitigating unacceptable exposures
- Identifies performance metrics, how and where they are measured, why they are appropriate for the design,
- Includes: a description of the overall goal of the VMS, an understanding and discussion of how the VMS will function, the specific performance metrics used to verify function, and an outline of the OM&M program.

Installation and Commissioning of a VMS



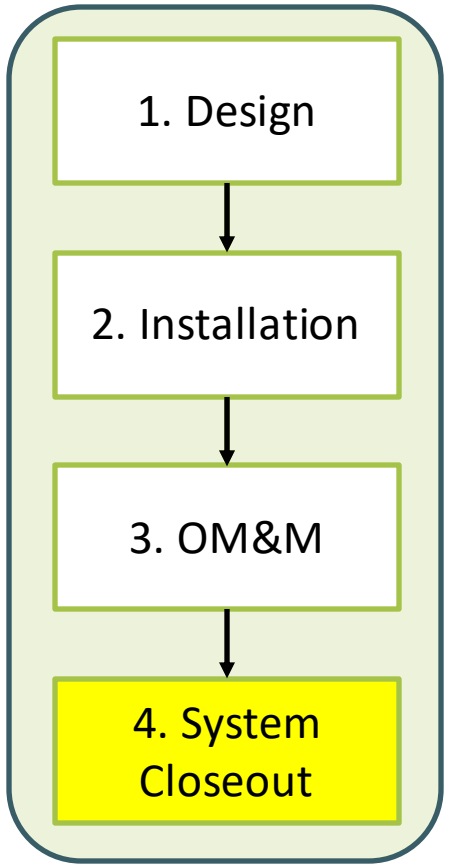
- System is fully installed and successful in mitigating the risk under the expected range of site conditions (i.e., commissioning)
- Commissioning also is the process used to establish and confirm the necessary operational parameters
- Report includes:
  - System commissioning information
  - Final performance metrics
  - Monitoring locations
  - As-built drawings
  - Identifies the expected OM&M Plan

Operation, Maintenance, and Monitoring (OM&M)



- Ensure the continued operation and that the system is:
  - Maintained
  - Undergoes repairs or preventative maintenance
- Identifies:
  - Documentation to be collected and the process
  - Alarms addressed
  - How repairs or modifications to VIMS should be handled
  - How quickly things need to happen

System Closeout



- The purpose this phase is to demonstrate the vapor source(s) no longer pose an unacceptable risk
- VERY site-specific
  - How long does it take for the site to stabile and return to “normal” conditions
- Documentation includes verification that vapors no longer pose an unacceptable health risk and mitigation is no longer necessary

2024 VIAP Guidance Update

- Volume 1 – Volatilization to the Indoor Air Pathway (VIAP) Overview
- Volume 2 – Investigation Methods for the Volatilization to the Indoor Air Pathway (VIAP)
- Volume 3 – Investigation Approach for Volatilization to the Indoor Air Pathway (VIAP)
- Volume 4 – Investigative Approach for Petroleum Volatilization to the Indoor Air Pathway (VIAP)
- Volume 5 – Response Activity
- Volume 6 – Volatilization to the Indoor Air Criteria
- Volume 7 – Updates

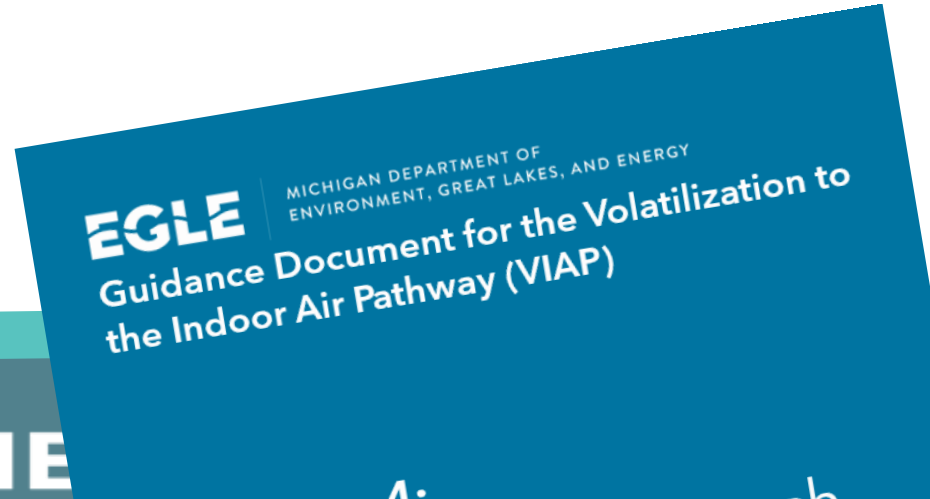
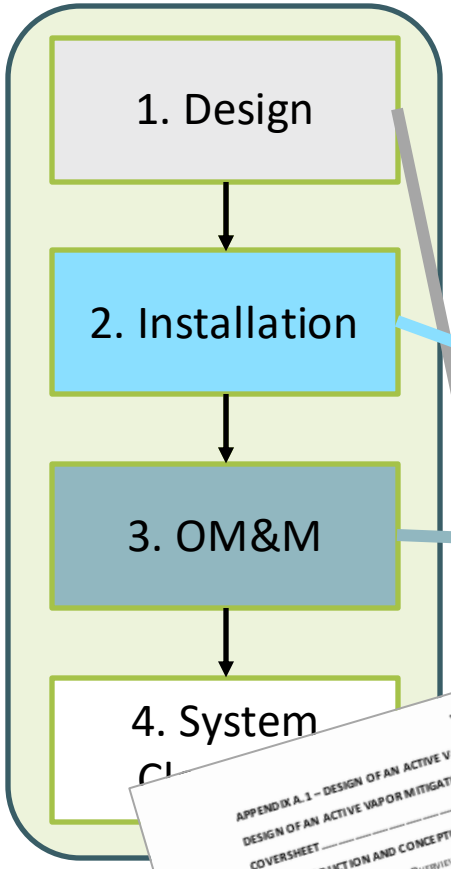


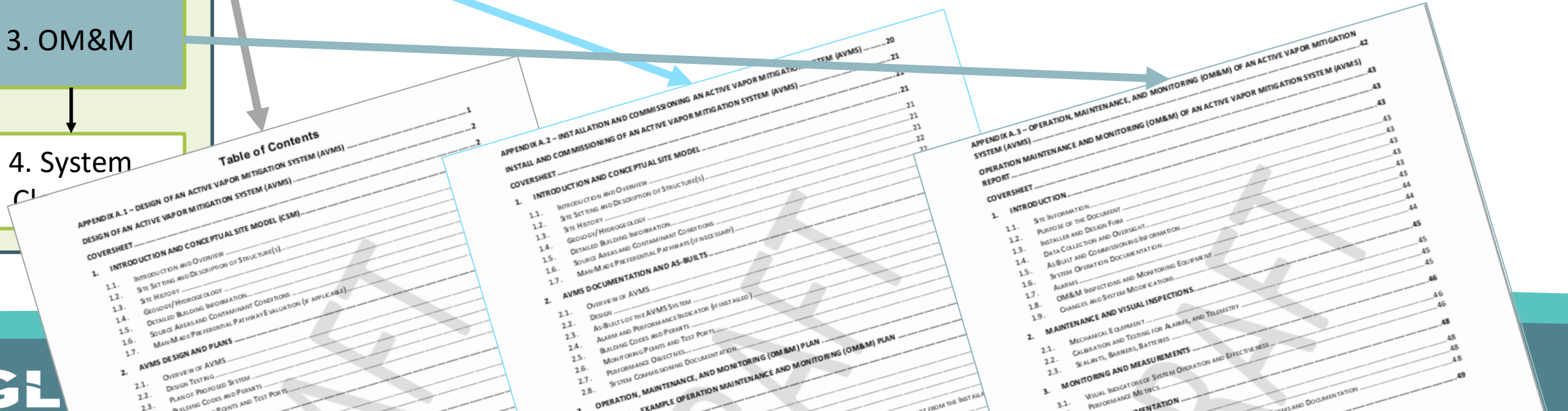
Table of Contents

- Replaces the mitigation checklists
- Developed with multiple stakeholder input and in accordance with published standards
- Establishes a “template” for each phase or bucket

How does it differ from a checklists?



- Requests the same information but makes it clearer how the information should be provided
- Clarifies where to put the information
- Sets up for success!



