PERFORMANCE SPECIFICATIONS
FOR ACTIVE SOIL DEPRESSURIZATION (ASD)
RADON MITIGATION SYSTEMS AT

GEORGE WASHINGTON CARVER
STEM ACADEMY FOR BOYS

FAYETTE COUNTY PUBLIC SCHOOLS

AUGUST 25, 2023

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AIR SOURCE TECHNOLOGY, INC. PROJECT # PC224.0

ACTIVE SOIL DEPRESSURIZATION (ASD)
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GEORGE WASHINGTON CARVER STEM ACADEMY FOR BOYS
LEXINGTON, KENTUCKY

INDEX TO TECHNICAL SPECIFICATIONS

1.0 Background

REVISION NOTES: Initial Issue Dated August 25, 2023

PROJECT IDENTIFICATION

General: Project name is Active Soil Depressurization (ASD) Radon Mitigation System Installation – George Washington Carver STEM Academy, 123 E. Sixth St., Lexington, KY, as shown on the specification prepared by the Owner's Representative, Air Source Technology, Inc. The initial issue of these Work Procedures is dated August 25, 2023.

Applicable History: Post Mitigation Radon measurements conducted by Air Source Technology, Inc. at George Washington Carver STEM Academy indicate the need for additional radon mitigation within the structure. The Scope of Work for ASD is detailed in Section 19. Additional radon mitigation efforts for other portions of the school may be addressed by other contracts/projects.

Important Project Notes:

1. Post-mitigation radon levels in mitigated building spaces shall be at or below EPA's action level (currently 4pCi/L) for the overall project to be considered complete. This specification addresses ASD systems installation and requirements. This specification does not address the complete radon mitigation process for this structure. Additional areas may be addressed by a later mitigation project or by a change order process for this project. Long term testing during the heating season may determine the need for additional mitigation work.
2. Installation of sub-slab depressurization systems and other radon mitigation methods are planned for this project. Sub-slab communication testing has been performed with the report provided in Appendix A. The sub-slab testing was designed (1) to support a competitive bid process by characterizing the sub-slab conditions of different slabs found in this structure and (2) to demonstrate the applicability of an active sub-slab depressurization (ASD) system of targeted areas of this structure. The diagnostic report and this specification may not provide the information needed to design the best ASD systems for this structure.

Summary of Work: Briefly and without force and effect upon the contract documents, the work of the Contract can be summarized as follows:

Pay particular attention to Paragraph 19 for the scope of work for this project. Other specification sections are included to address follow-up ASD work, if required for successful radon mitigation.

Use information provided and conduct any additional radon measurement or diagnostic testing deemed necessary to install active soil depressurization radon mitigation systems or other types of radon mitigation systems as specifically described herein. These systems are to be installed in selected areas at the structure.

Documents listed in Section 8 provide parameters for the design and installation of Active Soil Depressurization (ASD) and other Radon-reducing methods for this project, except where differences are specifically noted in this specification.

Project Completion: While means and methods are identified in this specification; this project is only considered successfully completed when Section 17 (Post-Mitigation testing) and Section 18 (Contracts and Documentation) have been satisfied.

DESCRIPTION

A. The Contractor shall furnish all labor, temporary facilities, enclosures, materials, and equipment in accordance with the requirements of the Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), and other regulatory agencies to complete active soil depressurization radon mitigation systems or other types of radon mitigation systems as specifically described herein.

B. The work specified herein shall be active soil depressurization radon mitigation system installation by persons who are knowledgeable, qualified, and trained in radon mitigation. These persons shall comply with federal and state regulations mandating work practices, and shall be capable of performing the work of this contract.

C. The requirements of this document will govern where it is more stringent than prevailing legal or regulatory requirements.

D. Section 6 describes documents that shall be onsite at all times during the work.

E. While the ultimate purpose of this project is to reduce Radon levels within the structure, the Contractor is not responsible for the amount of Radon reduction that is achieved by the active soil depressurization radon mitigation systems or other types of radon mitigation systems as specifically described herein. The Contractor is responsible for the proper installation of the systems in accordance with standards as described in this specification. For this portion of the overall radon mitigation plan for this structure, successful contractor completion is defined solely by Section 17 (Post-Mitigation testing) and Section 18 (Contracts and Documentation).

STOP WORK

If the Owner or the Owner's Representative presents a written stop work order, immediately stop all work. Do not recommence work until authorized in writing by the Owner or Owner's Representative. Designated Representatives of the Owner shall provide a minimum of 48 hours' notice to the Contractor prior to entering areas where work is being performed.

OWNER OCCUPANCY

The Owner will occupy the work area on a limited basis during installation. Designated Representatives of the Owner may enter the work area, if necessary, to maintain building operations. Designated Representatives of the Owner shall provide a minimum of 48 hours' notice to the Contractor prior to entering areas where work is being performed. The Owner shall provide a week notice to the Contractor Site supervisor, if the Contractor is required to vacate the work area after Construction Start.

IDENTIFICATION OF THE OWNER

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128 Walton Ave.
Lexington, KY 40502
(859) 381-4063

PROJECT DESIGNER

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Lexington, KY 40509
(859) 299-0046

2.0 Purpose

The purpose of the specification is to provide radon mitigation contractors with uniform standards that will ensure quality and effectiveness in the design, installation, and evaluation of active soil depressurization radon mitigation systems in buildings three stories or less in height. The specification serves as a standard set of requirements to fulfill the objectives of specific radon contractor certification, licensure programs and work practices.

3.0 Participants

Contractors who wish to perform the work of this project shall participate in the National Environmental Health Association - National Radon Proficiency Program (AARST-NRPP) as Mitigation Service Providers or be a National Radon Safety Board - Radon Mitigation Specialist (NRSB-RMS).

4.0 Scope

The requirements addressed in the specification include the following categories of contractor activity: General Practices, Building Investigation, Worker Health and Safety, Systems Design, Systems Installation, Materials, Monitors and Labeling, Post-Mitigation Testing, and Contracts and Documentation. Additional project-specific scope of work details are provided in Section 19.

5.0 Assumptions

Appropriate radon/radon decay product measurements have been performed within the structure, and that the Owner has decided that radon remediation is necessary. Selected areas within the facility are specifically identified and are addressed by this specification.

6.0 Implementation

6.1 The specification provides requirements for installation of active soil depressurization radon mitigation systems, including a basis for evaluating the quality of the installation. It may also be used as a reference during inspection of in-progress or completed work.

6.2 Copies of the following documents shall be onsite at all times during the work:

6.2.1 ANSI/AARST RMS-LB 2018 - Radon Mitigation Standards for Schools and Large Buildings, 2018, AARST Consortium on National Radon Standards (Reference Document 8.19)

6.2.2 Material Safety Data Sheets (MSDS) for all chemicals used onsite and other applicable safety, permit-related, and regulatory documentation

6.2.3 The latest version of this specification

6.2.4 The Contractor’s active soil depressurization radon mitigation systems (ASD-RMS) plan as approved by the Project Designer.

6.3 Prior to construction start, the Contractor shall present an active soil depressurization **r**adon mitigation system (ASD-RMS) plan for approval by the Project Designer.

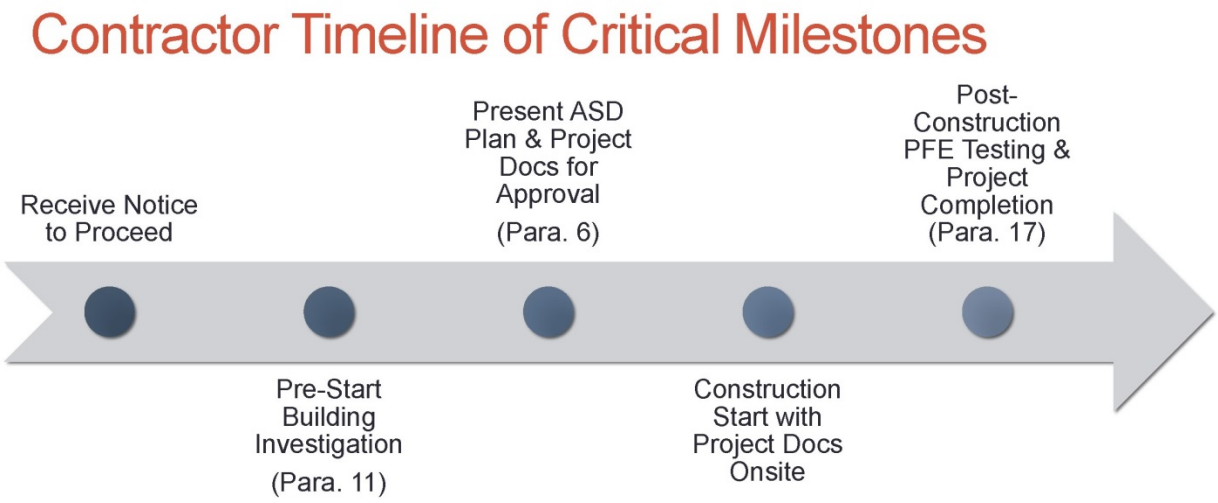
6.4 Contractors shall personally conduct follow-up inspection of any active soil depressurization radon mitigation systems installed by their firm or by subcontractors to insure conformance with the requirements of the specification. This requirement includes post-mitigation testing described in Section 17.0 and Reference Document 8.19.

6.5 The state of Kentucky or its agent may conduct inspections of radon mitigation projects. State radon program personnel or their contracted representatives are considered

EPA agents for conducting such inspections. Kentucky Revised Statues, KRS 211.9101 to 211.9135 Radon Measurement, Mitigation, Laboratory Analysis, and Quality Control define the roles of state inspectors.

6.6 Those provisions of the RMS that are considered to be mandatory are prefaced by the term "shall." Provisions that are considered good practice but which are not mandatory are prefaced by the terms "should" or "recommended."

6.7 Contractor's Timeline of Critical Project Deliverables



The importance of following this timeline cannot be over-emphasized. The Contractor's Pre-Start Building Investigation will reveal the variations and adjustments required for a successful implementation. Insufficient data has been provided in this specification and in the diagnostic report to design the optimum systems for this structure. Cosmetic details and installation requirements make imperative the presentation of an ASD Plan for Owner approval. Also, if diagnostic data reveal variations in sub-slab conditions and slab segmentation, the change order process can begin sooner to allow timely payment.

