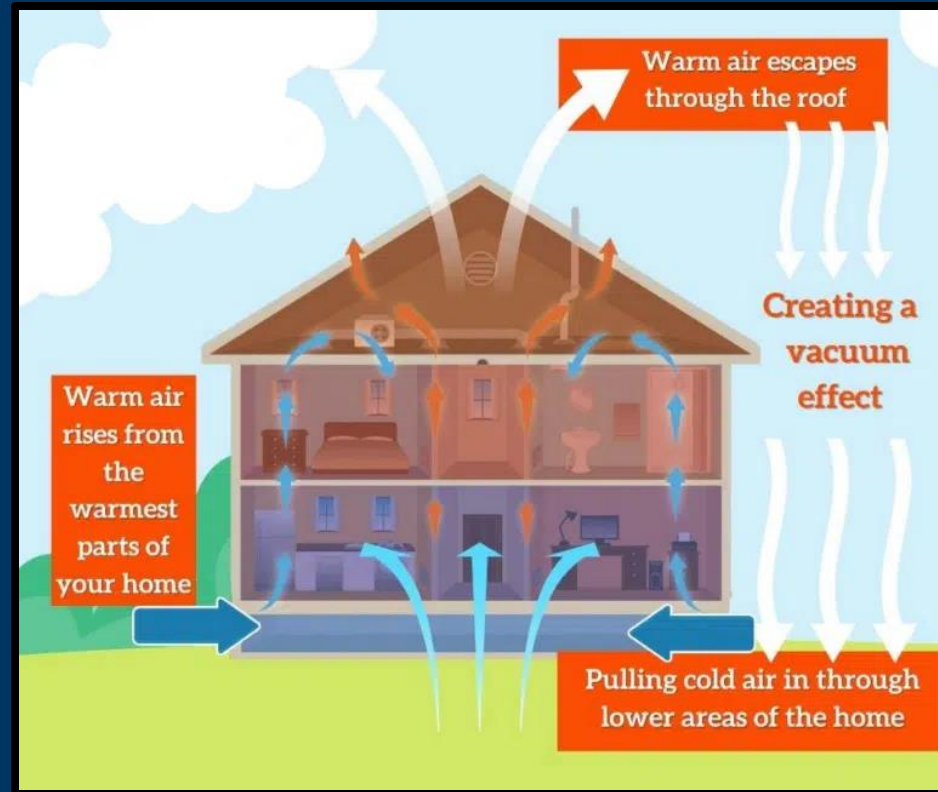


Case Studies

Two and Three Story Multifamily Mitigation

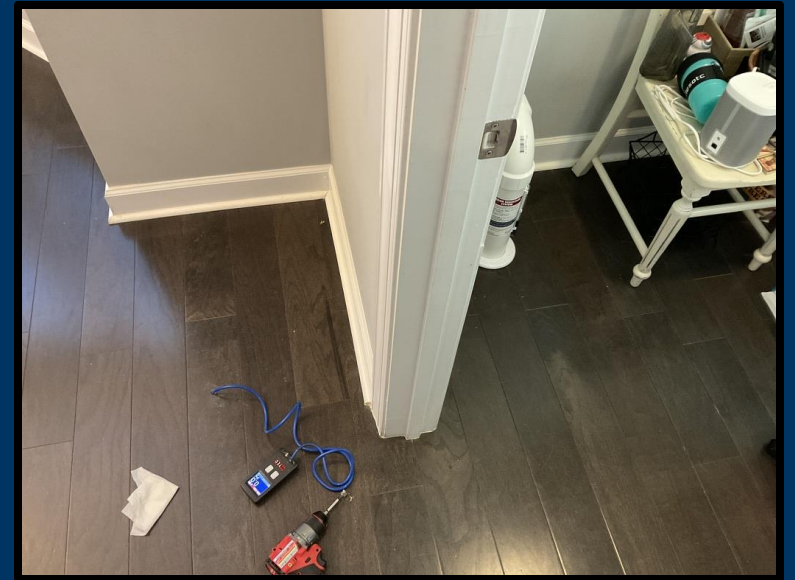
Merritt Gantt: True Air Technologies Radon Measurement and Mitigation Specialists

Buildings SUCK



The goal of (Active Soil Depressurization) mitigation is to create suction on the foundation that is slightly greater than that of the building.

Mitigation is more than just Poking and Hoping



The Process:

1. Gather Building Information
2. Diagnostics/Pilot Study
3. The Design
4. The Installation
5. The Results
6. Post Mitigation Documentation (OM and M)



Gather Building Information:

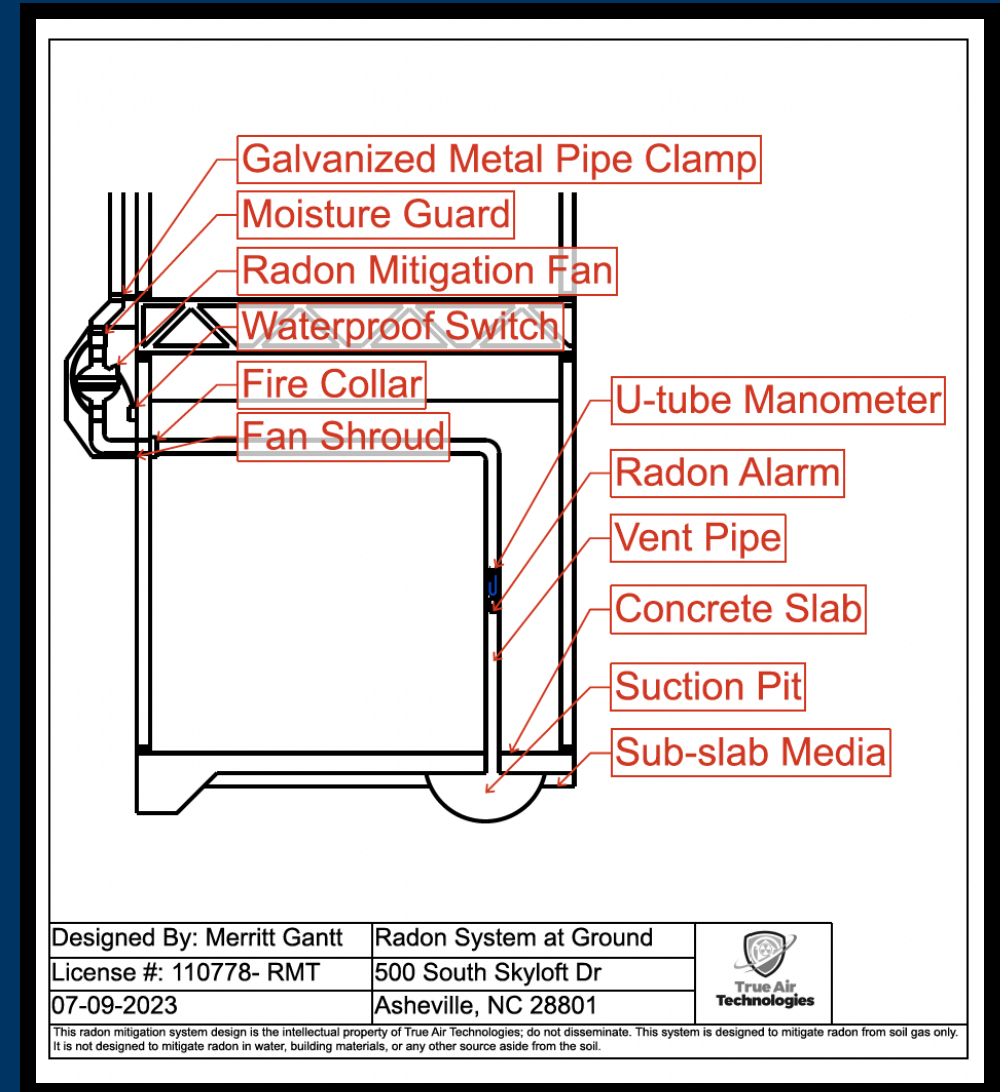
- During this phase of the project, we are seeking to gather as much information about the building(s) as possible.
- Some of the information includes:
 - Radon Test Reports
 - Foundation Type or Types
 - Building Plans (specifically foundation view)
 - Any other relevant information about the building(s)
- All of the information collected during this phase will help in the system design.