Describes and Identifies Information

1.5. Detailed Building Information

1.5.1. *Below Grade Building Features and Foundations*

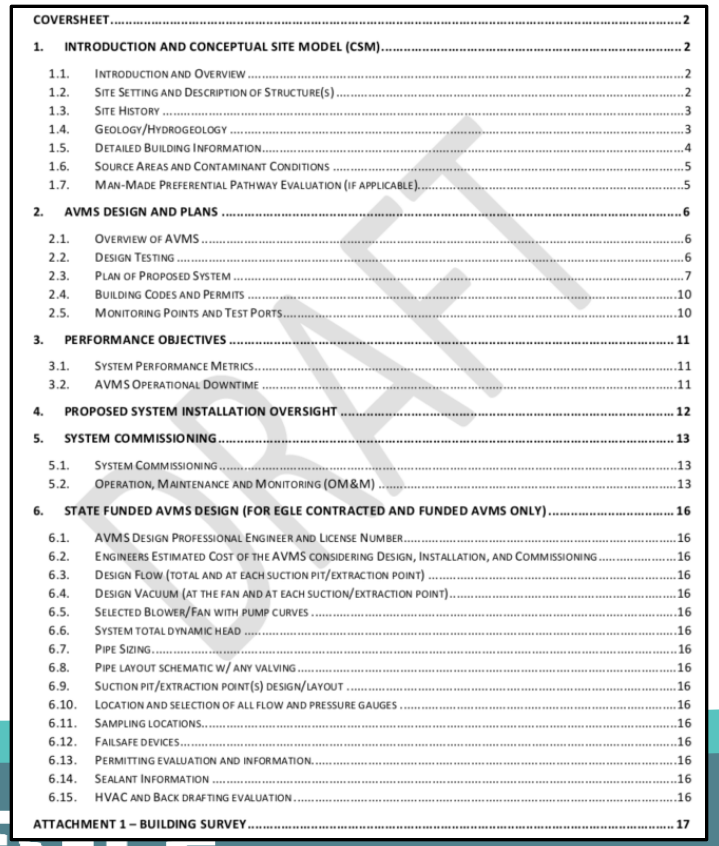
This section should describe the foundation type (i.e., footings, pier, columns, cast pilings, etc.) and building portions that are below grade (basements, crawlspaces, elevator sumps, pits, utilities, tunnels, etc.) that are in contact with the soil or the groundwater. If there are any foundations that are unknown that may impact the function of the AVMS, they should be identified here and addressed in Section 2.2.

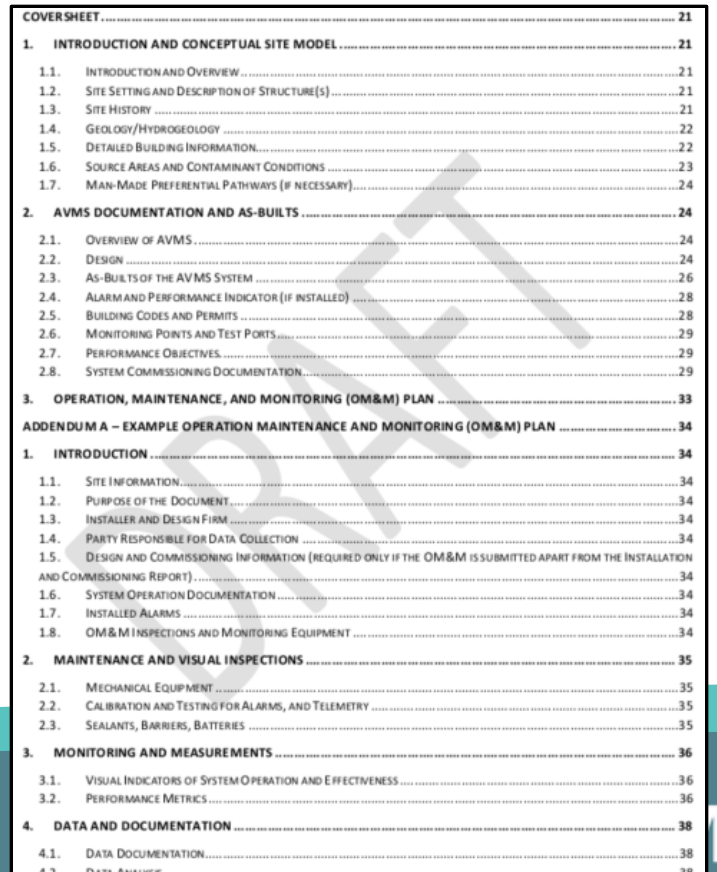
KEY SUPPORTING INFORMATION

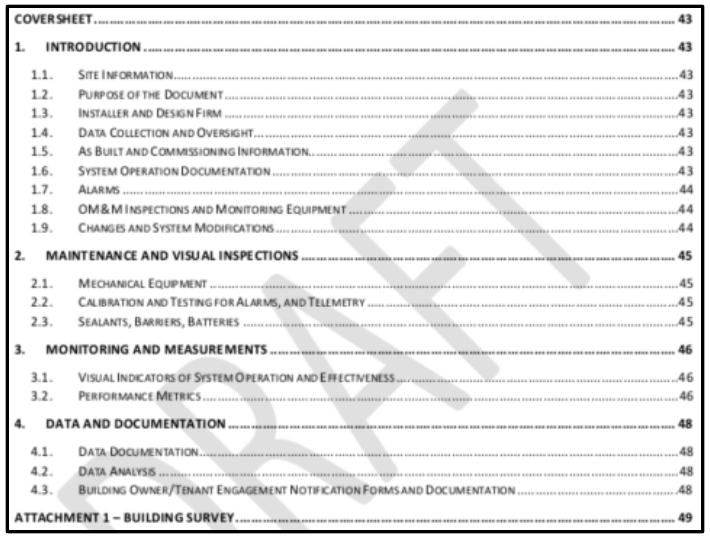
- All below grade building features and foundations should be identified in plan view
- Subsurface features should be depicted on the cross sections developed in Section 1.4

Makes the Transition “Easier” between Submittals

1. Design → 2. Installation → 3. OM&M







Next Steps…

- Have been actively receiving comments from users of the Table of contents
- Will be released in Volume 5 – Response Activity in 45 to 90 Days

AVMS TOC

PVMS TOC

Case Study

Questions will follow the Case Study!

Introduction: Active Vapor Mitigation System (AVMS) Table of Contents and Case Study

- Document provides the framework/template for generating a more technically complete VMS Design package
  - Purposefully light on detail; left to designer to provide specific details
- Valuable tool to make compliance easier
  - Decreases confusion as to EGLE expectations for planned VMS design
  - Results in fewer comments on a design package submittal and timelier EGLE review
- Presentation Goals
  - Describe how the TOC was utilized to develop VMS Design and Installation Specifications for an approved RAP at a Case Study site
  - Includes discussion of VMS installation and commissioning
  - Highlights components of the TOC relative to case study site; not an exhaustive discussion of the TOC or components
  - Highlight importance of EGLE communication during investigative and design process

fishbeck
Engineers | Architects | Scientists | Constructors

Case Study: Background

- Building constructed in late 1800s
- Three-story structure with 19,000 SF basement
  - Basement floor ranges from 8 to 10 feet below grade
- Commercial on ground-floor level with basement access for storage
- Residential on upper two floors
- Elevator, 4-foot-deep shaft pit in basement