7.0 Limitations

7.1 Although the provisions of the specification have been carefully reviewed for potential conflicts with other regulatory requirements, adherence to the specification does not guarantee compliance with the applicable codes or regulations of any other Federal, state, or local agency having jurisdiction. The Contractor is responsible for all regulatory compliance issues associated with this project.

7.2 Where discrepancies exist between provisions of the specification and local codes or regulations, local codes shall take precedence. However, where compliance with local codes necessitates a deviation from the specification, the mitigation contractor shall immediately report the deviation in writing to the Project Designer.

7.3 Because of the wide variation in building design, size, operation and use, the specification does not include detailed guidance on how to select the most appropriate mitigation strategy for a given building. That guidance is provided in various documents referenced in Sections 8. Prior to construction start, the Contractor shall present the Active Soil Depressurization - Radon Mitigation System (ASD-RMS) plan for approval by the Project Designer.

7.4 The provisions of the specification are limited to proven technologies and methods. This standard is not intended, however, to inhibit research and evaluation of other

innovative radon mitigation techniques. The Project Designer and the Owner shall provide formal approval and this specification shall be amended to reflect the research being conducted. A performance standard shall be applied, i.e., at a minimum post-mitigation radon levels shall be at or below EPA's action level (currently 4 pCi/L), and the systems design criteria as described in Section 13.0.

7.5 Upon approval, Contractors who deviate from proven radon mitigation technologies and methods (as defined in the specification and in Sections 8.17 and 8.19) for purposes of research on innovative mitigation techniques, shall document the non-standard techniques and participate in testing the performance of the deviation from standard procedures. Any impact on the Contractor's warranty shall be expressly stated.

8.0 Reference Documents

Reference Documents 8.13 and 8.15 shall be the "means and methods" for this project. Any discrepancy shall be resolved by the Project Designer and documented by a revision to this document. Such revisions shall take precedence over any other communications, verbal or otherwise.

The following documents are sources of additional radon mitigation information and are recommended reading for contractors participating as Radon Mitigation Providers:

8.1: Radon test history at George Washington Carver STEM Academy for Boys including testing in areas not addressed by this project.

8.2: EPA Training Manual, "Reducing Radon In Structures," (Third Edition), January 1993.

8.3: "Radon Reduction Techniques for Detached Houses, Technical Guidance (Second Edition)" EPA/625/5-87/019, January 1988.

8.4: "Application of Radon Reduction Methods," EPA/625/5-88/024, August 1988.

8.5: "Indoor Radon and Radon Decay Product Measurement Device Protocols," EPA 402-R-92-004, July, 1992.

8.6: "Chimney Safety Tests User's Manual," Second Edition, January 12, 1988, Canada Shelter Consortium Inc., for Canada Mortgage and Housing Corp.

8.7: OSHA "Safety and Health Regulations for Construction, Ionizing Radiation," 29 CFR 1926.53.

8.8: OSHA "Occupational Safety and Health Regulations, Ionizing Radiation," 29 CFR 1910.96.

8.9: NIOSH "Guide to Industrial Respiratory Protection," DHHS (NIOSH) Publication No. 87-116, September, 1987.

8.10: EPA "Handbook, Sub-Slab Depressurization for Low Permeability Fill Material," EPA/625/6-91/029, July 1991.

8.11: "Active Soil Depressurization Radon Mitigation Standards (ASD RMS) for Low Rise Residential Buildings," reprinted 2012, AARST Consortium on National Radon Standards

8.12: EPA 402-R-94-008 "Reducing Radon in Schools: A Team Approach" April 1994.

8.13: ANSI/AARST RMS-LB 2018 - Radon Mitigation Standards for Schools and Large Buildings, 2018, AARST Consortium on National Radon Standards

8.14: ”Using a Model to Estimate the Effects of Ventilation and Exhaust Appliances on the Accuracy of a 48 Hour Radon Test,” 2000, J.F. Burkhart and R.E. Camley, Physics Department, University of Colorado

8.15: Fergusson, B.N., “Average Radon Levels vs. Actual Occupant Exposure Levels in a Public School”, 2010, Indoor Air Quality Association, Proceedings of the 13th Annual Indoor Air Quality Association Conference

8.16: Hatton, T.E., Nuzzetti, Daniel J., “Applying Dynamic Controls and Remote Monitoring to Radon Mitigation Systems to Advance Energy Conversation and the Stabilization of Indoor Radon Concentrations,” 2013, Proceedings of 2013 American Association of Radon Scientists and Technologists International Symposium

8.17: Hatton, T.E., “Designing Efficient Sub Slab Venting and Vapor Barrier Systems for Schools and Large Buildings,” 2010, 2010 International Radon Symposium

8.18: Moorman, L., “Solving Turbulent Flow Dynamics of Complex, multiple Branch Radon Mitigation Systems,” 2008, 2008 International Radon Symposium

8.19: Kentucky Revised Statues, KRS 211.9101 to 211.9135 Radon Measurement, Mitigation, Laboratory Analysis, and Quality Control

8.20: “Standard Guide for Application of Engineering Controls to Facilitate Use or Redevelopment of Chemical-Affected Properties,” ASTM E2435-05 (Reapproved 2015); ASTM International

8.21: ANSI/AARST RMS-MF 2018 - Radon Mitigation Standards for Multifamily Buildings, 2018, AARST Consortium on National Radon Standards

8.22: Neri, A., Evaluation of Percentage-based Radon Testing Recommendations for Multi-family Housing, Centers for Disease Control (CDC)

8.23: Fergusson, B.N., “Alternative Approaches to Managing School Mitigation and Sub-Slab Diagnostic Testing”, 2016, 2016 Proceedings of the International Radon Symposium

8.24: Fergusson, B.N., “Follow-up Report - Alternative Approaches to Managing School Mitigation and Sub-Slab Diagnostic Testing”, 2017, 2017 International Radon Symposium

9.0 Description of Terms

For this RMS, certain terms are defined in this section. Terms not defined herein should have their ordinary meaning within the context of their use. Ordinary meaning is as defined in "Webster's Ninth New Collegiate Dictionary."

9.1 Backdrafting: A condition where the normal movement of combustion products up a flue, resulting from the buoyant forces on the hot gases, is reversed, so that the combustion products can enter the house. Backdrafting of combustion appliances (such as fireplaces and furnaces) can occur when depressurization in the house overwhelms the buoyant force on the hot gases. Backdrafting can also be caused by high air pressures or blockage at the chimney or flue termination.

9.2 Block Wall Depressurization: A radon mitigation technique that depressurizes the void network within a block wall foundation by drawing air from inside the wall and venting it to the outside.
9.3 Perimeter Channel Drain: A means for collecting water in a basement by means of a large gap or channel between the concrete floor and the wall. Collected water may flow to aggregate beneath the slot ("French Drain") or to a sump where it can be drained or pumped away.
9.4 Certified: A rating applied by some jurisdictions to individuals or firms that are qualified and authorized to provide radon testing or mitigation services within the area of their jurisdiction. Kentucky Revised Statues, KRS 211.9101 Radon Measurement, Mitigation, Laboratory Analysis, and Quality Control provide regulatory guidance for certification.
9.5 Communication Test (a.k.a. Sub-Slab Communications Test, Pressure Field Extension): A diagnostic test designed to quantitatively measure the ability of a suction field and air flow to extend through the material beneath a concrete slab floor and thus evaluate the potential effectiveness of a sub-slab depressurization system. This quantitative test is commonly conducted by applying suction on a centrally located hole drilled through the concrete slab and measuring the pressure generated beneath the slab at strategically-located test points. A similar qualitative assessment involves using smoke tubes to observe the movement of smoke downward into small holes drilled in the slab at locations separated from the central suction hole.
9.6 Contractor: An individual listed in EPA's RPP program, specifically one listed as a "Mitigation Service Provider," or certified by a state which requires adherence to the RMS.
9.7 Fan: AARST or NRPP-approved device for use in sub-slab or sub-membrane depressurization systems that is rated to deliver air at a maximum static pressure up to 5 inches w.g.
9.8 pCi/L: The abbreviation for picocuries per liter which is a unit of measure for the amount of radioactivity in a liter of air. The prefix "pico" means a multiplication factor of 1 trillionth. A Curie is a commonly used measurement of radioactivity.
9.9 Pressure Field Extension (PFE): The distance that a pressure change is induced in the sub-slab area, as measured from a single or multiple suction points. (See also Section 9.5, Communication Test.)
9.10 Radon: A naturally occurring radioactive element (Rn-222) which exists as a gas and is measured in picocuries per liter (pCi/L).
9.11 Radon Decay Products (a.k.a. Progeny): The four short-lived radioactive elements (Po-218, Pb-214, Bi-214, Po-214) which exist as solids and immediately follow Rn-222 in the decay chain.
9.12 Re-Entrainment: The unintended re-entry into a building of radon that is being exhausted from the vent of a radon mitigation system.
9.13 Radon Mitigation System (RMS): Any system or steps designed to reduce radon concentrations in the indoor air of a building.
9.14 Soil Gas: The gas mixture present in soil which may contain radon.
9.15 Soil-Gas Retarder: A continuous membrane or other comparable material used to retard the flow of soil gases into a building.
9.16 Stack Effect: The overall upward movement of air inside a building that results from heated air rising and escaping through openings in the building envelope, thus causing indoor air pressure in the lower portions of a building to be lower than the pressure in the soil beneath or surrounding the building foundation.

9.17 Sub-Membrane Depressurization: A radon control technique designed to achieve lower air pressure in the space under a soil-gas retarder membrane laid on the crawl-space floor, relative to air pressure in the crawlspace, by use of a fan-powered vent drawing air from beneath the membrane.
9.18 Sub-Slab Depressurization (Active): A radon control technique designed to achieve lower sub-slab air pressure relative to indoor air pressure by use of a fan-powered vent drawing air from beneath the concrete slab.
9.19 Sub-Slab Depressurization (Passive): A radon control technique designed to achieve lower sub-slab air pressure relative to indoor air pressure by use of a vent pipe (without a fan) routed through the conditioned space of a building and connecting the sub-slab area to the outdoor air. This system relies primarily on the convective flow of warmed air upward in the vent to draw air from beneath the concrete slab.
9.20 Slab or Membrane Depressurization Zone: A slab segment that supports a continuous pressure field extension zone under the defined area. In the absence of diagnostic data, a slab segment or zone is defined as a segment that can be depressurized across the defined area with one or more fans. (See also Section 9.5, Communication Test and Section 9.8, Pressure Field Extension)
9.21 Working Level (WL): A unit of radon decay product exposure rate. Numerically, any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of 130,000 MeV of potential alpha energy. This number was chosen because it is approximately the total alpha energy released from the short-lived decay products in equilibrium with 100 pCi of Rn-222 per liter of air. (See also the referenced document in Paragraphs 8.11 and 8.13.)
9.22 Working Level Month (WLM): A unit of exposure used to express the accumulated human exposure to radon decay products. It is calculated by multiplying the average working level to which a person has been exposed by the number of hours exposed and dividing the product by 170.