Diagnostics/Pilot Study:

- Diagnostics/Pilot Study is a physical investigation of the building(s) of concern.
- During this process we are seeking to assess and confirm radon system design strategies.
- It may involve some or all of the following: creating a floor plan, measuring radon concentration, measuring pressure field extension (PFE), assessing the footings or other structural characteristics of the building, assessing the concrete with GPR, etc.

The Design:

- After building information has been gathered and a diagnostics/pilot study has been conducted, you are ready to design.
- The design illustrates to the customer/lender/inspector the scope of the work and how it will impact the building being mitigated.
- Include as much detail as possible.



The Installation:

- Execute the plan/design that you have created.



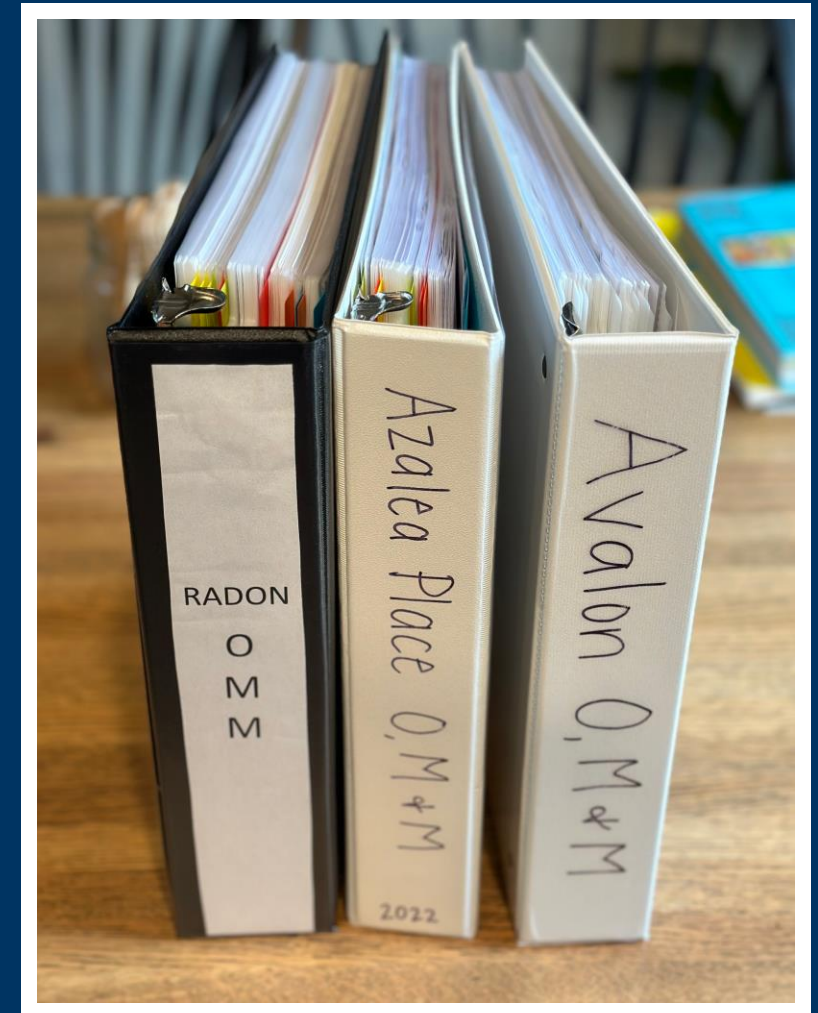
The Results:

- Re-test and verify low radon levels.



Post Mitigation Documentation:

- The Operations Maintenance and Monitoring Plan (OM and M) is a formal document that documents all of the processes and results throughout the mitigation process.
- It includes any test results, building information, permits, notices, design drawings, etc. (It is the culmination of your work)
- It can be as simple as a few pages or very complex.



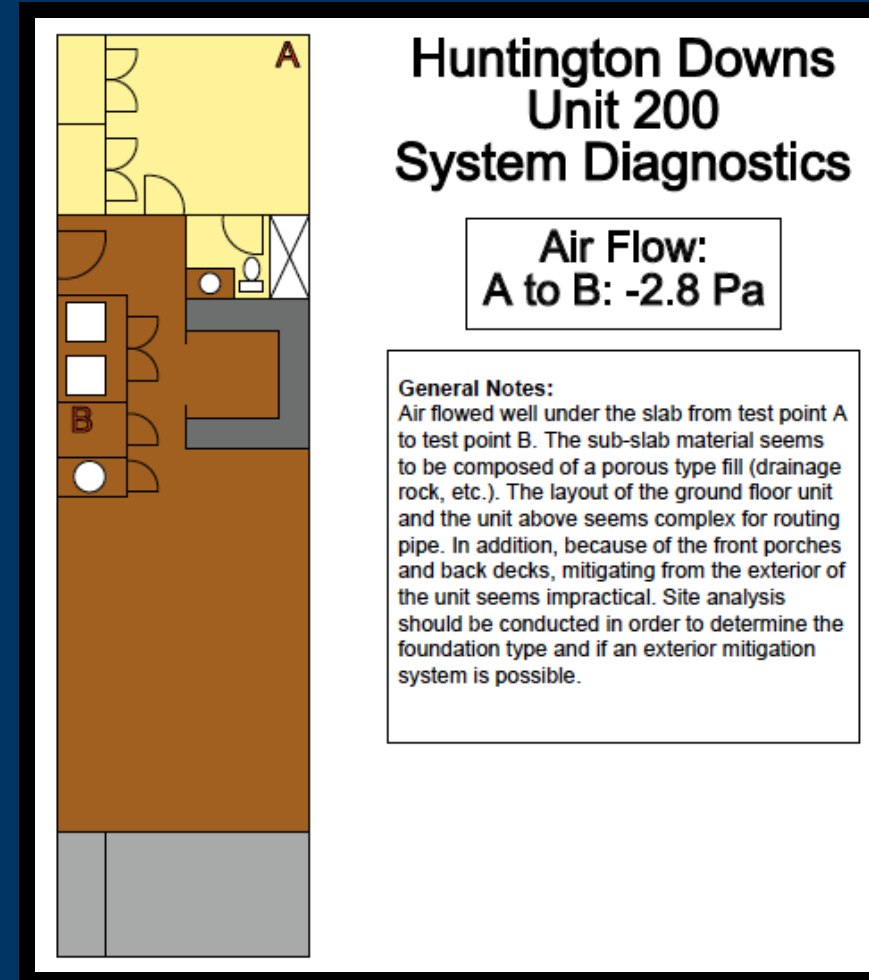
1. Gather Building Information

- Seventy Seven Units to Be Mitigated
- Five Different Floor Plans
- Two Stories
- Slab on Grade???
- HVAC Controlled By Each Individual Unit
- No Building Plans
- Large Maintenance Team, No Knowledge of the Buildings