Potential Source Areas

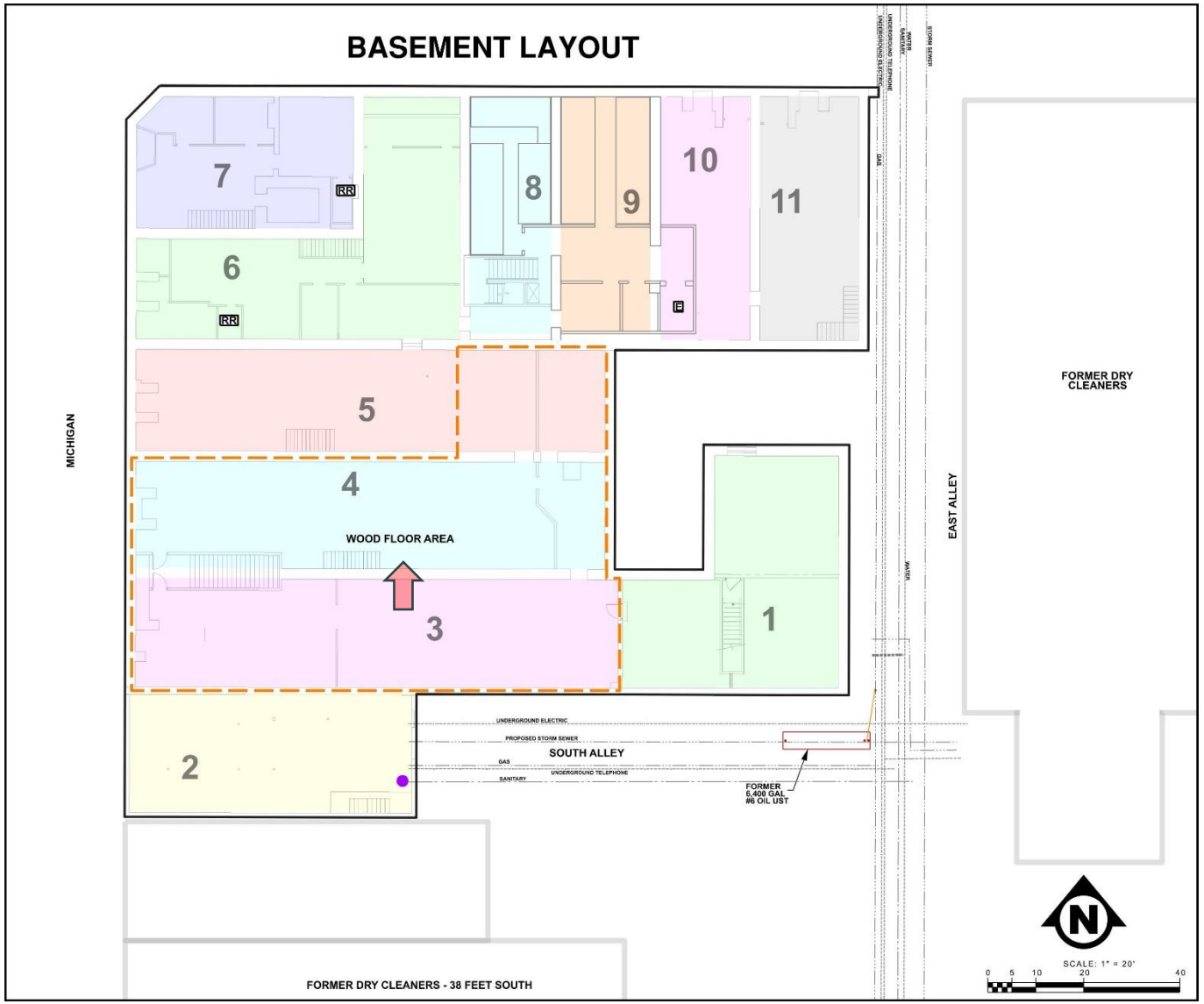
- Project initiated in pursuit of MSHDA funding for rehabilitation of residential/commercial structure
- Previous due diligence indicted release from former onsite fuel oil UST
  - Soil impacts above SSVIAC; no indication of NAPL
  - Groundwater >40 feet
- MSHDA concerned with historic dry cleaners to east and south
  - No reported environmental conditions; but no known investigations

Geology/Hydrogeology

- Natural soils consist predominantly of well-sorted fine to medium sand with occasional discontinuous lenses and layer of a sandy clay or silt to 45+ feet; some areas of sub-slab soils clayey
- Groundwater at 42 feet; 30 feet beneath basement slab
- Groundwater flow not determined, assumed to be to the east toward nearby river

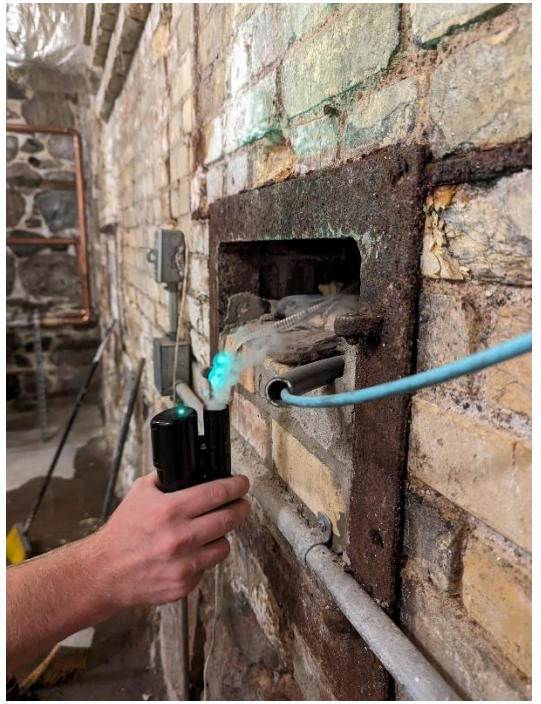
Basement Layout

- 11 areas separated by 2-foot-thick fieldstone walls and foundations; perimeter walls include fieldstone and brick



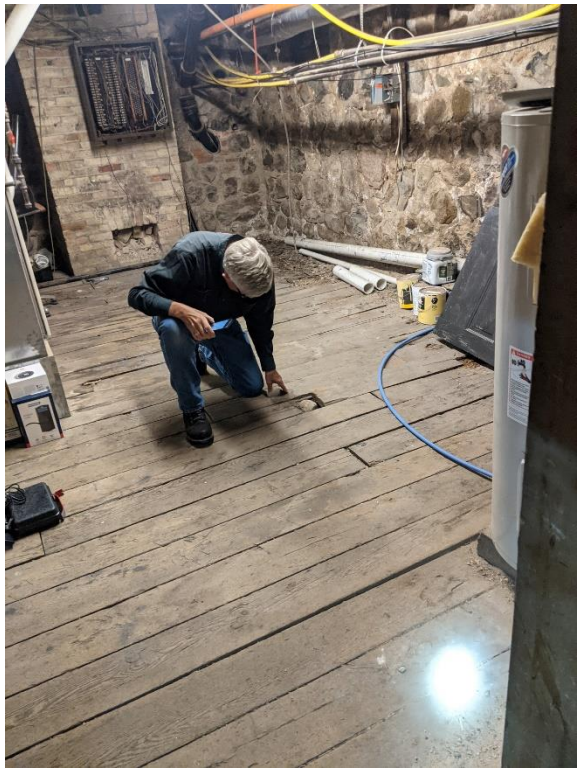
Floor/Wall Condition

- Mortar between fieldstone blocks significantly deteriorated in areas, particularly around perimeter walls
  - Scope of mitigation to include mitigation of perimeter walls due to lateral sources
- Floor slab in good condition *(where present)*; some gaps along perimeter walls and elevator shaft pit
- Significant gaps at some utility penetrations