10.0 General Practices

Kentucky Revised Statues, KRS 211.9101 to 211.9135 Radon Measurement, Mitigation, Laboratory Analysis, and Quality Control provide regulatory guidance for the relationship between radon mitigation contractors and their clients.

10.1 Based on guidance contained in "A Citizen's Guide to Radon," (EPA 402-K-12-002 May 2012) the contractor shall refer the client to the discussions of interpreting indoor radon test results and the health risk associated with the radon level found in the building. The "Consumer's Guide to Radon Reduction," (EPA 402-K-10-005 March 2013) is another appropriate reference for providing consumer advice on indoor radon mitigation.
10.2 When delays in the installation of a permanent radon control system are unavoidable due to building conditions or construction activities, and a temporary system is installed, the contractor shall inform the client about the temporary nature of the system. A label that is readable from at least three feet shall be placed on the system. The label shall include a statement that the system is temporary and that it will be replaced with a permanent system within 30 days. The label shall also include the date of installation, and the contractor's name, phone number, and RPP Identification Number. (EXCEPTION: The 30 day limit on use of a temporary mitigation system may be extended in cases where a major renovation or change in building use necessitates a delay in installation of a permanent mitigation system that is optimized to the new building configuration or use. The appropriate state or

local building official or radon program official should be notified when this exception is being applied.)
10.3 When the selected mitigation technique requires use of sealants, caulks, or bonding chemicals containing volatile solvents, prior to starting work the contractor shall inform the client of the need to ventilate work areas during and after the use of such materials. Ventilation shall be provided as recommended by the manufacturer of the material. Safety Data Sheets for such materials shall be onsite and shall be made available to the Owner.

11.0 Building Investigation

Limited sub-slab communication or Pressure Field Extension (PFE) testing has been performed (See Appendix A). The testing was designed to support a competitive bid process, provide PFE data of the various types of slab construction found at this site, and to demonstrate the applicability of an active sub-slab depressurization (ASD) system; not to provide all the information needed to design the best system for this structure. Additional testing shall be performed at the contractor's discretion to optimize the ASD systems for each space.

11.1 The contractor shall conduct a thorough visual inspection of the building prior to initiating any radon mitigation work. The inspection is intended to identify any specific building characteristics and configurations (e.g., large cracks in slabs, exposed earth in crawlspaces, open stairways to basements) and operational conditions (e.g., continuously running HVAC systems or operational windows) that may affect the design, installation, and effectiveness of radon mitigation systems. As part of this inspection, clients may be asked to provide selected information on the building (e.g., construction specifications, pictures, drawings, etc.) that might be of value in determining the radon mitigation strategy.
11.2 The contractor shall immediately inform the Project Designer in writing of any site information that may warrant deviation from this specification.
11.3 Certain diagnostic testing may have occurred to select the most effective radon control system; to avoid the costs of installing ineffective systems; and to provide information sufficient to conduct a competitive bid process. However, it is recommended that the contractor conduct any additional diagnostic tests deemed appropriate to assist in identifying and verifying suspected radon sources and entry points. Radon grab sampling, continuous radon monitoring, differential pressure measurements, and chemical smoke sticks are several examples of commonly-used diagnostic testing devices.
11.4 It is recommended that during the building investigation, contractors routinely perform diagnostic tests to evaluate the existence of, or the potential for, backdrafting of natural draft combustion appliances. Published procedures for conducting backdrafting tests are addressed in the Reference Documents.

If spillage is confirmed from any natural draft combustion appliance, the Contractor shall advise the Project Designer of the backdrafting condition and that active radon mitigation systems cannot be installed until the condition has been corrected. (See Section 17.3 for post-mitigation backdrafting testing.)

11.5 Applicable drawings, site notes, and illustrations of the building characteristics (foundation details, utilities, HVAC systems, etc.) have been provided as part of this specification. The contractor shall edit drawings as required to include any conditions noted onsite, such as changes in the location of load-bearing walls, drain fixtures and HVAC systems. Suspected or confirmed radon entry points, results of any diagnostic testing, the

anticipated layout of any radon mitigation system piping, and the anticipated locations of any vent fan and system warning devices for the envisioned mitigation systems shall be noted. Sketches shall be finalized during installation and shall be included in the documentation. (See Section 18.2)

12.0 Worker Health and Safety

12.1 Contractors shall comply with all OSHA, state and local standards or regulations relating to worker safety and occupational radon exposure. Applicable references in the Code of Federal Regulations and NIOSH publications are listed in Sections 8.11, 8.12, and 8.13.

12.2 In addition to OSHA and NIOSH standards, the following requirements that are applicable for the safety and protection of radon mitigation workers shall be met:

12.2.1 The contractor shall advise workers of the hazards of exposure to radon and the need to apply protective measures when working in areas of elevated radon concentrations.

12.2.2 The contractor shall have a worker protection plan on file that is available to all employees and is approved by any state or local regulating agencies that require such a plan. Exception: A worker protection plan is not required for a contractor who is a sole proprietor unless required by state or local regulations.

12.2.3 The contractor shall ensure that appropriate safety equipment such as hard hats, face shields, ear plugs, steel-toe boots and protective gloves are available on the job site during cutting, drilling, grinding, polishing, demolishing or other activity associated with radon mitigation projects.

12.2.4 All electrical equipment used during radon mitigation projects shall be properly grounded. Circuits used as a power source should be protected by Ground-fault Circuit Interrupters (GFCI).

12.2.5 When work is required at elevations above the ground or floor, the contractor shall ensure that ladders or scaffolding are safely installed and operated.

12.2.6 Work areas shall be ventilated to reduce worker exposure to radon decay products, dust, or other airborne pollutants. In work areas where ventilation is impractical or where ventilation cannot reduce radon levels to less than 0.3 WL (based on a short term diagnostic test, e.g., grab sample), the contractor shall ensure that respiratory protection conforms with the requirements in the NIOSH Guide to Industrial Respiratory Protection. (See Sections 8.11 and 8.12.) (Note: If unable to make working level measurements, a radon level of 30 pCi/L shall be used.)

12.2.7 Where combustible materials exist in the area of the building where radon mitigation work is being conducted and the contractor is creating temperatures high enough to induce a flame; the contractor shall ensure that fire extinguishers suitable for type A, B, and C fires are available in the immediate work area.

12.2.8 Pending development of an approved personal radon exposure device and a protocol for its use, contractors shall record employee exposure to radon at each work site, based on the following:

1. the highest pre-mitigation indoor radon or working level measurement available, and
2. the time employees are exposed (without respirator protection) at that level (See Section 12.2.6.)

(Note: This approach is not intended to preclude the alternative use of on-site radon or radon decay product measurements to determine exact exposure.) Consistent with OSHA Permissible Exposure Limits, contractors shall ensure that employees are exposed to no more than 4 working level months (WLM) over a 12 month period. (An equilibrium ratio of 50 percent shall be used to convert radon exposure to WLM.)

12.2.9 In any planned work area where it is suspected that friable asbestos may exist and be disturbed, radon mitigation work shall not be conducted until a determination is made by a properly trained or accredited person that such work will be undertaken in a manner which complies with applicable asbestos regulations.
12.2.10 When mitigation work requires the use of sealants, adhesives, paints, or other substances that may be hazardous to health, contractors shall provide employees with the applicable Material Safety Data Sheets (MSDS) and explain the required safety procedures.

13.0 Systems Design

13.1: All radon mitigation systems shall be designed and installed as permanent, integral additions to the building, except where a temporary system has been installed in accordance with Section 10.3.
13.2: All radon mitigation systems shall be designed to avoid the creation of other health, safety, or environmental hazards to building occupants, such as backdrafting of natural draft combustion appliances.
13.3: All radon mitigation systems shall be designed to maximize radon reduction and in consideration of the need to minimize excess energy usage, to avoid compromising moisture and temperature controls and other comfort features, and to minimize noise.
13.4: Performance Requirements:

a. Slab-on-Grade: To maintain required depressurization during adverse conditions, the active SSD system shall depressurize the slab to levels as described in Section 17, when readings are normalized to the ambient static pressure across the slab. Measurement results to support this performance shall be recorded as part of final documentation.
b. Crawlspace: To maintain required depressurization during adverse conditions, the active SSD system shall depressurize the *membrane* to maintain no less than 0.006 in. WG (~1.5Pa) everywhere under the mitigated slab sections, when readings are normalized to the ambient static pressure across the *membrane*. Measurement results to support this performance shall be recorded as part of final documentation *as required in Section 18*.
c. Crawlspace Test Port Requirements: To provide for monitoring of sub-membrane differential pressures, test ports with flexible tubing that extends to a pre-determined access location shall be installed for each crawlspace segment. The Contractor shall install a minimum of three ports for each crawlspace section, each located midway between the suction manifold and the perimeter with two of the ports to be located at opposite ends of the section. Test port locations shall be included in the project plan.
d. Building Depressurization Requirements: Due to building-specific variations, the test requirement shall be specified in Section 19 as applicable.

13.5: Refer to Section 17 for post-installation test requirements and Appendix C for the initial configuration, which describes the slab segmentation to be assumed for competitive bid purposes. Additional test points shall be located at the slab segments of optional suction point locations, if no new suction point is created at that slab segment. The

baseline system is defined when the Contractor, the Project Designer, and the Owner mutually agree on specific slab segments and associated post-mitigation test point locations prior to project start.
13.6: All active soil depressurization radon mitigation systems and their components shall be designed to comply with the laws, ordinances, codes, and regulations of relevant jurisdictional authorities, including applicable mechanical, electrical, building, plumbing, energy, and fire prevention codes.