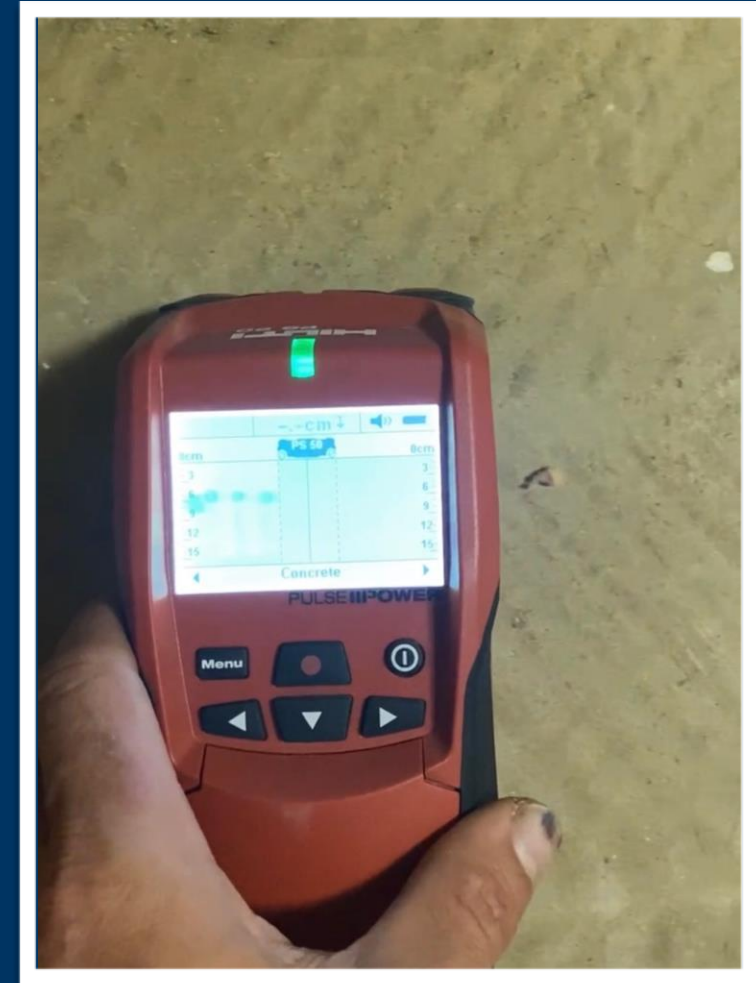
2. Diagnostics/Pilot Study

- We requested to perform diagnostics/pilot study in at least one ground floor unit.
- Unit 200 was the only accessible ground floor unit.
- We started by drawing a floor plan of the Unit 200.
- Unit 200 floor plan only represented 3 of 74 units.



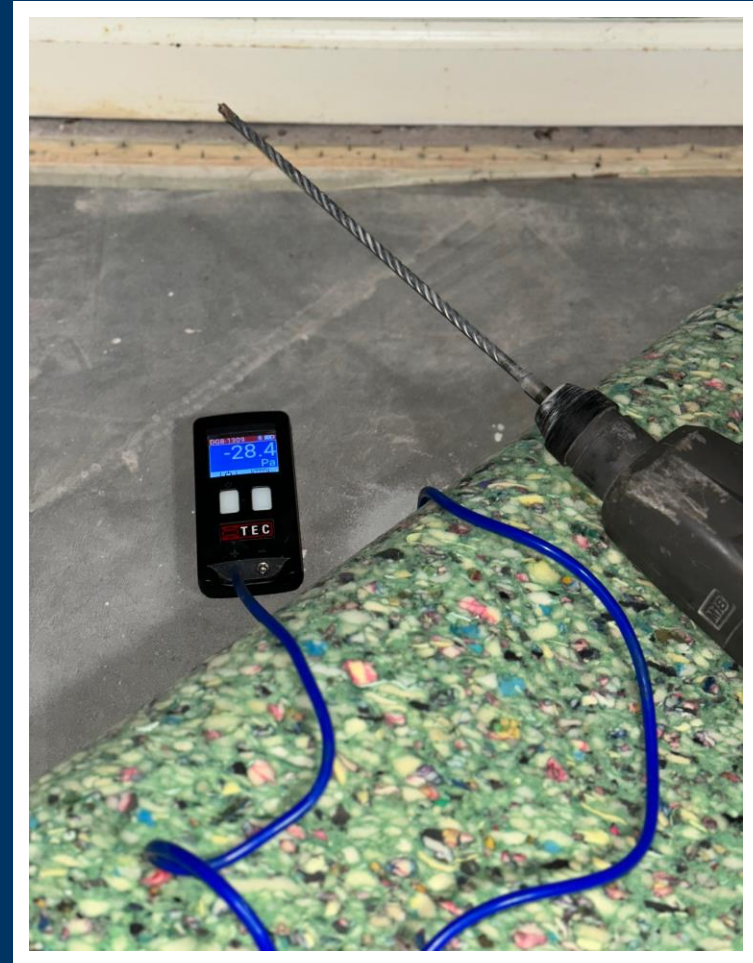
2. Diagnostics/Pilot Study

- Prior to conducting PFE a floor scanner was used to identify any items in or below the slab that could be damaged during drilling through the slab.
- This building was not constructed with post tension slab.