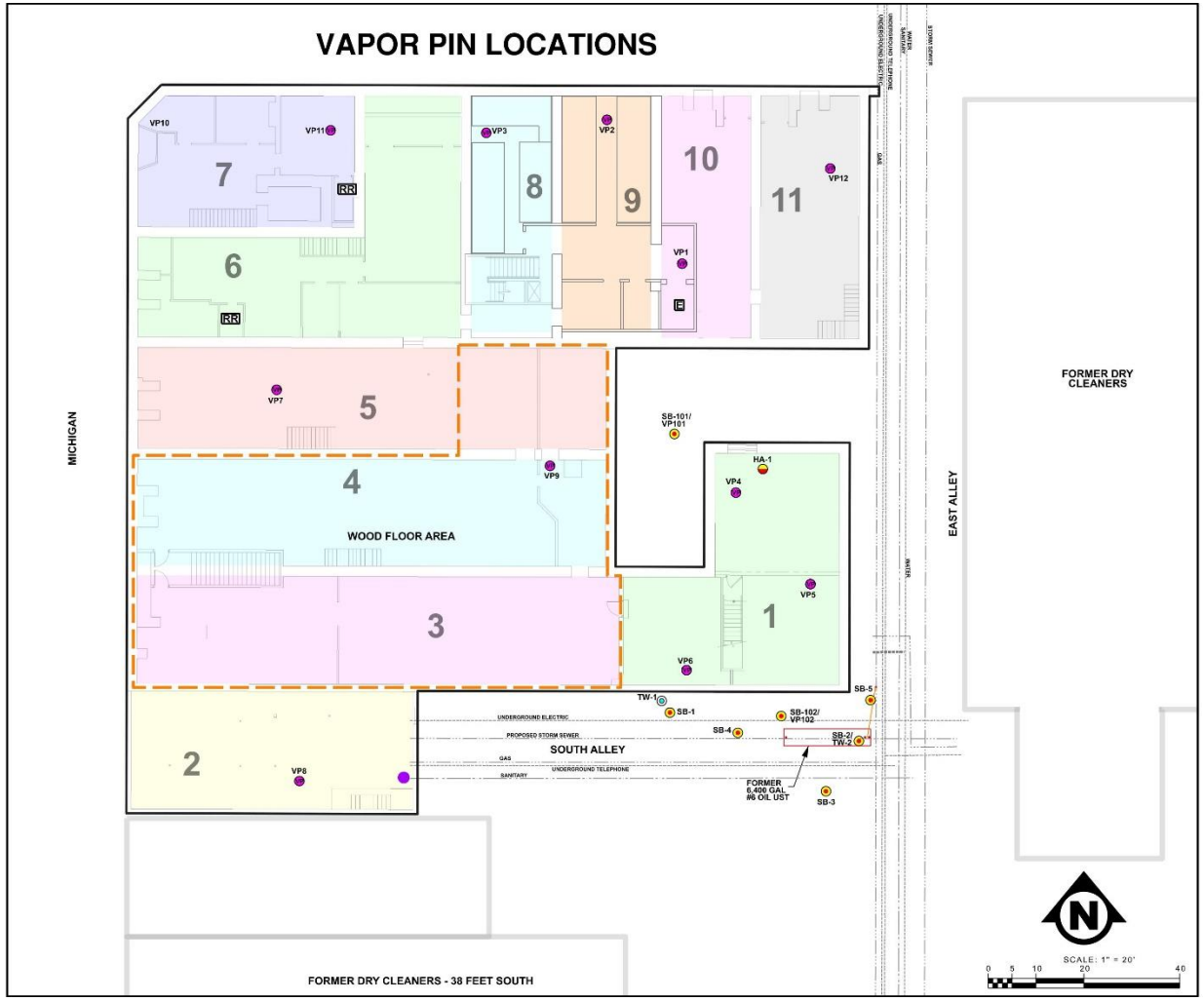
Wood Floor

- 4,500 SF of basement has wooden floor
  - Significantly rotted or missing around perimeter walls due to leakage stormwater infiltration



Soil Gas Evaluation

- EGLE performed multiple investigations in 2022 and identified:
  - Sporadic petroleum VIAC exceedances
  - Consistent VIAC exceedances for chloroform and PCE
  - Highest PCE concentrations in soil gas along south side of structure
- Fishbeck (Envirologic) brought on in July 2022
- MSHDA required design submitted as a RAP (Evaluation Plan) and a DDCC



Mitigation Strategy and Goals

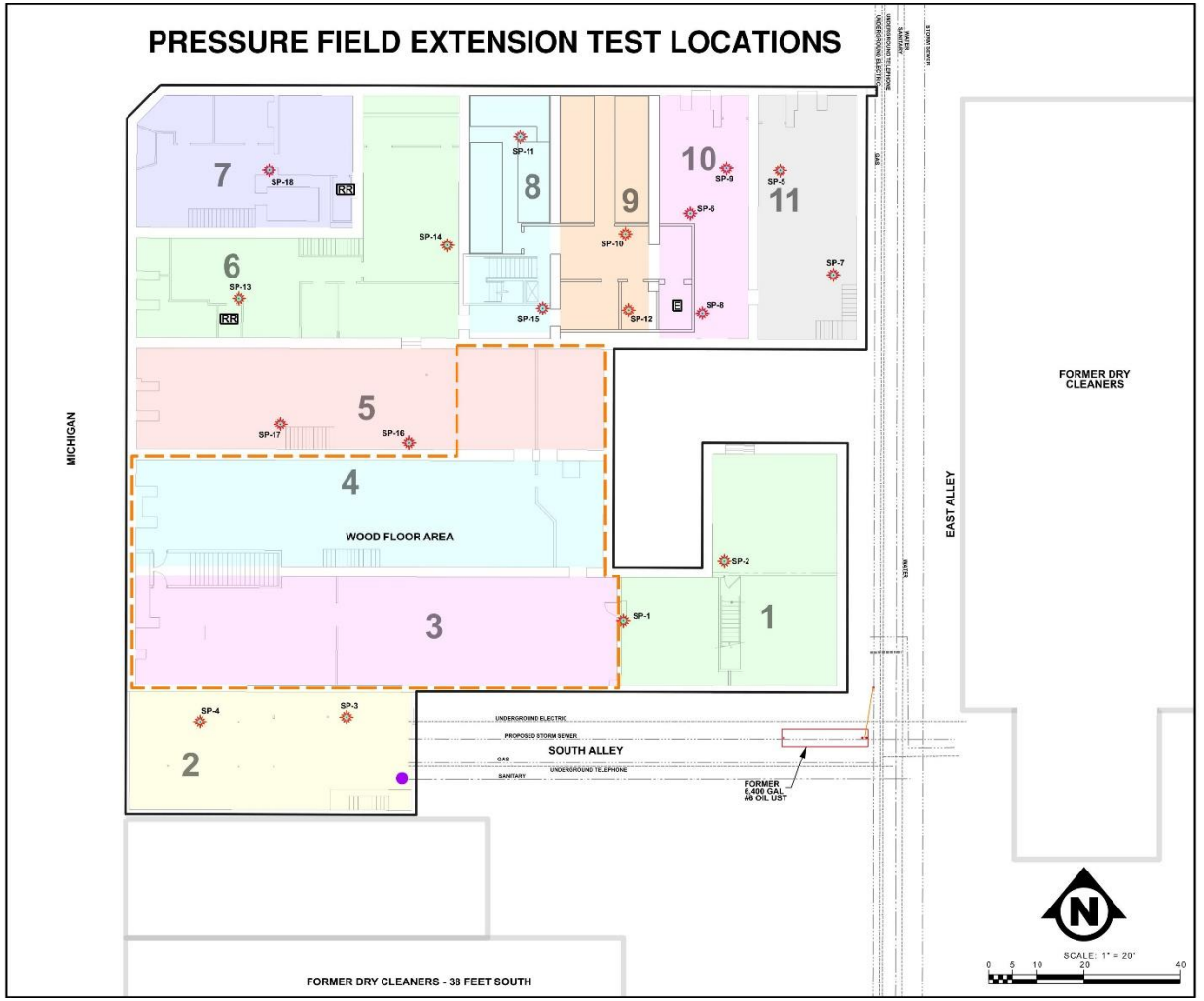
- Strategy
  - Sub-slab and cross wall depressurization capable of producing a minimal -0.02” WC pressure differential
  - Address preferential pathways and seal cracks and gaps, elevator shaft pit, cracks around utility penetrations
  - Address potential leakage through wood floor and perimeter basement walls
- GOAL
  - Design/develop a mitigation system that will induce continuous negative sub-slab/above-slab and indoor/cross wall pressure differential across the building under typical building operating conditions

Importance on Communication

- Early on in the design process, EGLE agreed:
  - Lateral mitigation would only be required along the south and east perimeter walls toward the dry cleaner sites
    - Due diligence work did not indicate any potential source areas to the north or west beyond the adjacent streets
  - Identify and allow for an alternate demonstration to pressure (flow) should an adequate pressure differential be difficult to obtain
    - Vertical leakage as well through wall leakage could prevent the pressure gradient from being maintained
- Saved time and resources