14.0 Systems Installation

14.1 General Requirements

14.1.1 All components of active soil depressurization radon mitigation systems installed in compliance with provisions of the RMS shall also be in compliance with the applicable mechanical, electrical, building, plumbing, energy and fire prevention codes, standards, and regulations of the local jurisdiction.
14.1.2 The contractor shall obtain all required licenses and permits, and display them in the work areas as required by local ordinances.
14.1.3 Where portions of structural framing material must be removed to accommodate radon vent pipes, material removed shall be no greater than that permitted for plumbing installations by applicable building or plumbing codes.
14.1.4 Where installation of an active soil depressurization radon mitigation systems requires pipes or ducts to penetrate a firewall or other fire resistance rated wall or floor, penetrations shall be protected in accordance with applicable building, mechanical, fire, and electrical codes.
14.1.5 When installing active soil depressurization radon mitigation systems that use sump pits as the suction point for active soil depressurization, if sump pumps are needed, it is recommended that submersible sump pumps be used.
14.1.6 *All suction points and test ports shall be sealed, including ones generated during the diagnostic work by the Owner prior to ASD installation*.
14.1.7 *External components shall be installed with equipment cosmetic cover panels and shall be painted to match exterior as specified by the Owner*.

14.2 Electrical Requirements

14.2.1 Wiring for all active radon mitigation systems shall conform to provisions of the National Electric Code and any additional local regulations.
14.2.2 Wiring may not be located in or chased through the mitigation installation ducting or any other heating or cooling ductwork.
14.2.3 Radon mitigation fans installed on the exterior of buildings shall be hard-wired into an electrical circuit. Plugged fans shall not be used outdoors.
14.2.4 An electrical disconnect switch or circuit breaker shall be installed in radon mitigation system fan circuits to permit deactivation of the fan for maintenance or repair by the building owner or servicing contractor (Disconnect switches are not required with plugged fans)
14.2.5 The written Operations, Maintenance, and Monitoring Plan shall include specific information about variable speed controls that are installed to support energy conservation endeavors. Measurements of system performance shall be conducted to document system performance for each level of operation.
14.2.6 Such variable radon system controls shall provide for a method to prevent inadvertent adjustment of the control by non-authorized personnel, such as keyed access to controls and a written log of system adjustments.

14.3 HVAC Installation Requirements

14.3.1 Modifications to an existing HVAC system, which are proposed to mitigate elevated levels of radon, should be reviewed and approved by the original designer of the system (when possible) or by a licensed professional mechanical engineer or contractor.

14.3.2 Foundation vents, installed specifically to reduce indoor radon levels by increasing the natural ventilation of a crawlspace, shall be non-closeable. In areas subject to subfreezing conditions, the existing location of water supply and distribution pipes in the crawlspace, and the need to insulate or apply heat tape to those pipes, should be considered when selecting locations for installing foundation vents.

14.3.3 Heat/Energy Recovery Ventilation (HRV or ERV) systems shall not be installed in rooms that contain friable asbestos.

14.3.4 In HRV/ERV installations, supply and exhaust ports in the interior shall be located a minimum of 12 feet apart. The exterior supply and exhaust ports shall be positioned to avoid blockage by snow or leaves and be a minimum of 10 feet apart.

14.3.5 Contractors installing HRV/ERV systems shall verify that the incoming and outgoing airflow is balanced to ensure that the system does not create a negative pressure within the building.

14.3.6 Both internal and external intake and exhaust vents in HRV systems shall be covered with wire mesh or screening to prevent entry of animals or debris or injury to occupants.

14.3.7 The written Operations, Maintenance, and Monitoring Plan shall include specific information about HRV/ERV system operation and maintenance, such as periodic filter replacement and inlet grill cleaning requirements to maintain a balanced airflow.

15.0 Materials

15.1 All mitigation system electrical components shall be U.L. listed or of equivalent specifications.

15.2 As a minimum, all plastic vent pipes in mitigation systems shall be made of Schedule 40 piping or its equivalent. Foam core pipe is not acceptable.

15.3 Vent pipe fittings in a mitigation system shall be of the same material as the vent pipes. (Reference Documents 8.17 and 8.19 provide information about acceptable methods when installing radon vent pipes in sump pit covers.)

15.4 Only manufacturer-recommended cleaning solvents and adhesives shall be used to join plastic pipes and fittings installed in the mitigation system.

15.5 Penetrations of sump covers to accommodate electrical wiring, water ejection pipes, or radon vent pipes shall be designed to permit air-tight sealing around penetrations, using caulk or grommets. Sump covers that permit observation of conditions in the sump pit are recommended.

15.6 Plastic sheeting installed in crawlspaces as soil-gas retarders shall be a minimum of 12 mil (cross-laminated) polyethylene or equivalent flexible material, as measured at the plastic and not across raised reinforcement threads. A minimum of 20 mil (cross-laminated) polyethylene or equivalent reinforced flexible material, as measured at the

plastic and not across raised reinforcement threads, shall be used when crawlspaces are used for storage, or frequent entry is required for maintenance.

15.7 The same sheeting material shall be used in each crawlspace segment, i.e., no mixing of sheeting materials shall occur within the segment. If a crawlspace section is defined as storage or maintenance, then 20mil shall be used throughout.

15.8 Any wood used in attaching soil-gas retarder membranes to crawlspace walls or piers shall be pressure treated or naturally resistant to decay and termites.

16.0 Monitors and Labeling

16.1 All active soil depressurization and block wall depressurization radon mitigation systems shall include a mechanism to monitor system performance and warn of system failure. The mechanism shall be simple to read or interpret and be located where it is easily seen or heard by building occupants and protected from damage or destruction.

16.2 Electrical radon mitigation system monitors (whether visual or audible) shall be installed on non-switched circuits and be designed to reset automatically when power is restored after service or power supply failure. Battery operated monitoring devices shall not be used unless they are equipped with a low power warning feature.

16.3 Mechanical radon mitigation system monitors, such as manometer type pressure gauges, shall be clearly marked to indicate the range or zone of pressure readings that existed when the system was initially activated and tested.

16.4 A system description label shall be placed on the mitigation system, the electric service entrance panel, or other prominent location. This label shall be legible from a distance of at least three feet and include the following information: "Radon Reduction System," the installer's name, phone number, and RCP Identification Number, the date of installation, and an advisory that the building should be tested for radon at least every two years or as required or recommended by state or local agencies. In addition, all exposed and visible interior radon mitigation system vent pipe sections shall be identified with at least one label on each floor level. The label shall read, "Radon Reduction System."

16.5 The circuit breakers controlling the circuits on which the radon vent fan and system failure warning devices operate shall be labeled "Radon System."

17.0 Post-Mitigation Testing and Project Completion

17.1 After installation of an active soil depressurization radon mitigation system, the contractor shall re-examine and verify the integrity of the fan mounting seals and all joints in the interior vent piping. The inspection results shall be noted on marked drawings that indicate components and their locations within the system.

17.2 After installation of any active radon mitigation system, the contractor shall measure airflows in system piping or ducting to assure that the system is operating as designed.

17.2.1 The testing performed in the Sub-Slab Communications Tests (Appendix A) shall be duplicated on the completed system where suction points and test points agree. New test points shall be created for additional slab segments ventilated, but not previously tested. The approximate furthest point from each vent pipe shall be tested with results recorded in the final documentation.

17.2.2 Any existing test points may be reused, but additional test points shall be created to document successful system operation. The test points shall be located as follows:

17.2.2.1 A minimum of three test points at the approximate perimeter or furthest point away from the suction point(s)

17.2.2.2 A minimum of three test points approximately half the distance or midway between the furthest point and the suction point(s)

17.2.2.3 The number of far test points shall be equal or greater than the number of “midway” test points

17.2.3 Additional test points shall be located at the slab segments of optional suction point locations, if no new suction point is created at that slab segment. The Contractor and the Project Designer shall mutually agree on specific slab segments and associated post-mitigation test point locations prior to project start.

17.2.4 For certain mutually-agreed sub-slab locations and conditions, such as heavy clay, the Contractor and the Project Designer may agree on a delayed test schedule to allow for potential sub-slab drying. Likewise, since Fayette County is in a Karst region, conditions under a particular slab segment may not be conducive to creating a negative pressure relationship. In this case, the Contractor and the Project Designer may agree to pursue alternative approaches to mitigation beside ASD. Then the contractor may be compensated, based on the line item schedule presented as part of the bid documents.

17.2.5 The required PFE test results form is provided in Appendix B.

17.3 Immediately after installation and activation of any active (fan-powered) sub-slab depressurization or block wall depressurization system in buildings containing natural draft combustion appliances, the building shall be tested for backdrafting of those appliances. Any backdrafting condition that results from installation of the radon mitigation system shall be corrected before the system is placed in operation. (Procedures and a checklist for conducting backdrafting tests are covered in the reference documents.)

17.4 Upon completion of radon mitigation work, a radon test of mitigation system effectiveness shall be conducted using calibrated test devices in accordance with EPA testing protocols or state requirements or as specified herein. This test should be conducted no sooner than 24 hours nor later than 30 days following completion and activation of the mitigation system(s). This test may be conducted by the Owner (if properly trained per EPA requirements) or by a qualified third party testing firm at the Owners expense. The Contractor shall be furnished a copy of any post-mitigation testing conducted by the Owner.

17.5 To verify continued effectiveness of the radon mitigation system(s) installed, the Owner should retest mitigated areas at least every two years or as required by internal policy, or as recommended by state or local authority. Retesting is also recommended if the building undergoes significant alteration, including HVAC system modifications.

17.6 The Contractor has successfully installed the ASD mitigation system when all requirements of Section 17.0 Post-Mitigation Testing are conducted with results indicating achievement of slab depressurization targets as follows:

17.6.1 Achievement of at least 0.005”w.g. at the test points located at the approximate perimeter or furthest points away from the suction point(s).

17.6.2 Achievement of at least 0.01”w.g. when all test point readings are averaged.

17.7 The contractor has successfully completed the installation when the above criteria have been met and have been documented as described in Section 18.

18.0 Contracts and Documentation

18.1 Contractors shall provide the following written information to the Owner prior to initiation of work:

1. The contractor's AARST-NRPP Mitigation Service Provider or NRSB-RMS identification number.
2. A statement that describes the planned scope of the work and an estimate of the time needed to complete the work, including project milestones and deadlines.
3. Material Safety Data Sheets for all chemicals to be used in the installation.
4. A statement to indicate compliance with all EPA standards and those of other agencies having jurisdiction (e.g., code requirements).
5. A statement describing any system maintenance that the building owner would be required to perform.
6. An estimate of the installation cost and annual operating costs of the system.
7. The conditions of any warranty or guarantee.