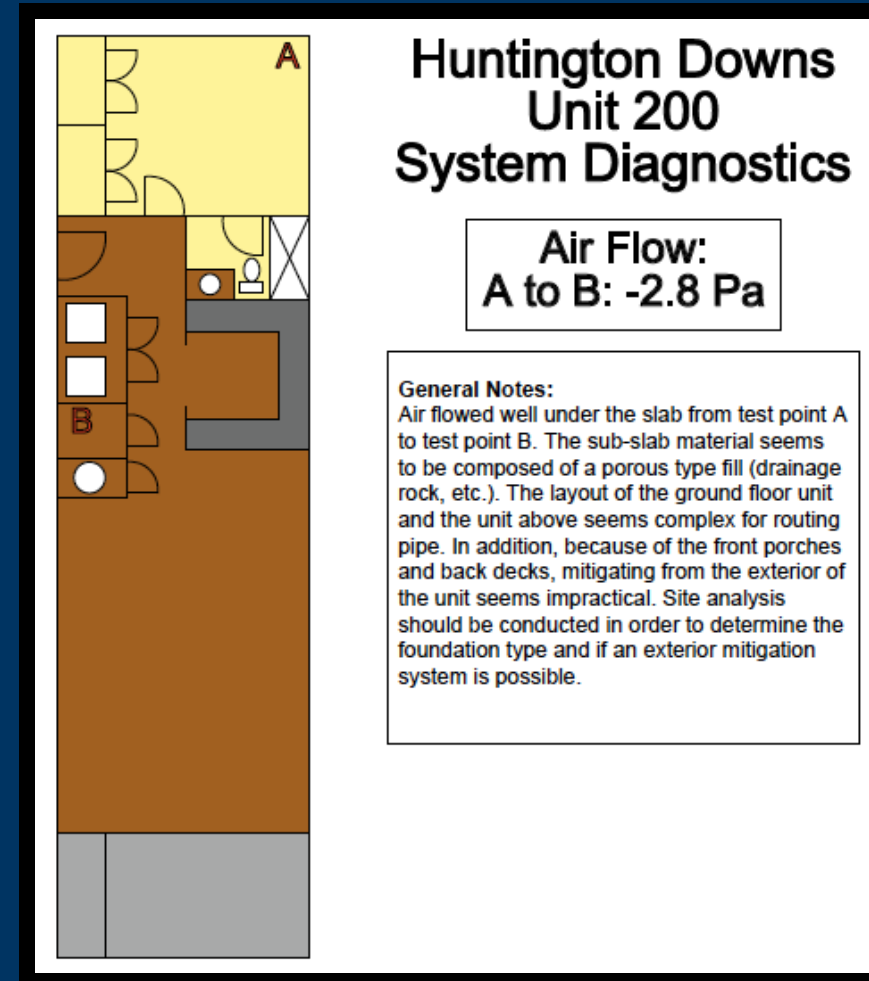
2. Diagnostics/Pilot Study

- A rotary hammer was used to drill 1/4" PFE test points through the slab at various points in one unit.
- A shop vacuum was used to create suction on one test point while measuring PFE at another.
- A micromanometer was used to measure the pressure differential (suction) in Pa.



2. Diagnostics/Pilot Study Findings

- There was adequate PFE.
- The suction point could be located anywhere.
- Routing pipe could be difficult due to the complex layouts of the buildings/units.



2. Diagnostics/Pilot Study Findings

- Where do you route pipe?
- Should the system go on the inside of the unit or should they be installed on the outside?
- How do you know?



2. Diagnostics/Pilot Study Round 2

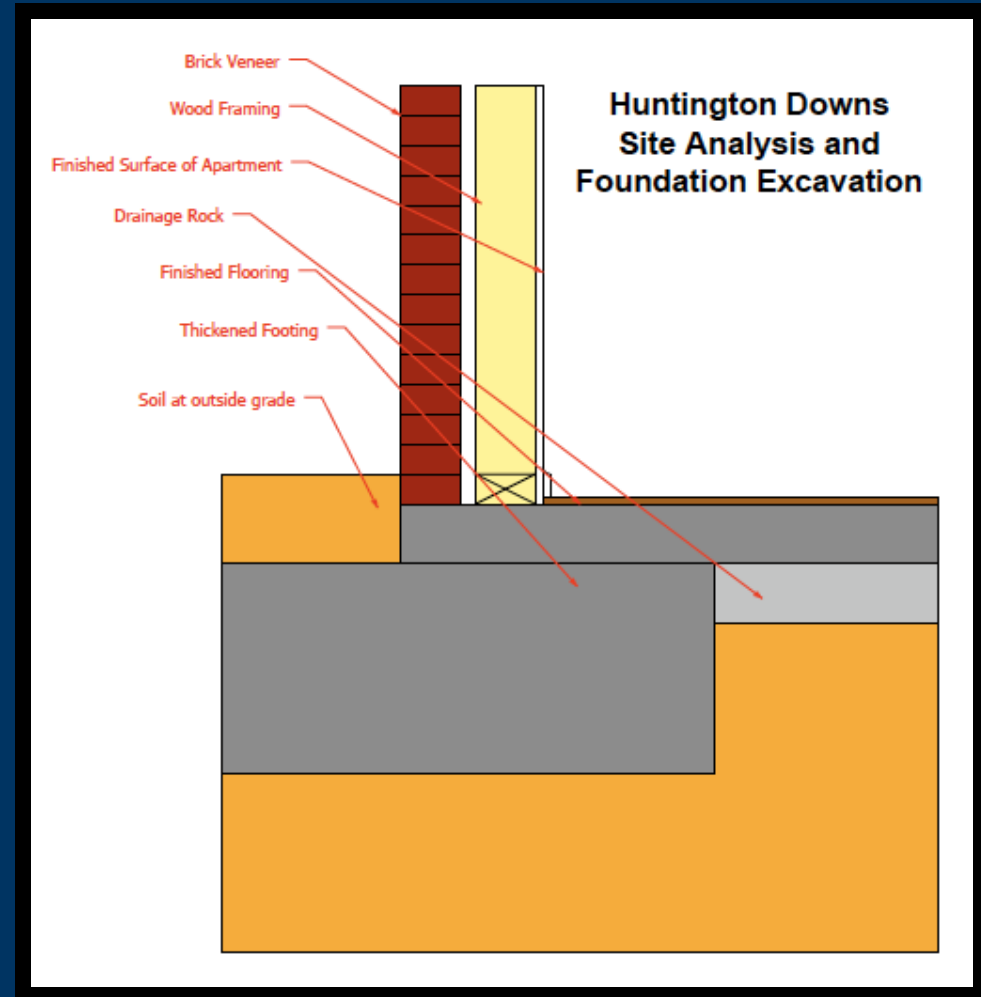
- We requested to perform a site analysis and foundation excavation.
- We had the property located (811 dig) and explored different pipe routing options.



2. Diagnostics/Pilot Study Round 2

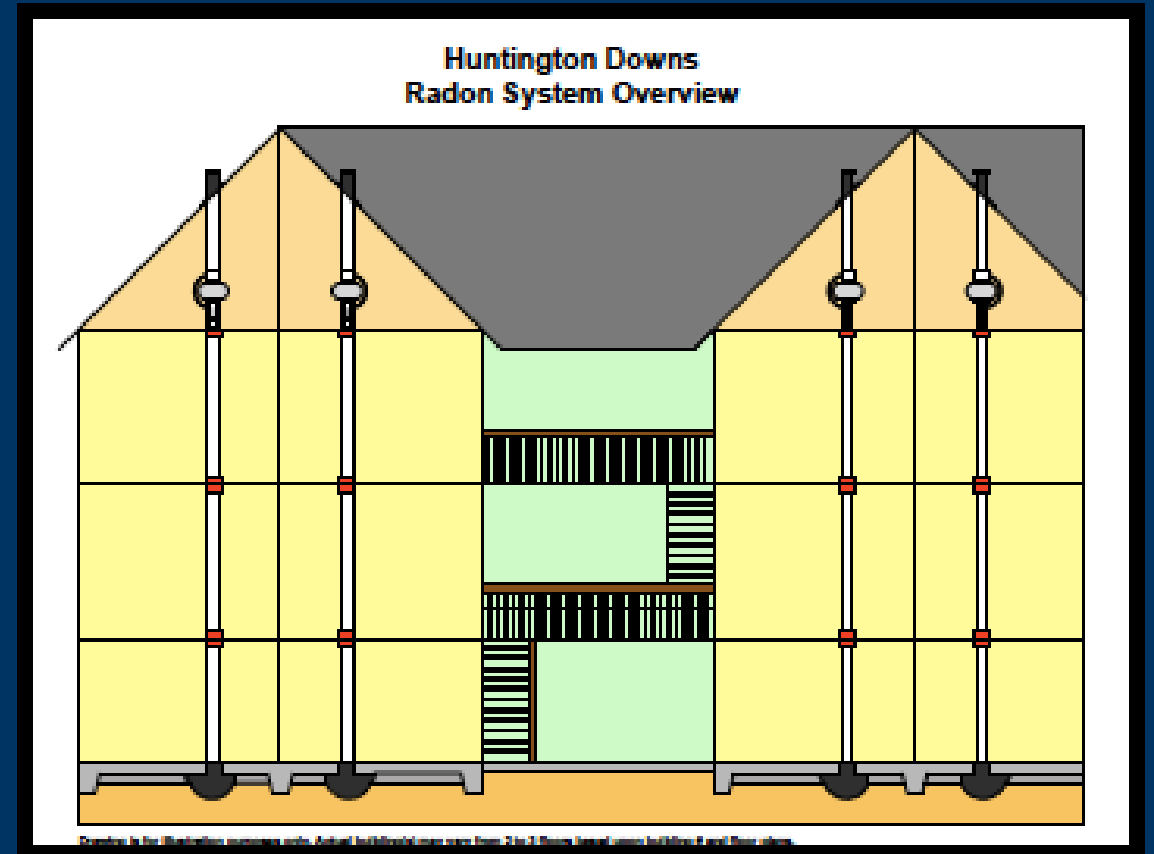
We Found:

- The building(s) had large footings around the perimeter of the building(s).
- Coring from the exterior of the building was not an option.

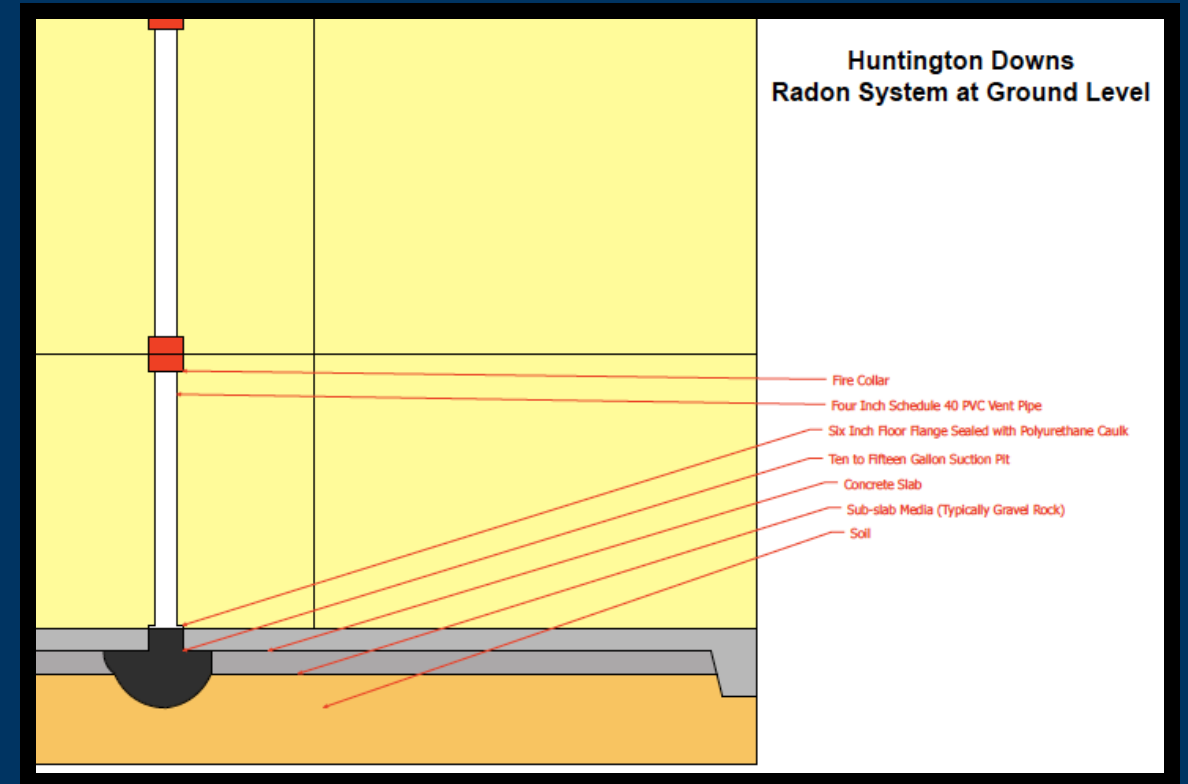
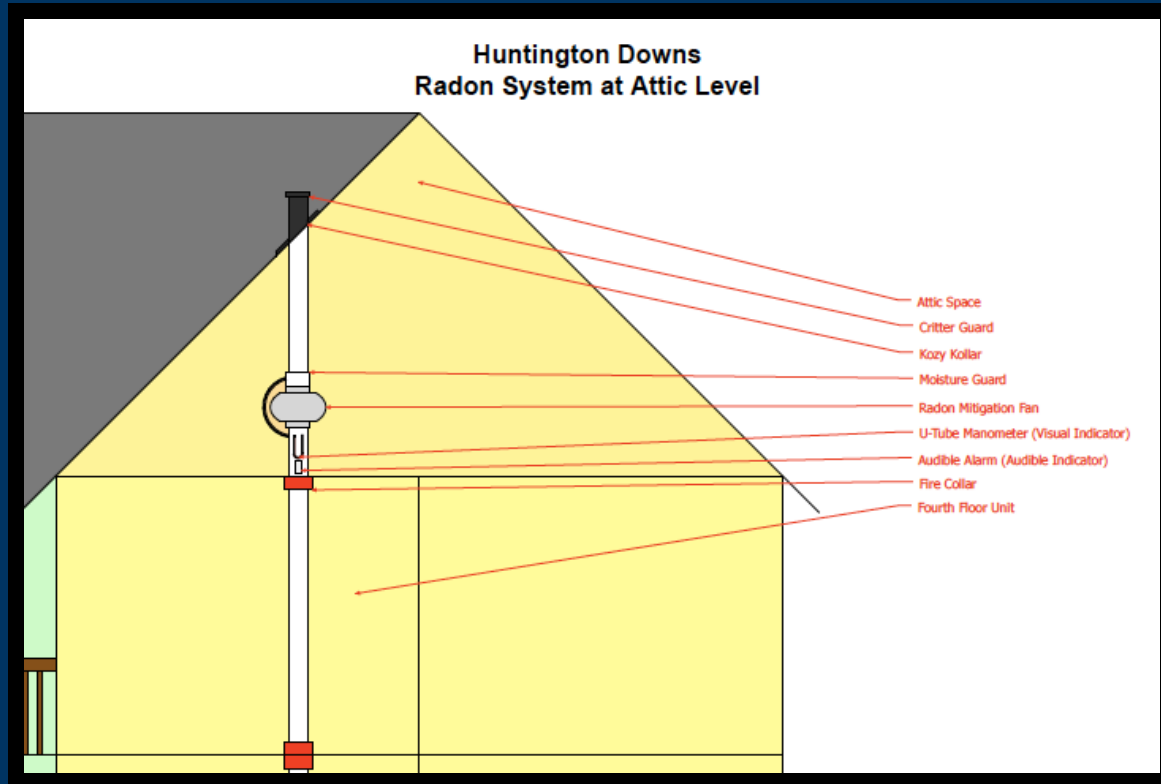