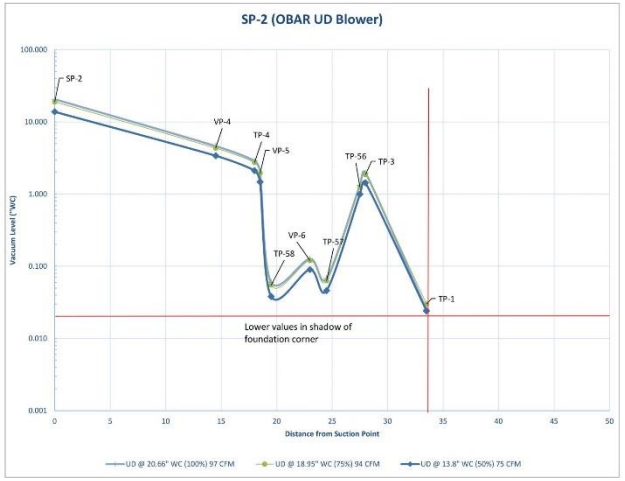
Diagnostic Testing

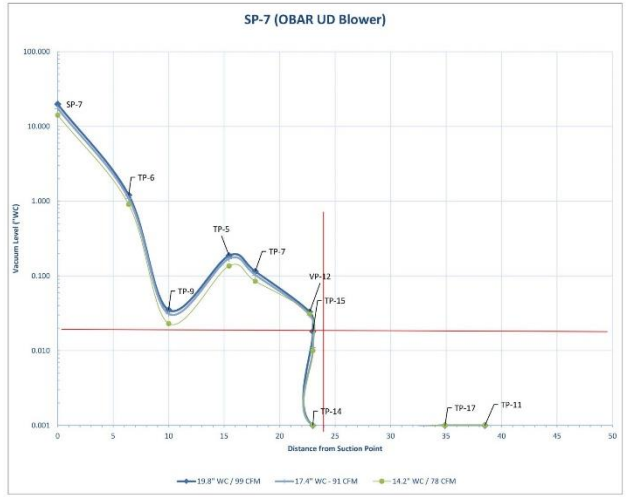
- *Determine*
  - Conditions are conducive to vapor extraction
  - Number of suction points and blower size necessary to achieve goals
- PFE testing initiated August 2022
- 18 PFE tests completed:
  - 9 of 11 areas isolated by known interior fieldstone footer;
  - Selected to evaluate cross-footer and cross elevator shaft pressure field extension
  - Wood floor areas not tested

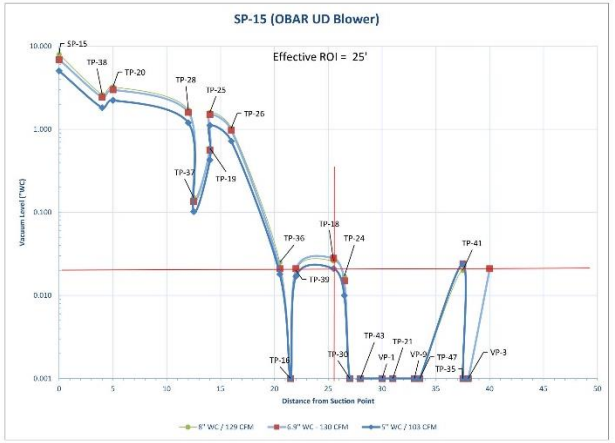


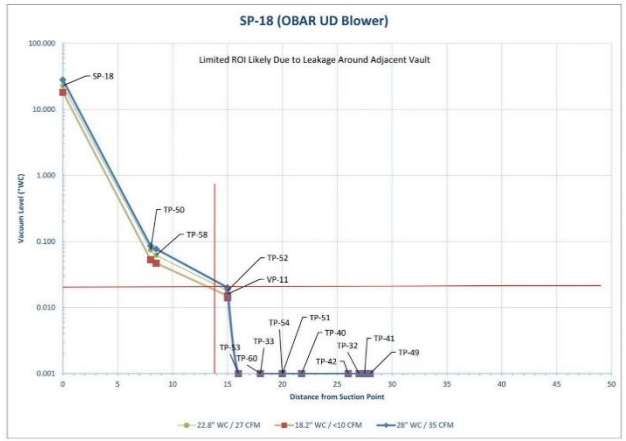
PFE Test Results

- PFE test results indicated ROI at distances of 12 to about 30 feet
- Cross-footer influence measured at most locations
  - Results somewhat subdued relative to equidistant points inside a given footer
- Response measured beneath the wood floor areas
- Able to get adequate response from test points installed opposite the elevator shaft pit from suction points





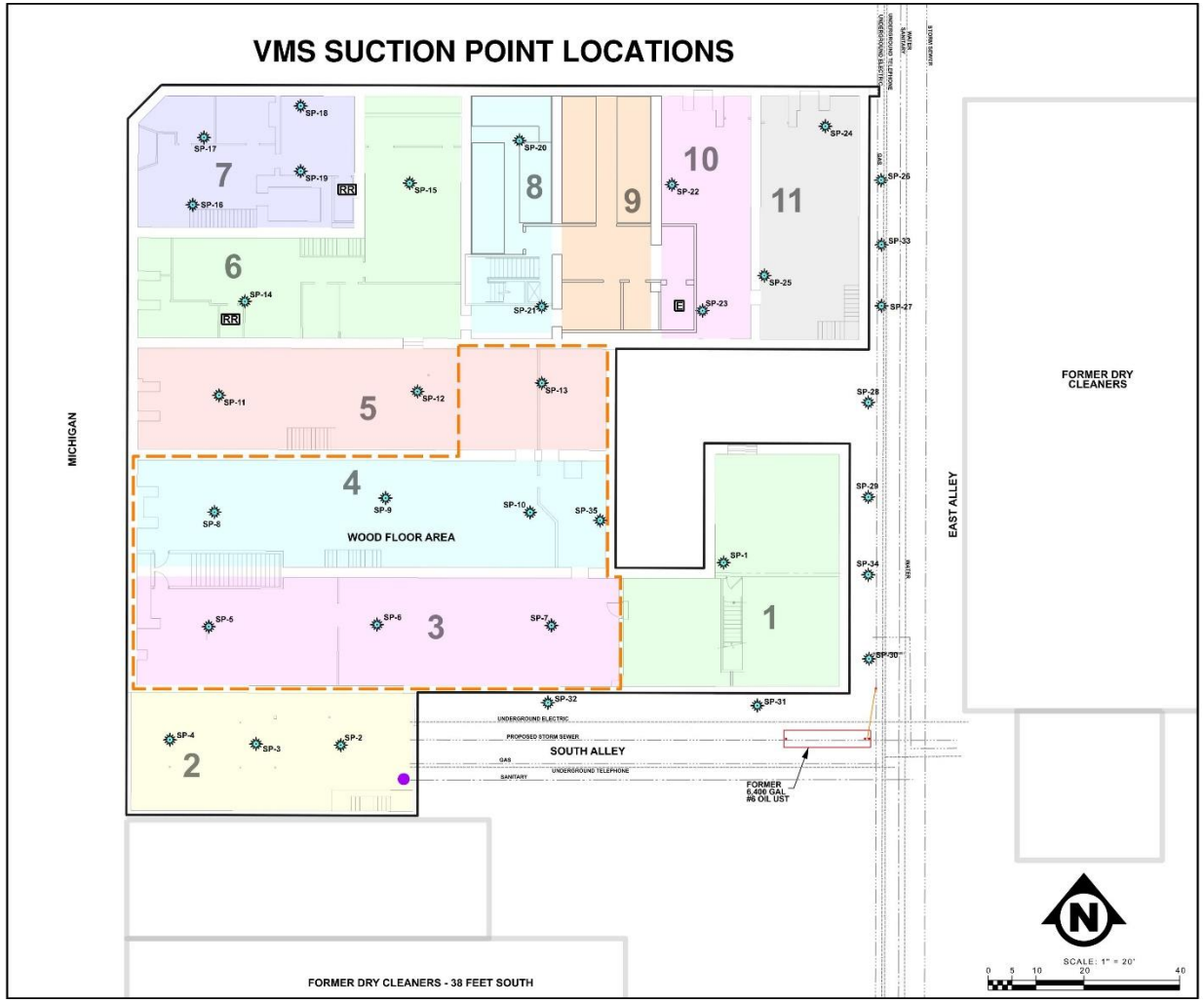




Appendix A.1 – Design, Section 2: VMS Design and Plans, Sub-Section 2.3 – Plan of Proposed System
Appendix A.2 – Install and Commissioning, Section 2: VMS Documentation and As-Builts, Sub-Section 2.3 – As-Builts of the VMS