18.2 In accordance with Kentucky Revised Statues, KRS 211.9101 to 211.9135 Radon Measurement, Mitigation, Laboratory Analysis, and Quality Control, the Contractor shall provide a written final operations, maintenance and monitoring (OM&M) plan for the mitigation systems. OM&M plans shall include the following essential information

18.2.1 ***A recommendation to retest*** mitigated areas at least every 2 years and as further stipulated in the most current version of the “Protocol for Conducting Radon and Radon Decay Product Measurements In Schools and Large Buildings” ANSI/AARST MALB.

18.2.2 ***Fan Monitors***:

18.2.2.1 ***A description of the fan monitors and recommendation to check the monitors*** at least quarterly or as otherwise specified in an operational and maintenance plan.

18.2.2.2 Documented startup parameters such as pressure gauge readings that existed at the time successful mitigation was initially achieved.

18.2.2.3 A list of appropriate actions for clients to take if the system failure warning device indicates system degradation or failure.

18.2.3 ***A description of the mitigation systems as installed to include***:

18.2.3.1 Basic operating principles

18.2.3.2 (1) Descriptive narrative of the system layout or (2) system components labelled on a floor plan sketch or both. Either method may be complemented with photographic documentation.

18.2.3.3 Completed Equipment Inventory Forms as shown in Appendix B.

18.2.4 ***A description of any important observations that might adversely affect the mitigation systems*** or other building systems and any deviations from state requirements.

18.2.5 ***A statement of limitations*** the Contractor places on professional obligations, future maintenance and monitoring of the mitigation systems effectiveness.

18.2.6 ***Contact information*** for service inquiries and identification of the Qualified Mitigation Professional responsible for adherence to protocols to include:

18.2.6.1 Name, address and phone number

18.2.6.2 Relevant radon mitigation certification and/or licensing number

18.2.6.3 Signature (manual or electronic in conformance with Electronic Signatures in Global and National Commerce {E-SIGN} Act).

18.3 In addition to the requirements of Section 18.2, the Contractor shall provide clients with an information package that includes:

- Any building permits required by local codes.
- Pre-and post-mitigation radon test data.
- Pre- and post-mitigation ventilation diagnostic test data.
- Copies of contracts and warranties.
- A description of the mitigation system installed and its basic operating principles.
- A description of the proper operating procedures of any mechanical or electrical systems installed, including manufacturer's operation and maintenance instructions and warranties.

18.4 The Contractors shall keep records of all radon mitigation work performed and maintain those records for 3 years or for the period of any warranty or guarantee, whichever is longer. These records should include:

- The Building Investigation Summary and floor plan sketch.
- Pre- and post-mitigation radon test data.
- Pre- and post-mitigation ventilation diagnostic test data.
- Copies of contracts and warranties.
- A narrative or pictorial description of mitigation system(s) installed.

18.5 Other records or bookkeeping required by local, state, or Federal statutes and regulations shall be maintained for the period(s) prescribed by those requirements.

18.6 EPA recommends that health and safety records, including worker radon exposure logs, be maintained for a minimum of 20 years.

18.7 Electrical permit documents and related invoices as required for Agencies Having Jurisdiction (AHJ) shall be submitted separately to the Owner for payment and document retention.

18.8 A template of the required OM&M Plan will be provided to the contractor. Refer to Appendix B in the OM&M Plan that includes other required documentation.

19.0 Site-Specific Notes and Drawings

19.1 This project addresses the sections of the building as noted in Figure 1 & 2. Non-color-coded areas of the structure either (1) do not require radon mitigation or (2) are to be addressed by other radon mitigation methods.

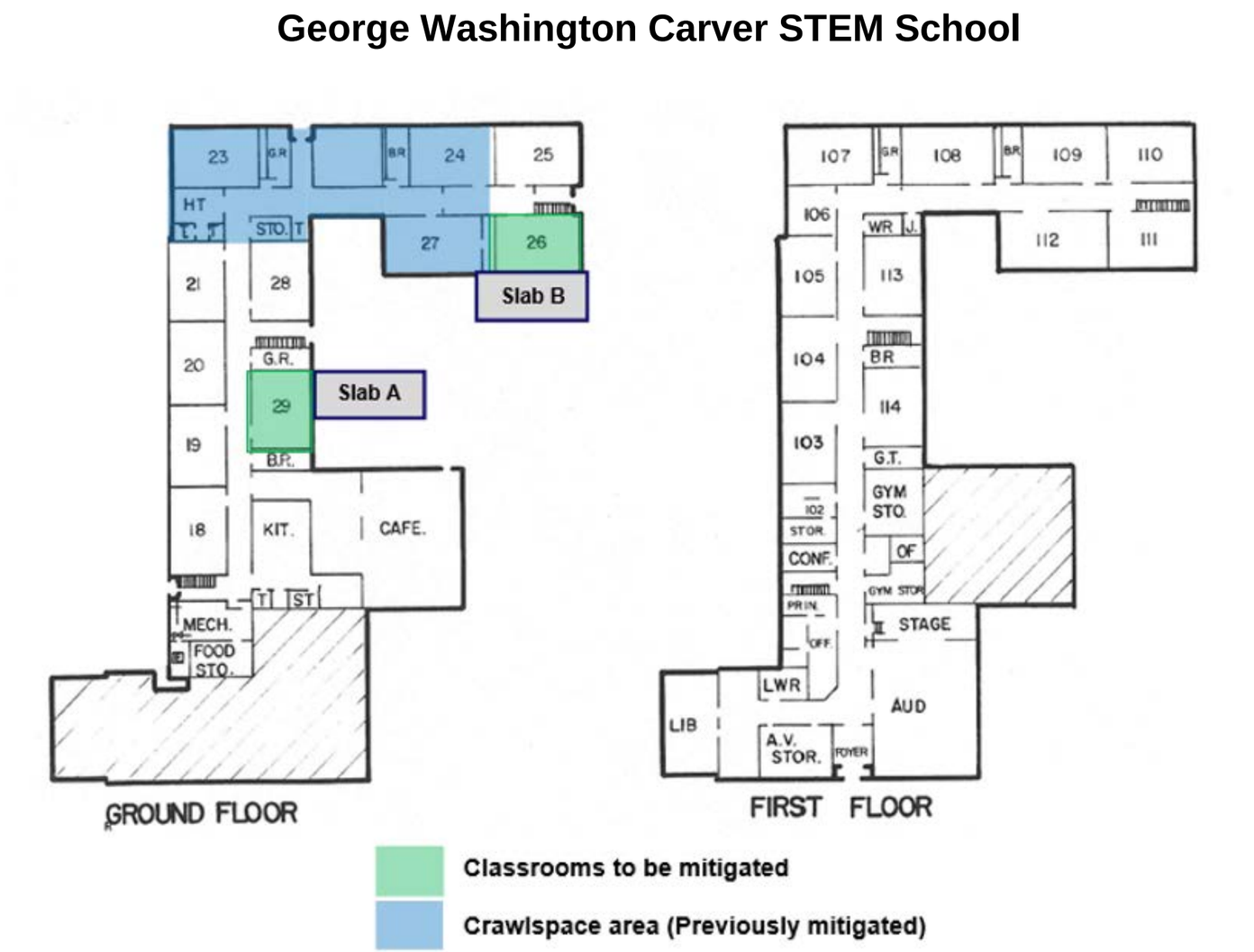


Figure 1: Targeted areas of George Washington Carver STEM Academy for ASD Radon Mitigation (Green).
Slabs A & B above correspond to the suction point in Appendix A: Radon Diagnostic Report.

Suction Point Example

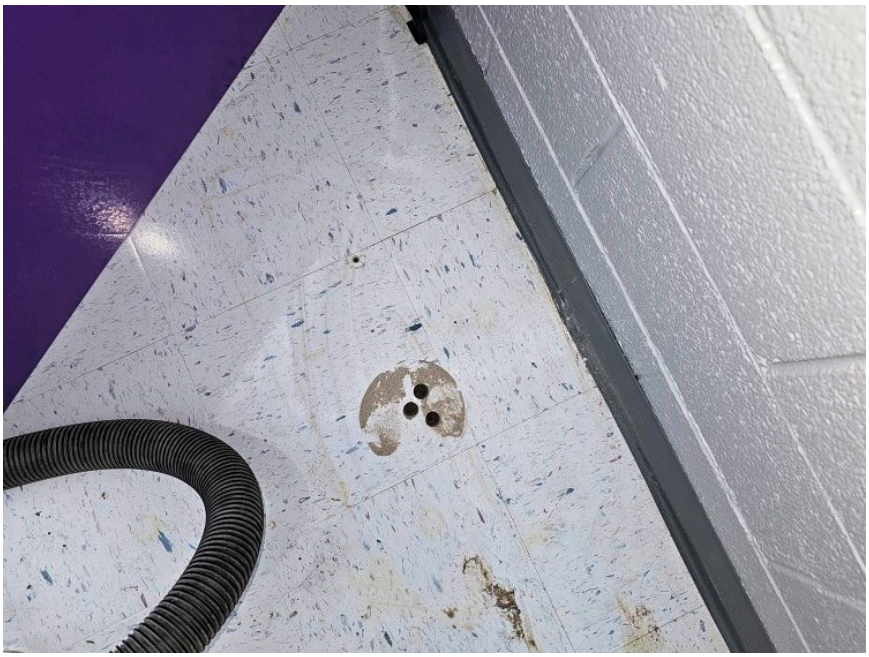


Figure 2: View of Test Suction Point B (Room #26)

19.2 The primary ASD sites are located in the lower level. A diagnostic report is furnished to describe actual conditions in this area.

19.3 Architectural, mechanical and foundation drawings may be furnished separately due to electronic file size. The report contained in Appendix A also provides pertinent foundation details and drawings that were used during PFE/Sub-Slab Communications testing.

19.4 The Contractor and the Project Designer shall mutually agree on specific slab segments and associated post-mitigation test point locations prior to project start. Otherwise, the Project designer shall solely select post-mitigation test points as part of post-mitigation testing for successful system installation.

19.5 Prior to physical construction start, the Contractor shall meet with the Owner to finalize Extraction Point locations and associated pipe routing. If roof penetrations are required, the Contractor shall not void any warranty pertaining to existing roof. *Contractors shall contact Jeff Harris of Fayette County Public Schools prior to penetrating/modifying roofing materials (859-338-9271).* Fan exhaust above the roof shall be finished with a 180 degree bend and screen or hardware cloth clamped to outlet. Roof penetration should stand off not less than four feet from the edge of roof or parapet. Route piping above ceiling where possible.

19.6 The contractor shall permanently repair all suction points, whether generated during the diagnostic phase prior to ASD installation or during the contractor's diagnostic PFE testing. Test ports shall be plugged and marked on final documentation to allow future testing as needed for system maintenance and repair.