3. The Design

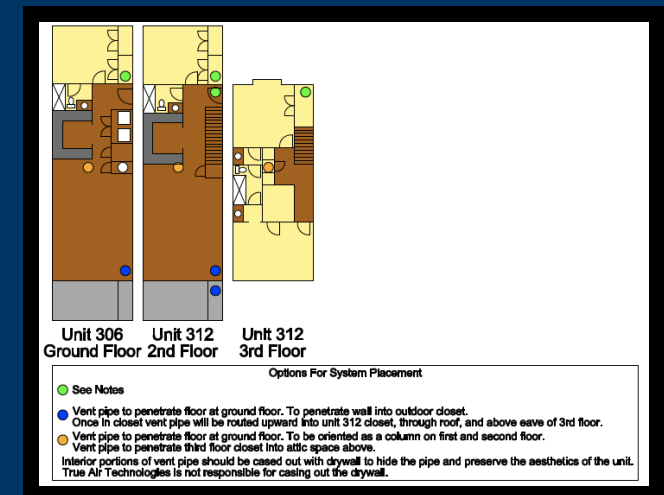
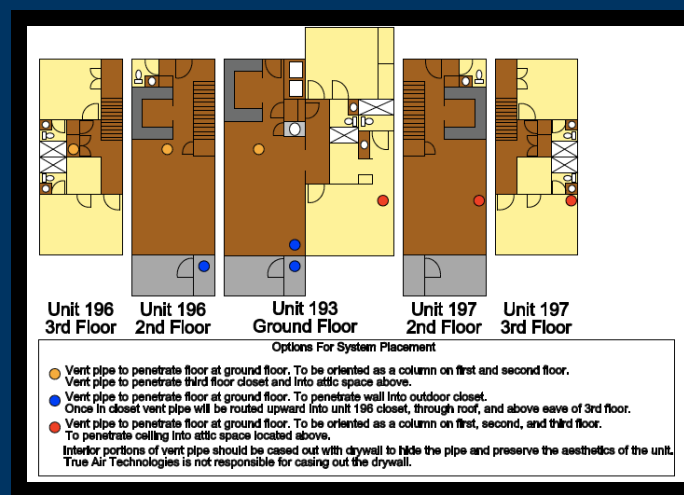
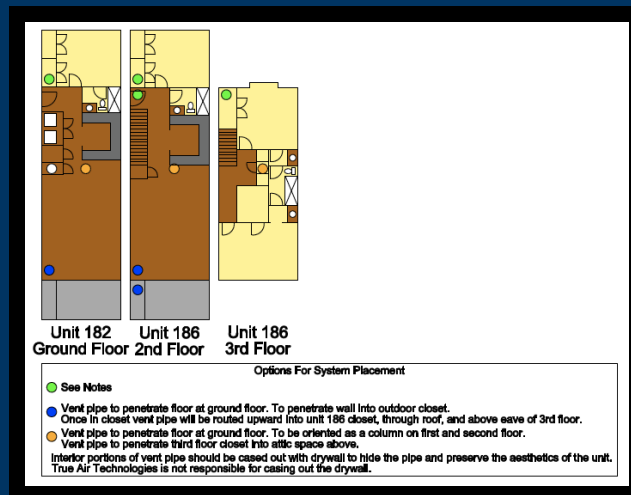
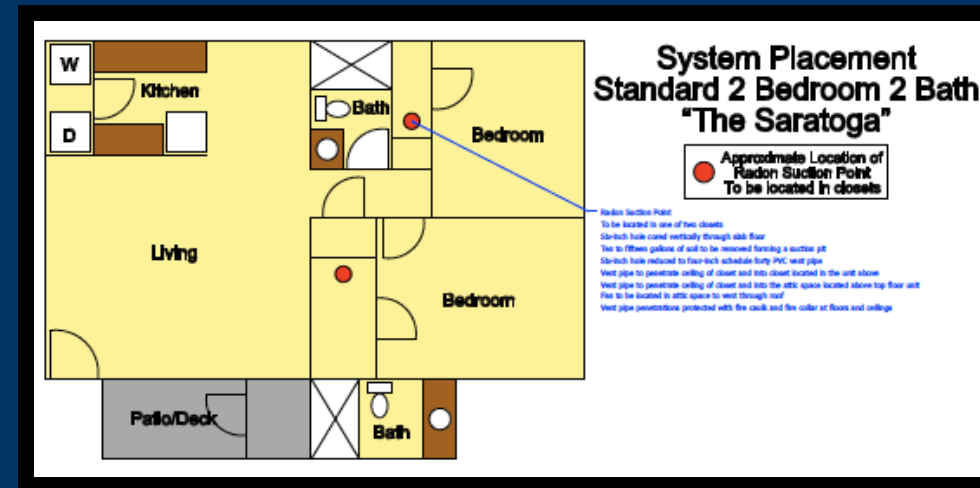
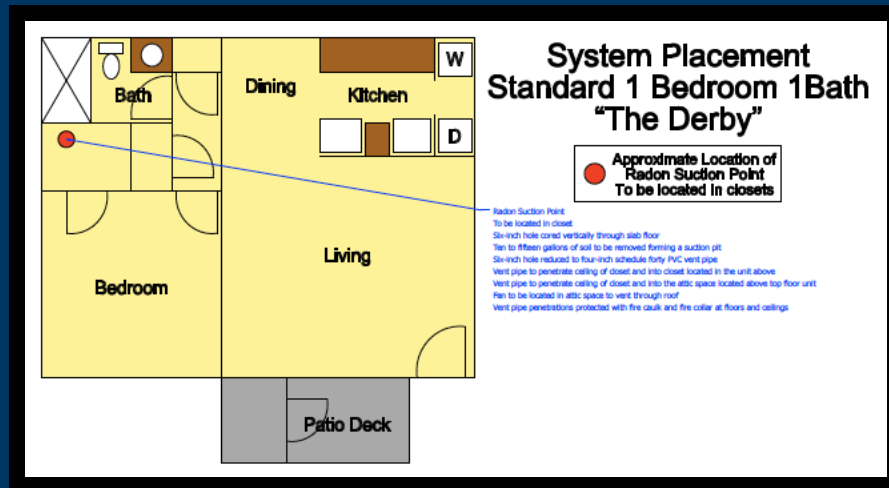
- There were five different floor plans.
- Each floorplan had to illustrate the approximate location of the radon mitigation system.