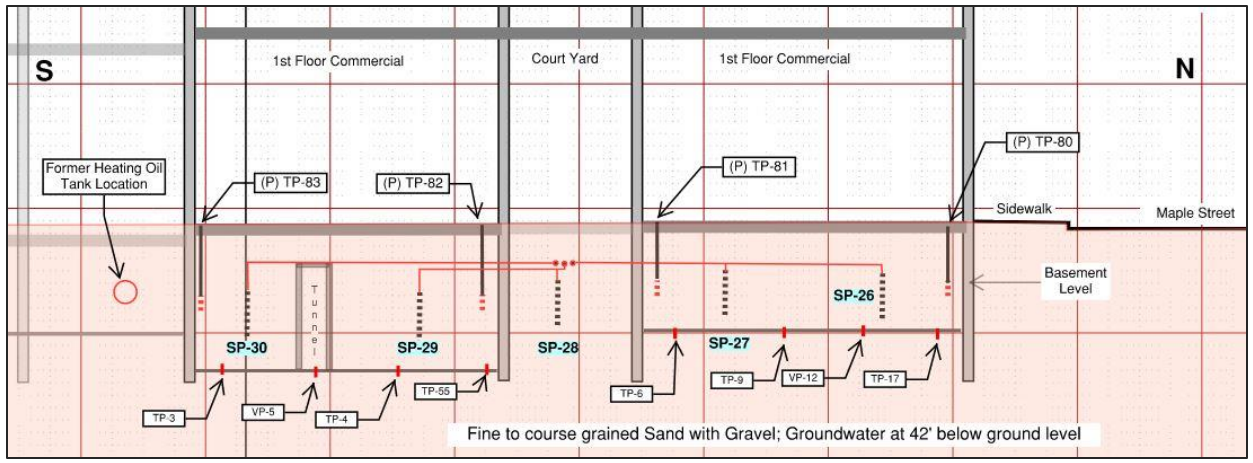
Suction Point Layout

- 25 sub-slab suction points across basement, centered within isolated footer areas
  - 2” x 2.5’ long well screens from 0.5’ to 3’ below slab areas
  - 2” x 2.5’ long well screens from 4’ to 4.5’ with upper bentonite seal below wood floor
  - Large screen size (0.125-slot) to minimize pressure loss
  - Anulus backfilled with pea stone
- 9 exterior suction points in east and south alleys adjacent to perimeter basement walls
  - 2” x 5’ long well screens from 5’ to 10’ bgl, across lower half of basement walls



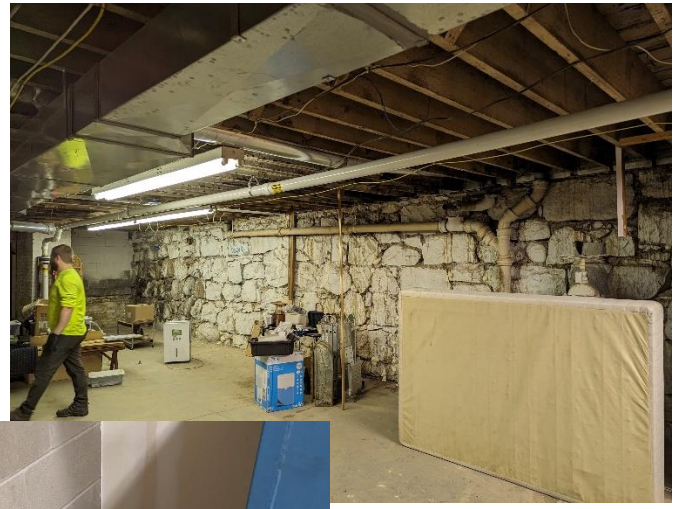
Exterior Suction/Test Point Schematic

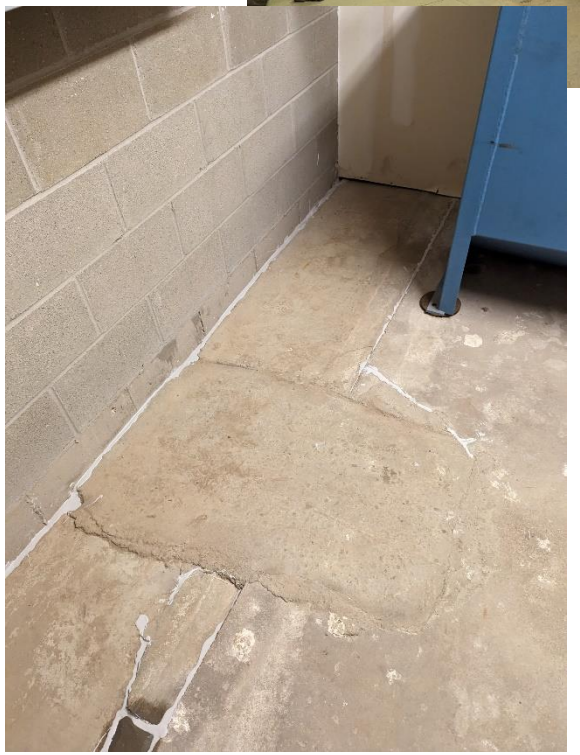
- 7 pressure monitoring (test) points in east and south alleys, centered between exterior suction points
  - 2” x 2’ long well screens at center of adjacent perimeter wall
  - Exterior test points allow for demonstration of air flow via smoke testing
  - Exterior test points adapted to ¼” tubing and extended to interior monitoring station for remote pressure monitoring



Sealing of Concrete Floors and Fieldstone Walls

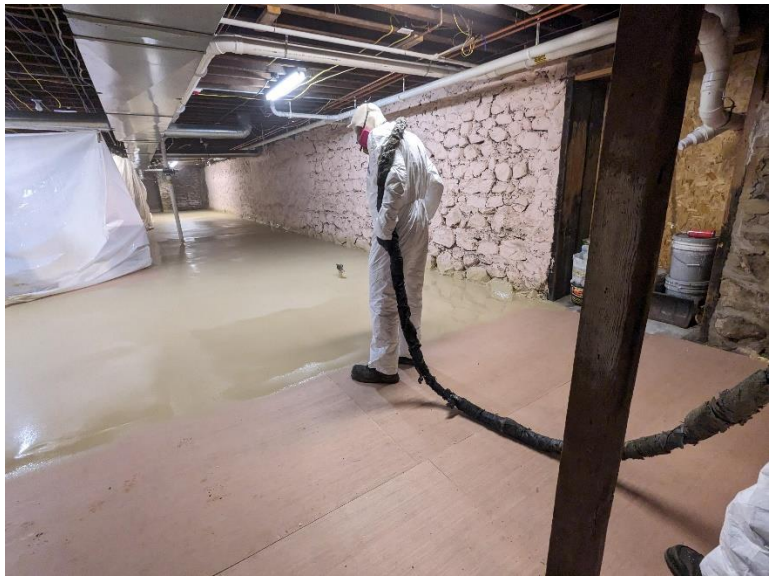
- Floor cracks sealed with cement and self-leveling caulk
- Leakage through perimeter basement walls
  - Assessed leakage via smoke testing following system activation
    - Not as significant as expected
  - Significant leakage around utility penetrations with deteriorated mortar
- Shallow leakage points sealed with caulk
- Deeper leakage points sealed with expandable foam

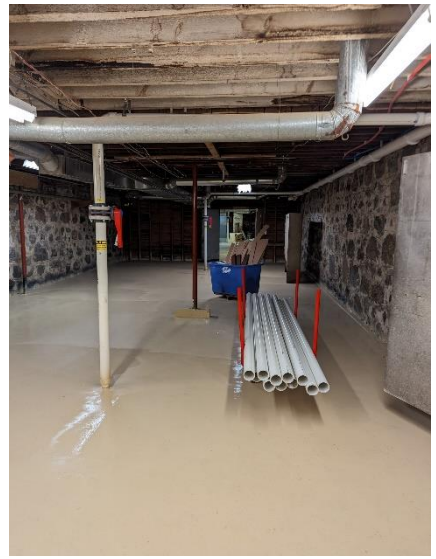




Wood Floor

- Shore up deteriorated floor areas
  - ¼” subfloor across entire wood floor area
- Applied an 80–100 mil spray polyurea coating
  - Not designed as contaminant barrier
  - Create an upper seal to propagate flow beneath the wood floor areas