Appendix A

Radon Diagnostic Report

RADON DIAGNOSTIC
TESTING AT

GEORGE WASHINGTON CARVER STEM SCHOOL

Prepared For:
Mr. Jeff Harris
Department of Risk Management
Fayette County Public Schools
Ambrose Building
128 Walton Ave.
Lexington, KY 40502

Testing Performed By:

David Maddux
Industrial Hygienist
NRPP ID#s
11110617-RMP & 110892-RMS

Reviewed by

Bruce Fergusson, CIH, PE (retired)

Air Source Technology, Inc.
131 Prosperous Place, Suite 17
Lexington, Kentucky 40509

THE AMERICAN BOARD OF INDUSTRIAL HYGIENE INCORPORATED
CERTIFICATION NUMBER 10354 CP
EXPIRES 12-1-2023
PENNSYLVANIA-1988
BRUCE N. FERGUSSON, CIH

Report Date: August 25, 2023
ASTI Project # PC224

TABLE OF CONTENTS

Executive Summary

Within the limits of the observations, testing conducted, and the analyses performed, the Pressure Field Extension (PFE) testing indicates that an Active Soil Depressurization (ASD) Radon mitigation system would have a high likelihood of successfully reducing Radon levels in the affected area of this structure, below the EPA action level of 4pCi/l.

Revision notes: This is the initial report dated August 25, 2023.

Introduction

Air Source Technology, Inc. (ASTI) conducted sub-slab communication diagnostic testing, a.k.a., Pressure Field Extension (PFE) testing at George Washington Carver STEM School located at 2010 Leestown Road in Lexington, KY. David Maddux & Brian Leifeld of ASTI, conducted the site visit and testing on July 3, 2023. The Scope of Work was to conduct sub-slab communication testing and to provide observations & drawings of testing to support the bid process for radon mitigation of this recently identified area.

A Note Regarding ASTI Diagnostic Services: This report is intended to document site survey results and to provide the owner and radon mitigation contractor with information and options, which will enable them to make informed decisions about potential radon system design and needed components. The radon mitigation contractor may require additional testing. The information and recommendations in this report supersede all other communications. Amendments and revisions to this report will be issued if required.

Sampling Protocols

SUB-SLAB COMMUNICATION TESTING

General Process Overview: This quantitative process is part of an assessment of sub-slab pressure field extension beneath a concrete slab floor. Field extension is evaluated by applying suction at strategically-located suction holes that are drilled through the slab; then measuring the resultant pressure at remotely located test points. The standard procedure as described below:

1. Examine floor plans and foundation drawings, if available; to determine suction point(s) that would be practical spots for sub-slab suction piping.
2. A suction point with three 1/2" diameter holes was used at this location. (Active school activities prevented extensive diagnostics.)
3. Use a standard shop vacuum (shop-vac) to apply a negative pressure to suction points while measuring the volume of airflow exhausting the shop-vac. As part of the assessment the reference pressure was also measured at a nearby (approximately 1 foot) 1/4" diameter test point.
4. The negative pressure created is measured at 1/4" diameter test points, located away from the suction point. These measurements are used to map the field extension of each suction point or combinations of suction points. Prior to each test, the micro-manometer is "zeroed" to the pressure across the slab to allow direct measurement of the differential pressure created by the shop-vac.
5. Using the airflow volumes at the suction holes and the pressures measured at the test points, the characteristics of the sub-slab communication are evaluated. Knowing the airflow volume needed to create pressure is useful in identifying the general characteristic of the slab; i.e., "leaky" versus "tight."
6. Where the test points measure at or less than 0.01" w.g., the measurement is repeated at least three times to verify measurement precision by stopping the vacuum source, waiting for "zero" reading; then repeating the measurement.
7. Pressure Field Extension (PFE) testing was performed only in the designated areas (Classrooms 26 & 29) as part of this project.

DIFFERENTIAL PRESSURES – Micro Manometer:

The TSI/*ALNOR* Model AXD610 Digital MicroManometer was used to measure static, total and velocity pressures, with a differential pressure range of -15 to 15 inches of water ("H_2O). If needed, it can also calculate velocity when used with a pitot tube. Applications include HVAC commissioning and troubleshooting, testing and balancing, pitot tube duct traverses, static pressure measurements and differential pressure measurements. For low-pressure difference readings, the instrument is re-zeroed, using the field self-calibration function.

Pressure Range: -15 to +15 in. H2O (-28.0 to +28.0 mm Hg, -3735 to +3735 Pa)
Accuracy: ±1% of reading ±0.005 in. H2O (±1 Pa, ±0.01 mm Hg)
Resolution: 0.001 in. H2O (0.1 Pa, 0.01 mm Hg)
Velocity From a Pitot Tube Range: 250 to 15,500 ft/min (1.27 to 78.7 m/s)
Accuracy: ±1.5% at 2,000 ft/min (10.16 m/s)
Resolution: 1 ft/min (0.1 m/s)
Instrument Temperature Range Operating: 40 to 113°F (5 to 45°C)
Storage: -4 to 140°F (-20 to 60°C)

FOR THIS PROJECT: To allow for ambient pressure variations and to verify precision, with low-pressure difference readings (<0.01"w.g.), the instrument is re-zeroed. At least three consecutive readings are then collected, using the following procedure:

1. The vacuum source is shut off and the instrument reading is allowed to settle, then zero-calibrated.
2. The vacuum source is activated and the instrument reading is allowed to settle, then the reading is noted.

After three consecutive identical readings, the value is recorded.

VACUUM CLEANER (DIFFERENTIAL PRESSURE GENERATOR):

A heavy duty Shop-Vac®, equipped with 2½ inch flexible hoses, is used to generate differential pressures with measured airflow across the slab boundary. Each unit was equipped with an exhaust adapter fitting to allow direct measurement of exhaust airflow with a vane anemometer. The Shop-Vac® can generate approximately 150 cfm under no-load conditions and sufficient back-pressure to identify no-flow conditions beneath the slab.

SHOP-VAC AIRFLOWS - TESTO 417 VANE ANEMOMETER

The Testo 417 is a handheld instrument used to measure flow velocities, flow volumes, and temperatures by means of an integrated 100mm vane with temperature probe.

SPECIFICATIONS:

Measuring range: +0.3...+20m/s; 0...+50°C/+32...+122°F
Resolution: 0.01m/s; 0.1°C / 0.1°F
Accuracy: ±0.1m/s+1.5% of reading; (± 1 Digit) ±0.5°C/±0.9°F
Probe: Vane probe 100mm, NTC temperature probe (integrated)
Measuring rate: 2/s
Operating temperature range: 0...+50°C / +32...+122°F

GENERAL OBSERVATIONS:

A non-invasive limited visual survey of building characteristics that may affect slab communication and building envelope differential pressures was conducted while onsite, including, but not limited to such factors as HVAC characteristics and zones, slab vintage and modifications, building history and renovations, etc. Areas tested are representative of known foundation constructions.

Discussion of Results

OBSERVATIONS

The following observations were noted during the August 23, 2023 site visit:

1. Few foundation and other drawings relating to the affected portions of the building were available for review.
2. George Washington Carver STEM School for Boys was constructed in 1939 and opened as Johnson Elementary School. It is believed to have undergone multiple renovations and has had at least 1 addition. It also recently operated under the name CG Woodson School.
3. There are multiple sub-membrane radon mitigation systems installed in the (rear) crawlspace area of this school.
4. The areas of the school requiring mitigation are two stories.
5. A dirt base mixed with gravel was found in room 26 under the slab.
6. A gravel base was found in Room 29. A perimeter drain system may be present in the area of the suction point. This room is located between two restrooms.
7. After school activities were active during diagnostic testing. Quick diagnostic testing was conducted to confirm sub-slab communication given the lack of available foundation drawings.
8. Static pressure differentials between the sub-slab space and occupied space were stable and measurable in each classroom. Additional diagnostics will be required by the mitigation contractor.
    a. In classroom 29, the reading from the furthest accessible space measured -0.03”w.g. during testing.
    b. In classroom 26, the reading from the furthest accessible space measured -0.003”w.g. during testing.
9. Sub-slab communication and sub-slab pressure fields were established in each area measured.
10. Backdrafting of combustion appliances can occur when depressurization restricts the buoyant force on the exhausted hot gases, causing a number of potentially hazardous conditions. The operation of a radon sub-slab ventilation system can aggravate and/or cause backdrafting of combustion appliances by impacting the makeup air. Note: Contractors should consult with the building owner.

COMMUNICATION TEST RESULTS

Table 1 Pressure Measurements – 8/23/23 (Room 29)						
Test #	**Suction Point #**	**Reference Pressure[1] ("H_2O)**	**Suction Volume (CFM)**	**Test Point**	**Test Point Pressure ("H_2O)**	**Additional Comments**
1	A	-4.93	75	1	-0.37	Gravel beneath slab, with possible plumbing or perimeter drain in the area of the SP.
				2	-0.13	
				3	-0.03	

[1]Reference pressure measured approximately 6 to 12 inches from the suction point.

[2] Additional test points were not feasible due to school activities.

COMMUNICATION TEST RESULTS

Table 1 Pressure Measurements – 8/23/23 (Room 26)						
Test #	**Suction Point #**	**Reference Pressure[1] ("H_2O)**	**Suction Volume (CFM)**	**Test Point**	**Test Point Pressure ("H_2O)**	**Additional Comments**
1	B	-0.4	23	1	-0.003	Mud and gravel beneath slab.
				2	-0.004	
				3	-0.007	

[1]Reference pressure measured approximately 6 to 12 inches from the suction point.

[2] Additional test points were not feasible due to school activities.

Conclusions

Within the limits of the observations, testing conducted, and the analyses performed, the Pressure Field Extension (PFE) testing indicates that an Active Soil Depressurization (ASD) Radon mitigation system would have a high likelihood of successfully reducing Radon levels in the affected area(s) of this structure, below the EPA action level of 4pCi/l.

An HVAC engineer should be consulted once the system is complete to assess its influence on the building.

Air Source Technology, Inc. makes the following recommendations:

1. ASTI recommends conducting a Post-Mitigation Functional Evaluation/Inspection of the completed Radon Mitigation Systems (RMS).
2. ASTI recommends obtaining RMS details, including total airflow delivery, to allow an assessment by a qualified mechanical engineer of the systems' impact on the building from energy and HVAC perspectives.
3. ASTI recommends a written operations, maintenance and monitoring (OM&M) plan for the mitigation system(s) upon completion of the project to comply with Radon industry standard of care and to provide for maintenance in the future.
4. Additional recommendations/requirements should be included in a separate Radon Mitigation Specification document.