3. The Design



3. The Design

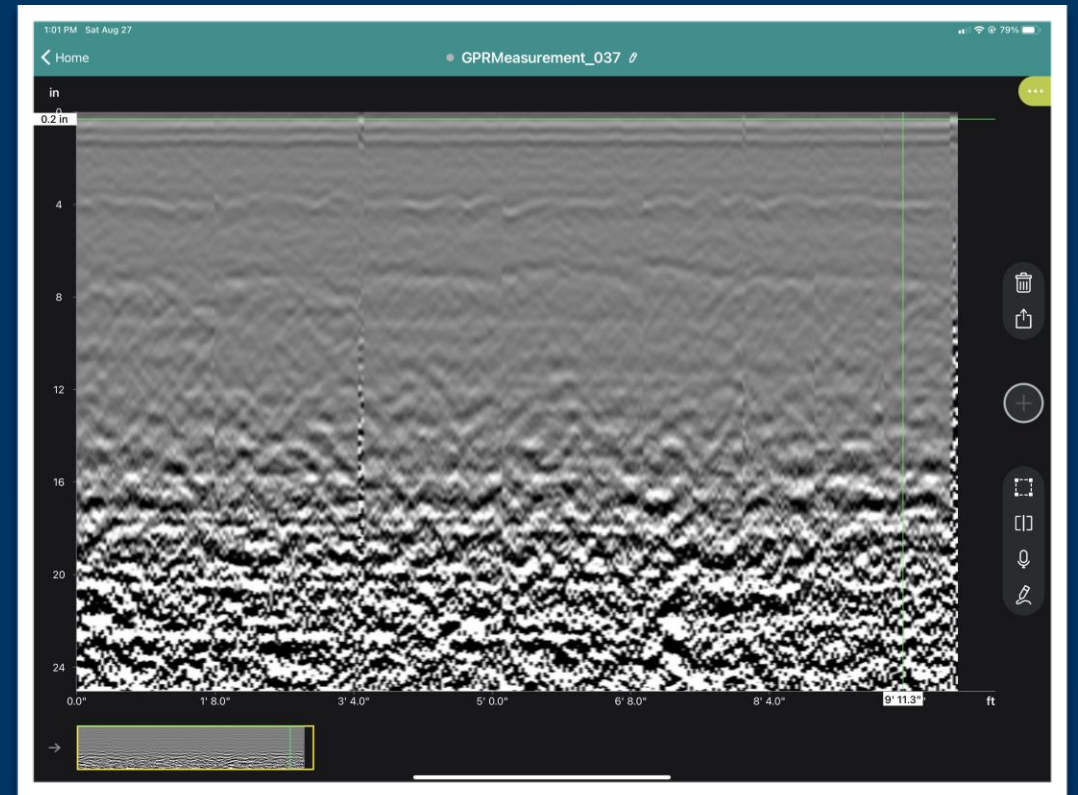


3. The Design

- The county would not approve the permit unless an engineer stamped the drawings for approval.
- Had to meet with the county officials and use the standard to explain what we were doing.
- Drawings, illustrations, and diagnostics data was crucial in getting the permits approved.

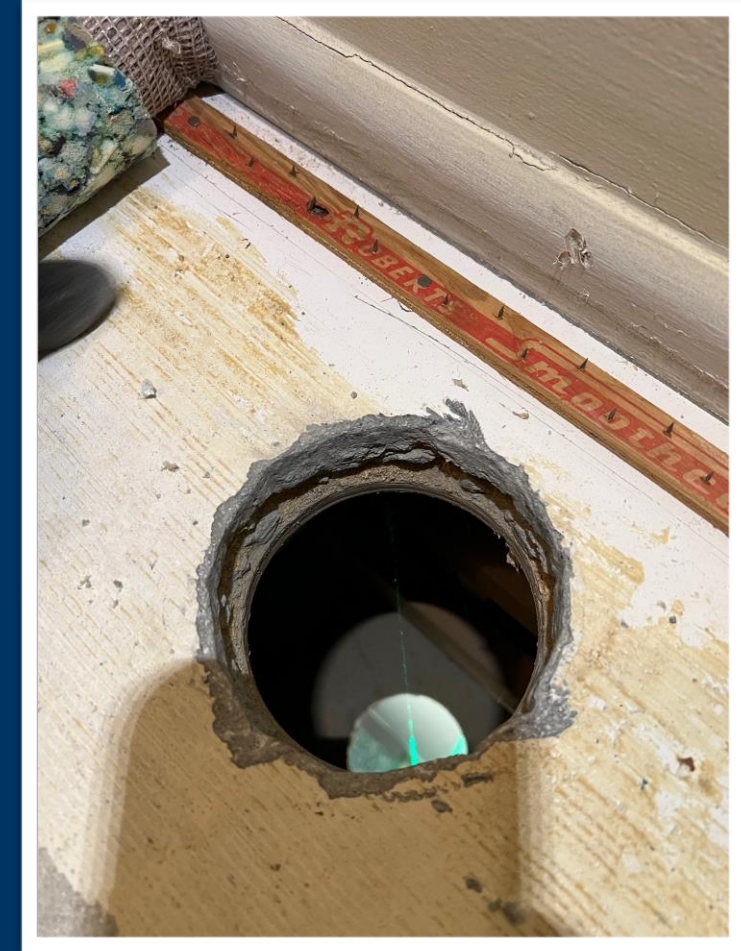
4. The Installation

- Prior to coring suction ground penetrating radar (GPR) was used to identify any items in or below the slab that could be damaged during drilling through the slab.



4. The Installation

- Let the problems begin!
- The first suction pit cored, we hit a water line that was missed during GPR.
- The building(s) were wood framed structures with 1-2" of concrete parged over top the second floor sub-floor.



4. The Installation

- We cored the first suction pit and found 1-2” of sand under the slab.
- We removed approximately 20-25 gallons of sand from the suction pit.
- We used a Fantech PFEDK fan kit to measure PFE.
- The fan indicated low pit pressure (lots of cfm of air) and little to no suction at our test point.
- Why couldn't we achieve PFE??
- Should we just get a bigger fan (maybe a commercial grade fan)???

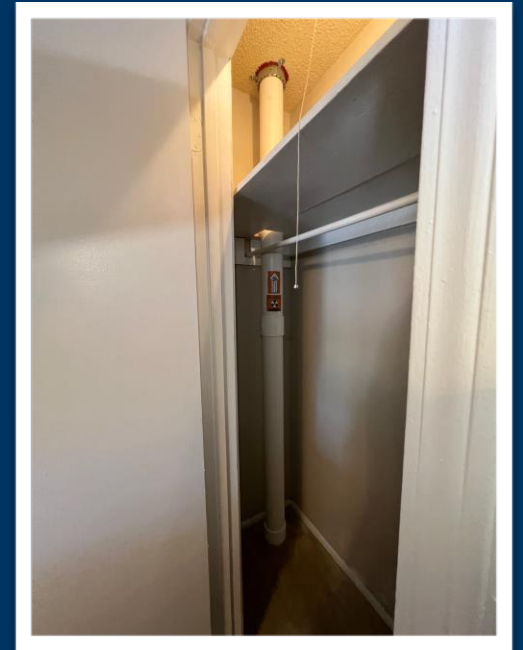
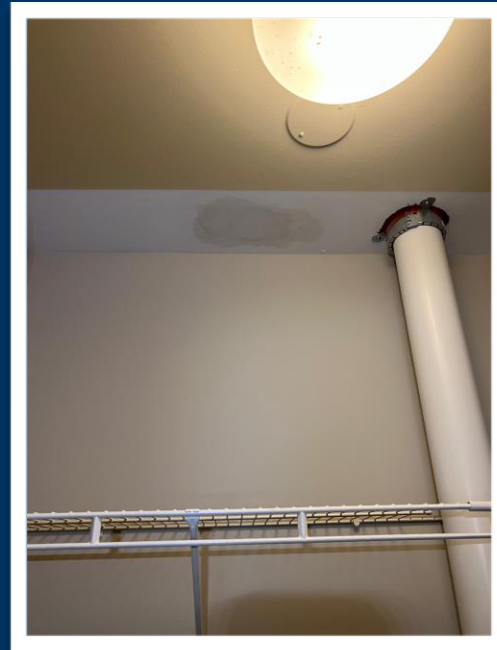
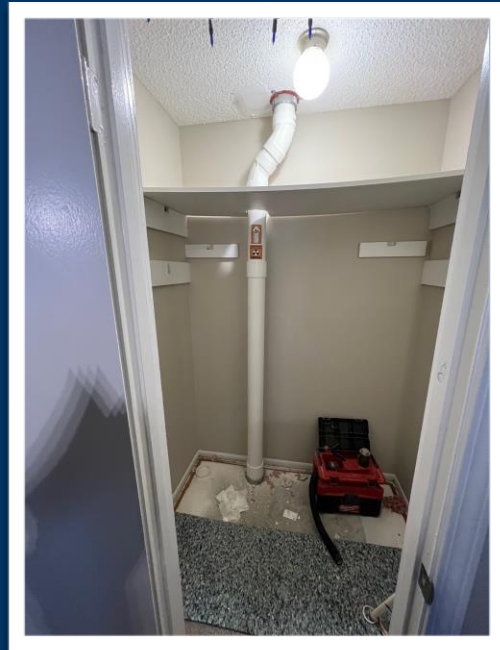
4. The Installation