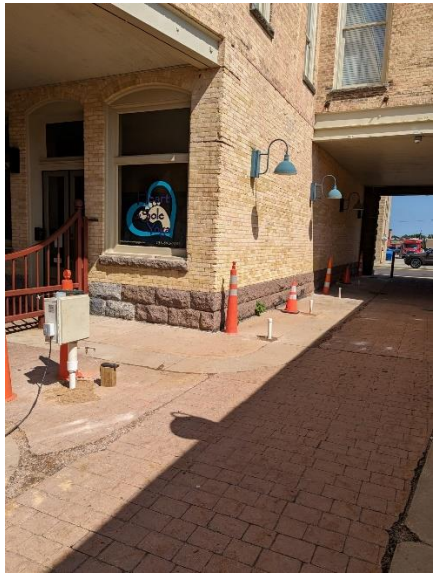


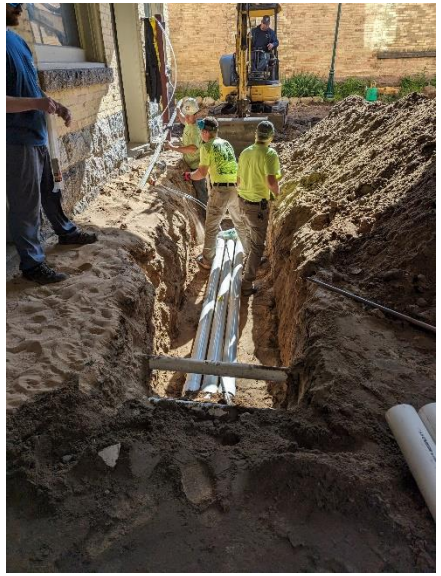


Appendix A.1 – Design, Section 2: VMS Design and Plans, Sub-Section 2.3 – Plan of Proposed System
Appendix A.2 – Install and Commissioning, Section 2: VMS Documentation and As-Builts, Sub-Section 2.3 – As-Builts of the VMS

Conveyance Piping

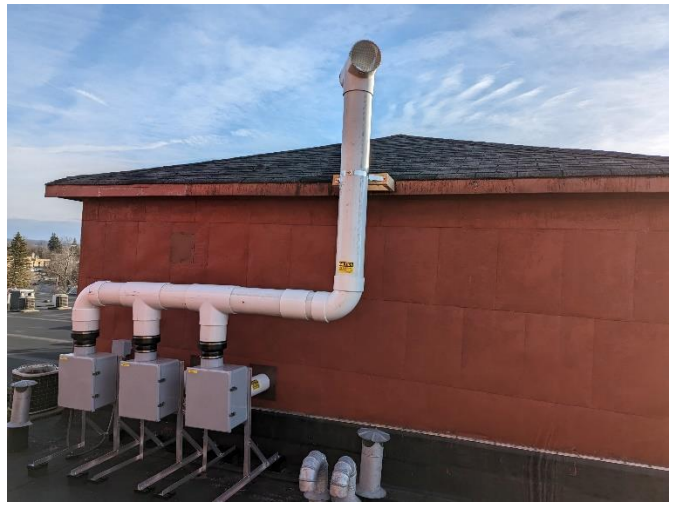
- Utilized client's contractor for piping,
  - Familiar with the building
  - Coordinated exterior piping runs with replacement of concrete as part of the rehabilitation
- Horizontal soil gas conveyance piping runs in the basement and vertical runs to the roof were challenging
  - Utilized existing openings in field stone walls where possible
  - Slope toward suction point not always possible; cleanouts installed at low points





Blowers

- Estimated six blowers capable of producing 10” to 20” WC and up to 1,100 CFM in total
  - Blower selection testing conducted to verify blower needs
  - Test results indicated that three OBAR 123 CRBs would be sufficient to achieve objectives
- Rooftop mounted blowers; exhausts manifolded to one 8” exhaust stack

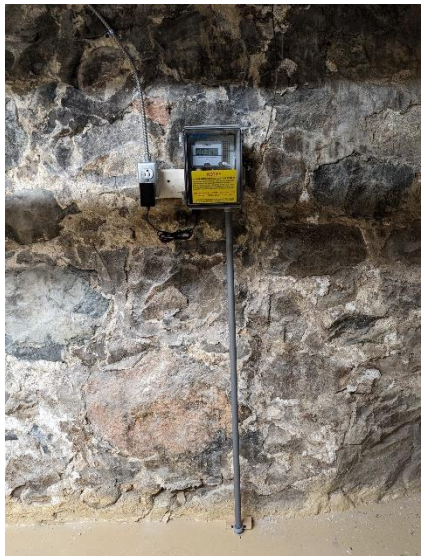


Telemetry Systems

- VMS equipped with Remote Telemetry Monitoring System (RTMS)
  - Document continuous operation of each blower unit
  - Demonstrate the system continuously maintains a negative pressure differential and meets the performance objective
- Minimize physical performance monitoring inspections
  - Monitor system operation via phone or computer
  - Receive notifications of a system malfunction via text/email

Telemetry Systems

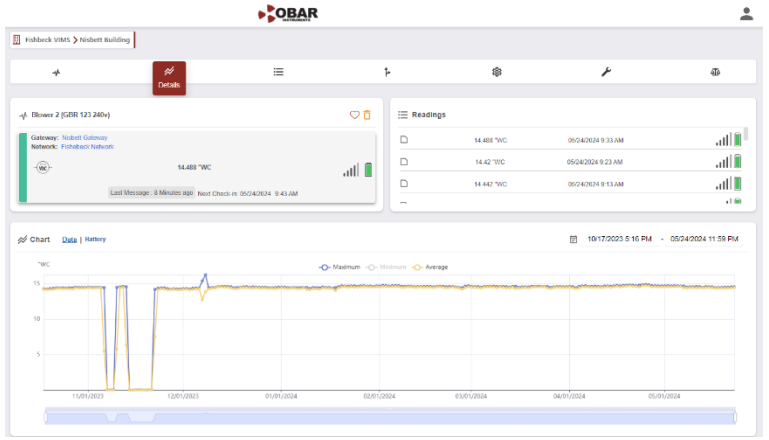
- One sub-slab monitoring station in each of the 11 isolated basement areas
  - Monitoring point placed in area of lowest pressure differential
- Two interior monitoring stations for the east and south alleys



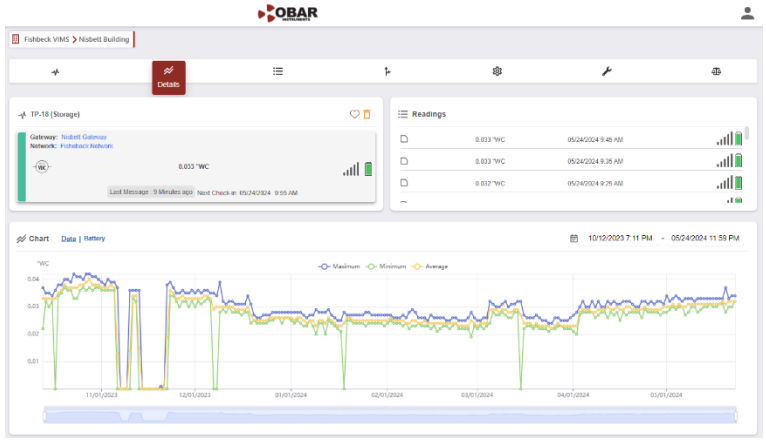
Telemetry System

- Telemetry systems collects a reading from each sensor every 10 minutes
- Readings are immediately transmitted
  - Near-real time data regarding system operation
- RTMS configured to forward monthly operational log of all readings to designated personnel
  - Information used to evaluate building operational conditions