REFERENCES

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2. "Application of Radon Reduction Methods," EPA/625/5-88/024, August 1988.
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9. "National Gas Code," Appendix H (p.2223.1-98), 1988, Recommended Procedure for Safety Inspection of an Existing Appliance Installation.
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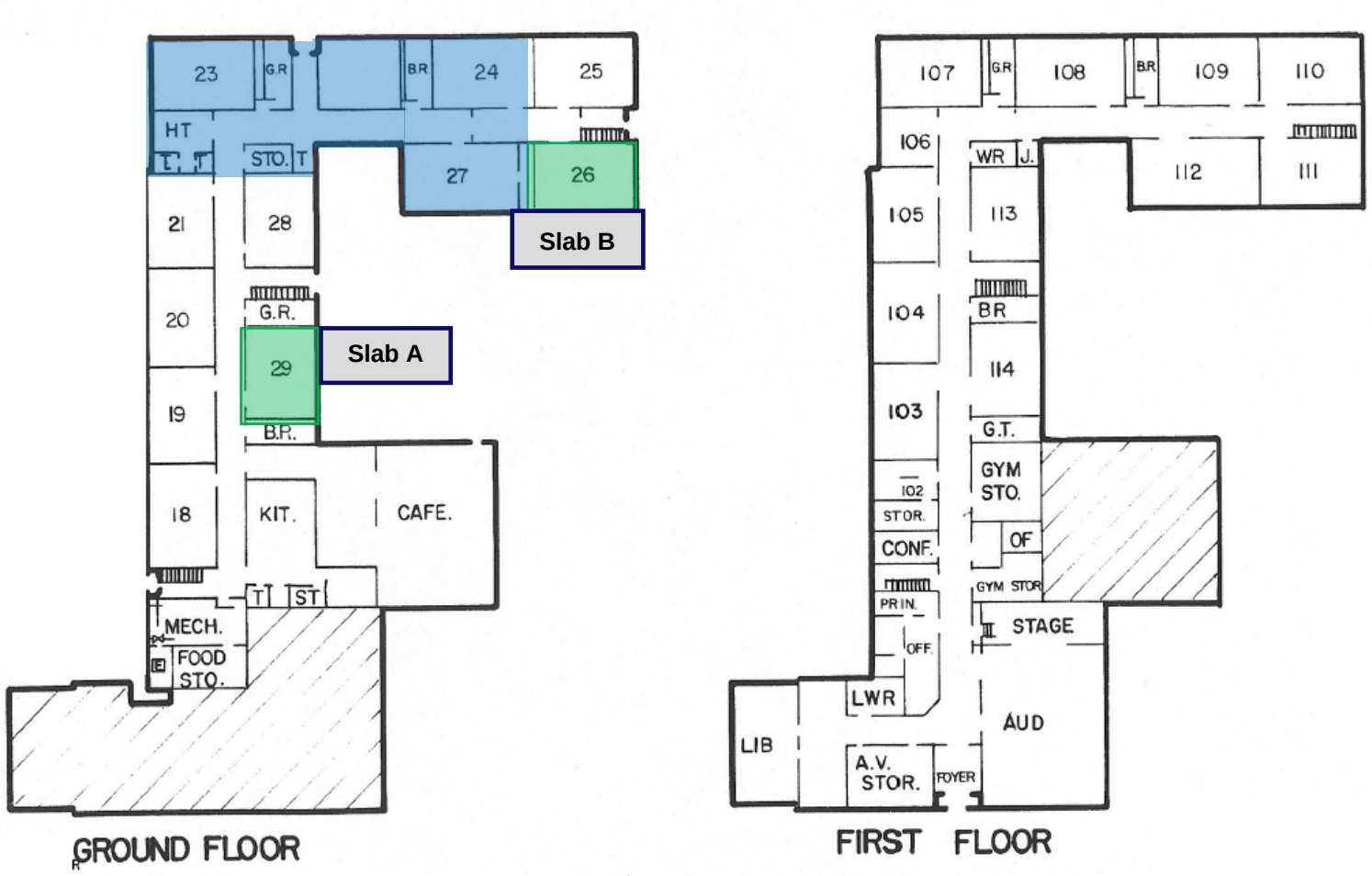
19. ANSI/AARST RMS-LB 2014 - *Radon Mitigation Standards for Schools and Large Buildings*, 2015, AARST Consortium on National Radon Standards
20. Fergusson, B.N., “Alternative Approaches to Managing School Mitigation and Sub-Slab Diagnostic Testing”, 2016, 2016 Proceedings of the International Radon Symposium
21. Fergusson, B.N., “Follow-up Report - Alternative Approaches to Managing School Mitigation and Sub-Slab Diagnostic Testing”, 2017, 2017 International Radon Symposium

Appendix A
SLAB TEST LOCATIONS AND TEST IDS

George Washington Carver STEM School

Floor Plan

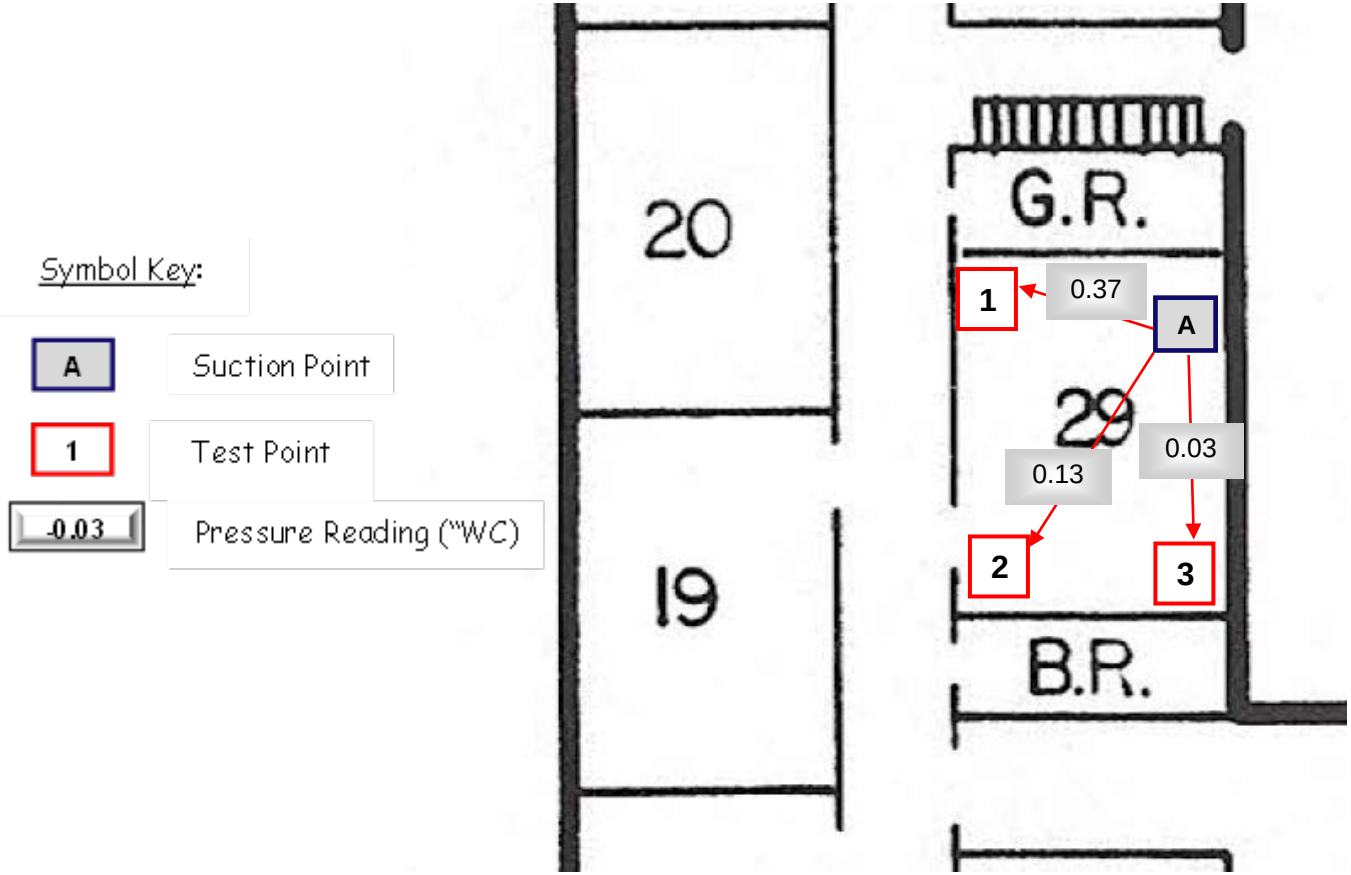


Classrooms to be mitigated

Crawlspace area (Previously mitigated)

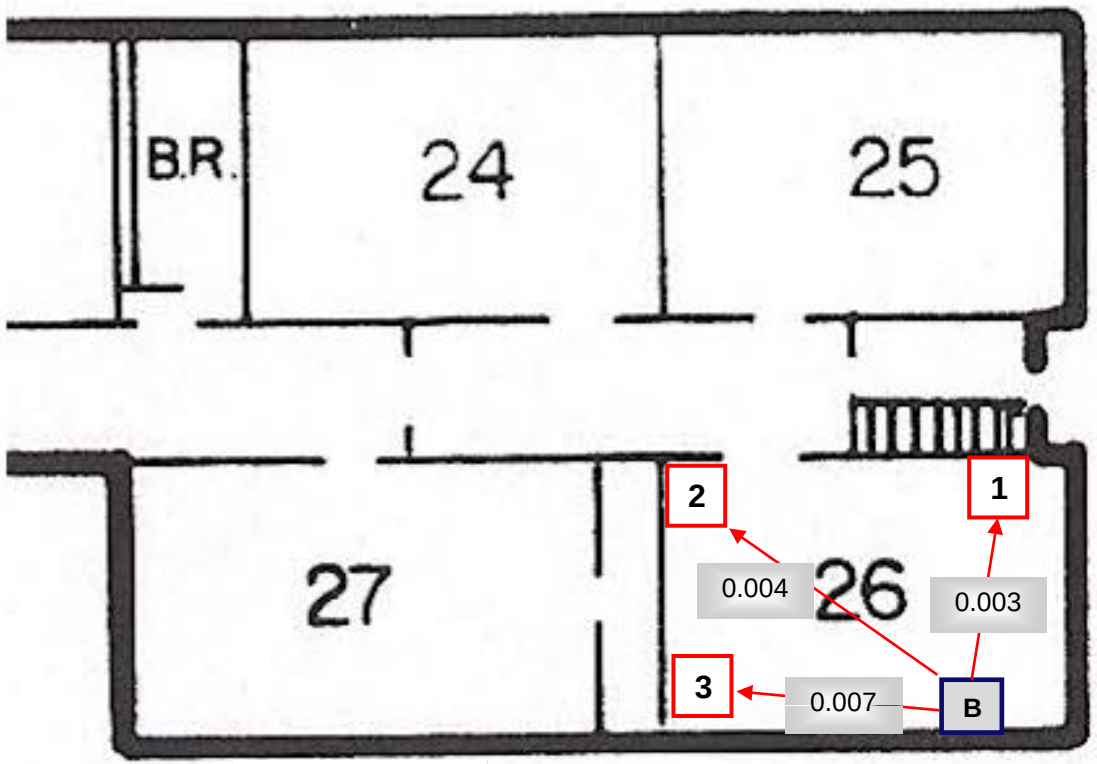
George Washington Carver STEM School

Classroom 29 Area



George Washington Carver STEM School

Classroom 26 Area



Appendix B
RADON MEASUREMENTS

P7236 / DAVID MADDUX

Kit Number	Start Date	Start Time	End Date	End Time	Temp.	Facility	Building	Room	Project ID	Floor	Result
11153455	2022-04-05	12:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	RECEPTION	NB825	1	1.5
11153456	2022-04-05	12:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	RECEPTION	NB825	1	1.5
11153457	2022-04-05	12:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	MEDIA	NB825	1	1.7
11153458	2022-04-05	12:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	MEDIA	NB825	1	1.5
11153459	2022-04-05	12:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	MEDIA OFC	NB825	1	2.0
11153460	2022-04-05	12:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	GYM	NB825	1	3.5
11153461	2022-04-05	12:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	GYM	NB825	1	3.7
11153462	2022-04-05	12:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	WORK RM	NB825	1	0.8
11153463	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	WORK RM OFC.	NB825	1	0.6
11153464	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	GYM STOR.	NB825	1	1.0
11153465	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	GYM STOR. OFC.	NB825	1	0.7
11153466	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	108	NB825	1	0.6
11153467	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	CAFé	NB825	0	1.4
11153468	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	CAFé	NB825	0	1.1
11153469	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	18	NB825	0	< 0.3
11153470	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	18	NB825	0	0.5
11153471	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	19	NB825	0	< 0.3
11153472	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	29	NB825	0	4.8
11153473	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	20	NB825	0	2.1
11153474	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	28	NB825	0	0.6
11153475	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	21	NB825	0	0.6
11153476	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	021 OFC.	NB825	0	0.7
11153477	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	22	NB825	0	< 0.3
11153478	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	23	NB825	0	< 0.3
11153479	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	TEACHER'S LOUNGE	NB825	0	< 0.3
11153480	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	24	NB825	0	1.2
11153481	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	27	NB825	0	1.0
11153482	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	27	NB825	0	1.0
11153483	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	25	NB825	0	3.0
11153484	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	26	NB825	0	5.5
11153485	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	26	NB825	0	< 0.3
11153486	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	PRINCIPALS OFC	NB825	1	1.1
11153487	2022-04-05	1:00 pm	2022-04-08	1:00 pm	70	FCPS	WOODSON	1000B	NB825	0	< 0.3

Appendix B

Required Forms

Equipment Inventory Form

System	1	2	3
System Fan Monitor Location			
Fan Model			
Fan Location			
Fan Circuit Location (Panel/Ckt #)			
Fan Monitor Type			
The following items are inspected with sealed components to remain sealed.			
Fan Monitor Startup Differential			
Sumps			
Crawlspace Membrane			
Isolation Assembly			

Provide floor plans that show eqpt locations, circuit breaker ID, etc. as required for locating and servicing systems.

Appendix C
Assumed Slab Segmentation

Important Note: The following information is provided for bid purposes only to allow quotations to deliver defined pressure performance on a common baseline configuration. Modifications are expected as part of the Contractor's final RMS Plan, which shall include unit pricing for modifications.

Sub-slab communication (a.k.a., PFE) testing has been performed (See Appendix A). The testing was designed to support a competitive bid process, provide PFE data of the various types of slab construction found at this site, and to demonstrate the applicability of an active sub-slab depressurization (ASD) system; not to provide all the information needed to design the best system for this structure. While slab segments have been identified by the Owner in the Diagnostic Report, additional testing should be performed at the contractor's discretion to optimize the ASD systems for each space.

For this project, refer to Figures 1 - 2 in Section 19.

Appendix D

Applicable Drawings

CUT AND PATCH CEM. PLAS. SOFFIT FOR INSTALLATION OF NEW LIGHT FIXTURE

MOVE EXIST. LOCKERS TO HERE

STAIRS 15

REPLACE WALL MNT. HANDRAIL DET. 2/A-11

PLASTER ON MET. STUDS EXTEND TO STRUCTURE

7'-0"

Room 26

CLASSROOM 14

2 UNITS T.B. - 4 UNITS C.B. = 24'

CLASSROOM 17

2 UNITS T.B. - 4 UNITS C.B. = 24'

5/8" PLASTER ON 3 5/8" METAL STUDS W/ SOUND ATTENUATING BATTS

F.E.C.

NEW PLAM T.P.

NEW PLAM T.P.

TOILET 18

TOILET 19

SHEET VINYL

8 UNITS C.B. = 12'-0"

6'-0" TYP.

2 UNITS T.B. - 3 UNIT C.B. = 20'

16' TACK STRIP

16' TACK STRIP

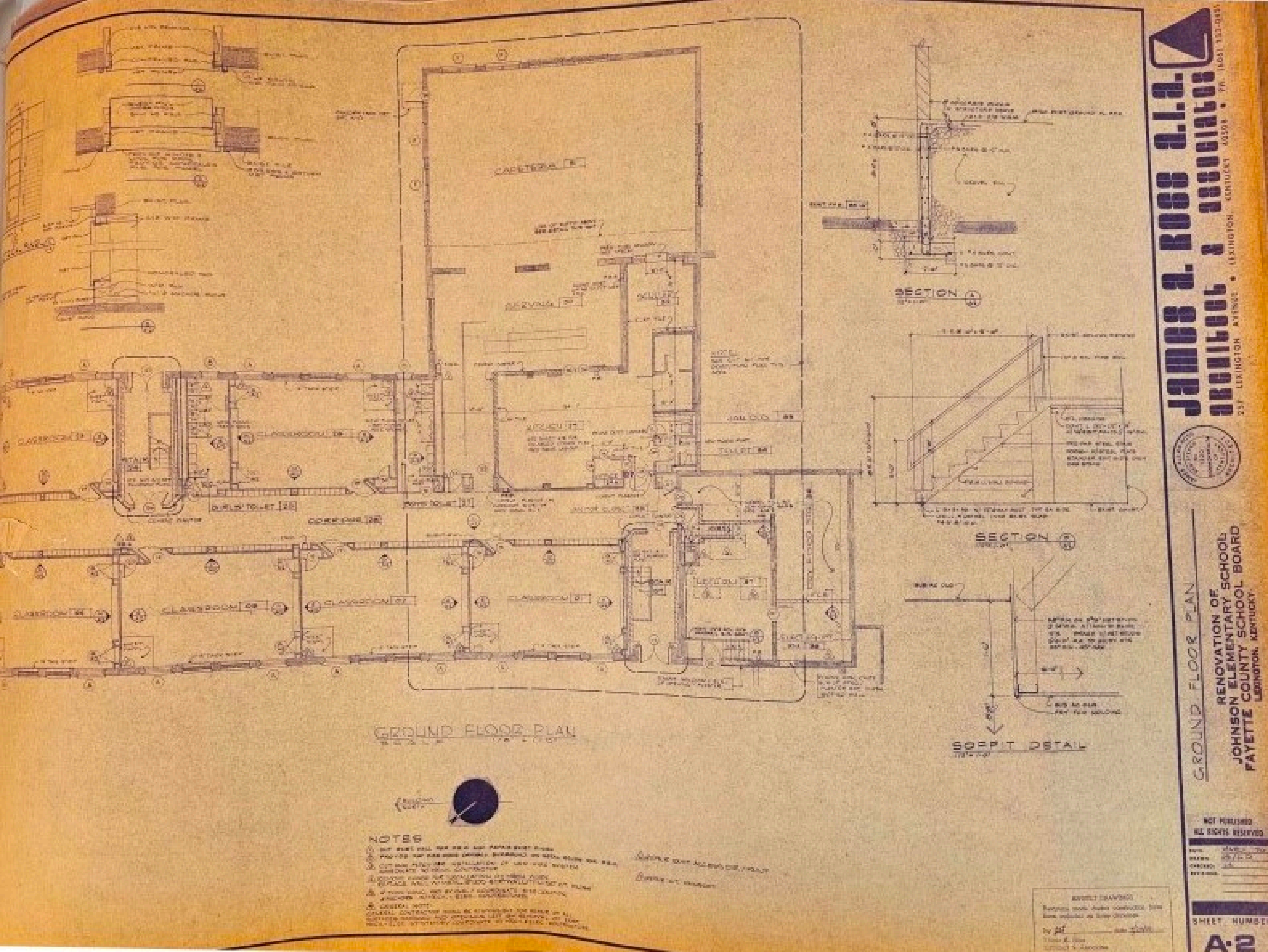
CLASSROOM 13

CLASSROOM 20

4 UNITS C.B. = 16'

BOY'S TOILET 12

NEW PLAM TOILET PART (SEE SPECS)


CAFETERIA
CLASSROOM
CORRIDOR
KITCHEN
SECTION
SOFFIT DETAIL
GROUND FLOOR PLAN
NOTES
JAMES A. ROSS A.I.A.
ARCHITECT & ASSOCIATES
257 LEXINGTON AVENUE • LEXINGTON, KENTUCKY 40508
GROUND FLOOR PLAN
RENOVATION OF
JOHNSON ELEMENTARY SCHOOL
FAYETTE COUNTY SCHOOL BOARD
LEXINGTON, KENTUCKY
NOT PUBLISHED
ALL RIGHTS RESERVED
SHEET NUMBER
A·2