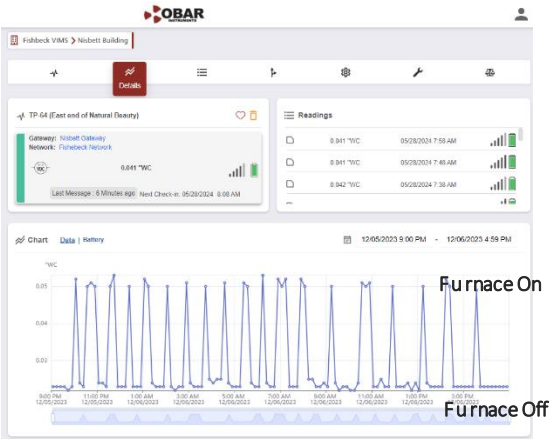
Blower 2



Test Point 18

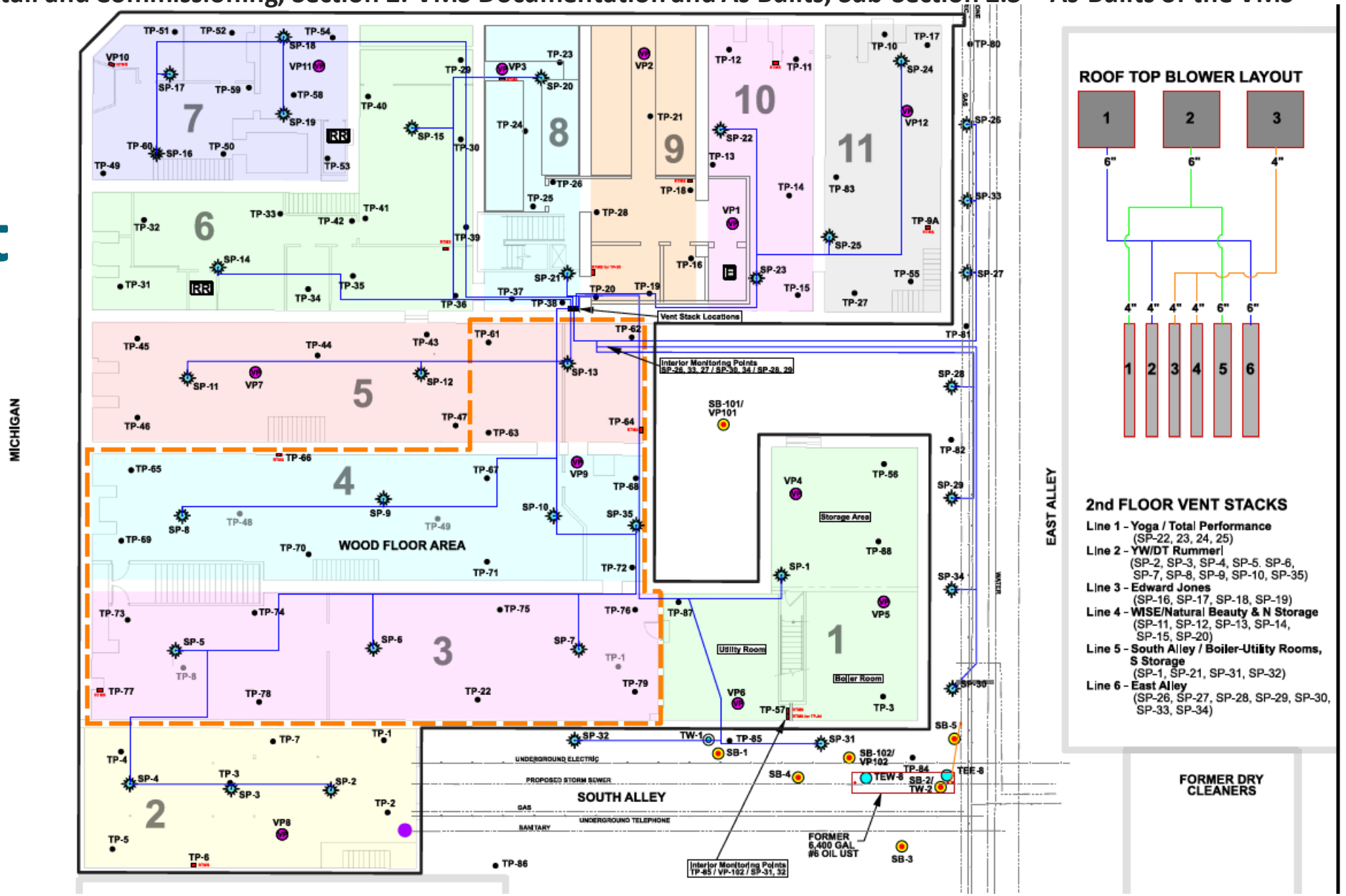


Test Point 64



Appendix A.1 – Design, Section 2: VMS Design and Plans, Sub-Section 2.3 – Plan of Proposed System
Appendix A.2 – Install and Commissioning, Section 2: VMS Documentation and As-Builts, Sub-Section 2.3 – As-Builts of the VMS

Final VMS Layout

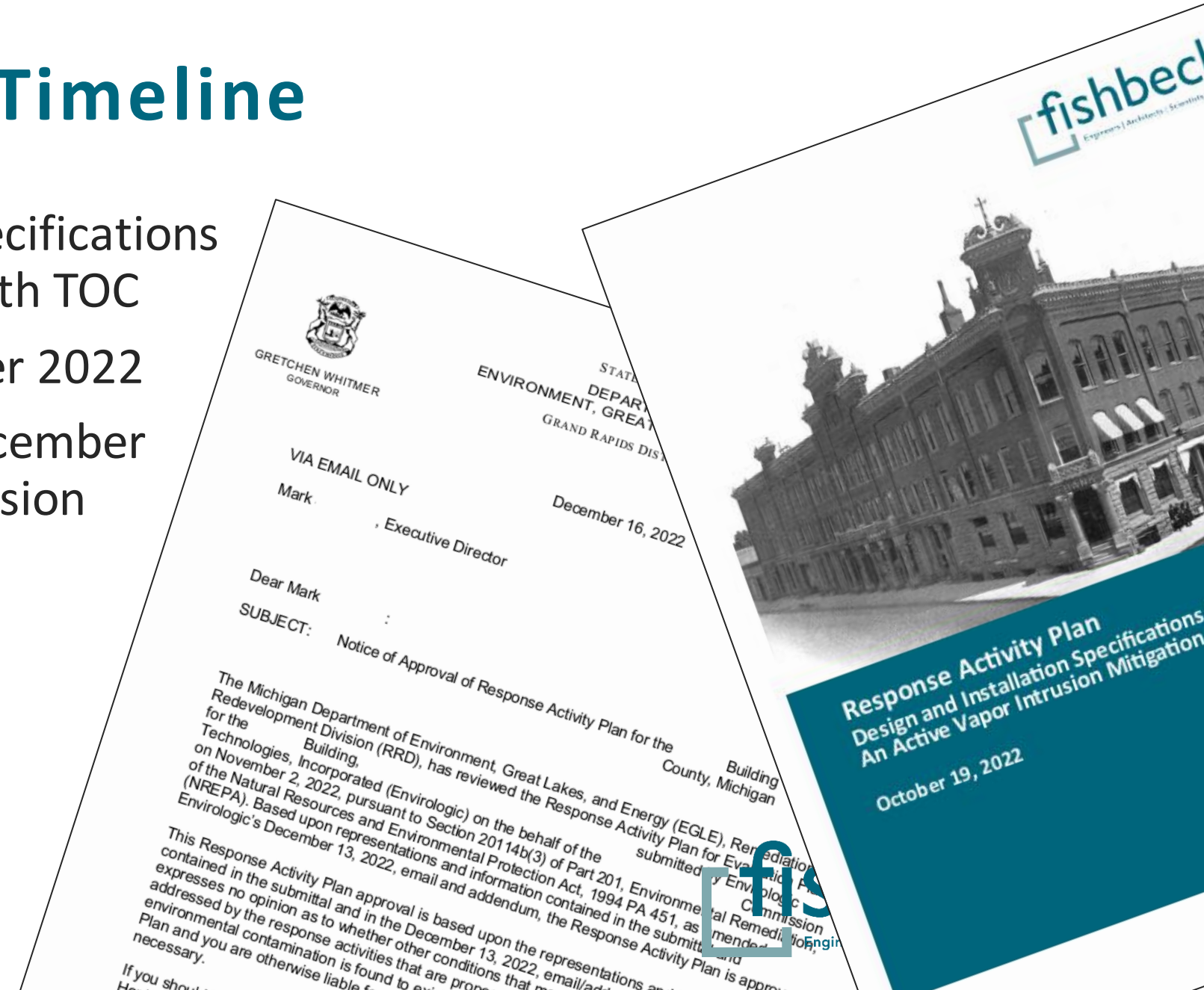


Operation, Maintenance, and Monitoring

- OM&M Plan to be developed during commissioning phase
- Design Document only contains a brief overview of OM&M to be conducted during commissioning
- Commissioning and OM&M Plan should include owner (onsite staff) responsibilities
  - Basic understanding of site conditions and VMS
  - Routine inspections of system and components
  - Monitoring of building activities that may affect VMS operation
  - Notification requirements, action, and records

In Closing - The Timeline

- Design and Installation Specifications prepared in accordance with TOC
- RAP submitted late October 2022
- Approval received mid-December 2022 following limited revision



Questions?

fishbeck
Engineers | Architects | Scientists | Constructors