- There was a bathroom adjacent the closet where the suction pit was located.
- We cut the drywall open exposing the underside of the tub.
- The concrete was cut out underneath the tub and a large exposed earthen void existed.
- We cut and sealed under every tub in every single unit.



4. The Installation

- The vent piping had to be routed through and around many obstacles.
- Some of the upper floors did not align with the lower floors and adjustments had to be made throughout the entire installation.



4. The Installation

- The sub-slab media was different in every single unit.
- Some units had 2” of sand while other units had 18” of sand.
- Some units had no sand at all and were built upon compact clay soil.
- How could we know if these systems were going to work or not since nothing was similar?

4. The Installation

- During the installation of the suction pits, air flow was measured with a Fantech PFEDK test fan.
- Per unit, A test point was drilled through the floor at a remote location.
- A micromanometer was used to measure PFE (the amount of suction) at the test point.
- The type and size of the fan was determined based upon PFE.



4. The Installation

- Knowing PFE helped ensure that our systems were going to work.
- All of the pre-mitigation PFE data was recorded and used in the final OM and M.

Pre-mitigation Pressure Field Extension Testing						
Unit	Suggested Fan Type	Pit Pressure ("WC)	Point Pressure @ 9.8 RPM Ratio	RPM Ratio Adjusted	Point Pressure @ RPM Adjusted Ratio	Test Point Location
182	EE	4.55"	-4.0 Pa	9.8	-4.0 Pa	Kitchen Counter
193	EE	4.55"	-1.0 Pa	9.8	-1.0 Pa	Far Right Corner
306	EE	4.3"	-1.8 Pa	9.8	-1.8 Pa	Far Right Corner
333	4 cfm/ 3.80" EE	4.4"	-1.6 Pa	9.8	-1.6 Pa	UD
337	44 cfm/ 1.0" RP145	3.9"	-51.3 Pa	5	-16.0 Pa	LRC
343	85 cfm/ 3.8" RP145	3.9"	-7.5 Pa	9.8	-7.5 Pa	UD
345	4 cfm/ 3.80" EE	4.6"	-12.1 Pa	9.8	-12.1 Pa	Bedroom Corner
351	48 cfm/ 3.33" RP145	3.3"	-4.5 Pa	9.8	-4.5 Pa	LRC
353	4 cfm/ 3.80" EE	4.6"	-2.1 Pa	9.8	-2.1 Pa	UD
357	88 cfm/ 3.18" RP145	3.1"	-6.0 Pa	9.8	-6.0 Pa	LRC
359	32 cfm/ 1.72" EE	3.0"	-15.8 Pa	7	-10.8 Pa	LRC
361	96 cfm/ 2.44" RP145	1.8"	-4.0 Pa	9.8	-4.0 Pa	LRC
367	75 cfm/ 2.10" RP145	3.8"	-11.9 Pa	7	-7.5 Pa	UD
369	4 cfm/ 3.80" EE	4.4"	-5.2 Pa	9.8	-5.2 Pa	UD
373	61 cfm/ 0.77" RP145	2.0"	-16.0 Pa	5	-6.2 Pa	UD
381	4 cfm/ 3.80" EE	4.7"	-4.0 Pa	9.8	-4.0 Pa	LRC
383	42 cfm/ 2.04" RP145	4.1"	-8.0 Pa	7	-4.3 Pa	LRC
385	20 cfm/ 0.51" RP145	2.2"	-37.9 Pa	4	-9.2 Pa	LRC
389	2 cfm/ 1.08" RP145	4.4"	-40.6 Pa	5	-11.1 Pa	UD
391	2 cfm/ 1.08" RP145	4.4"	-20.1 Pa	5	-5.8 Pa	LRC
393	87 cfm/ 1.58" RP145	2.4"	-10.3 Pa	7	-4.5 Pa	LRC
399	3 cfm/ 2.11" RP145	4.6"	-10.6 Pa	7	-4.0 Pa	UD
401	2 cfm/ 1.08" RP145	4.4"	-17.3 Pa	5	-4.7 Pa	UD

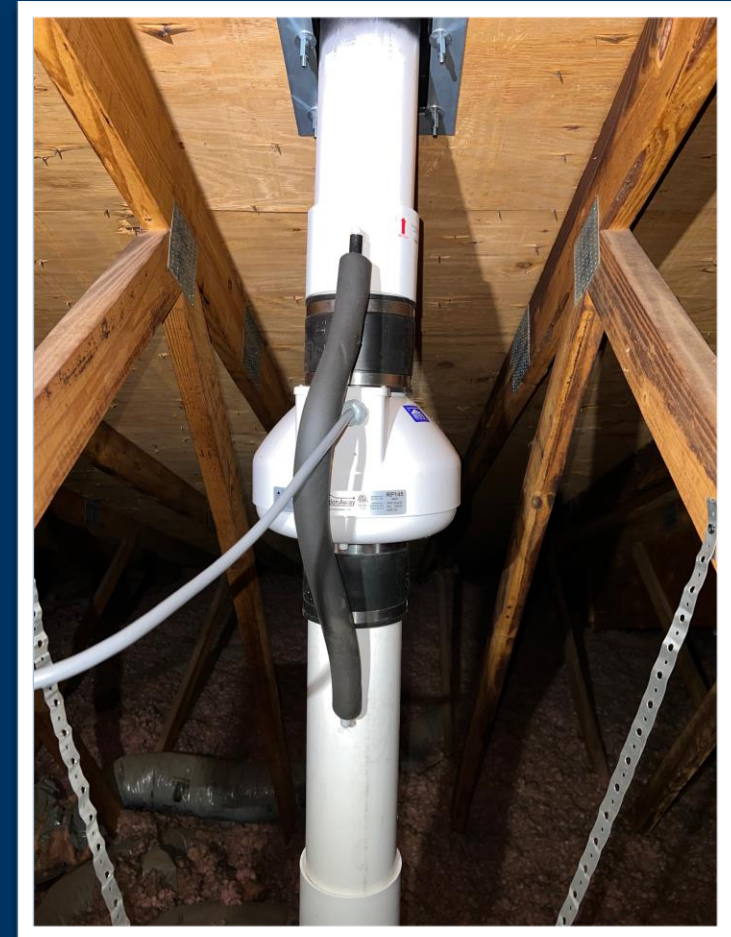
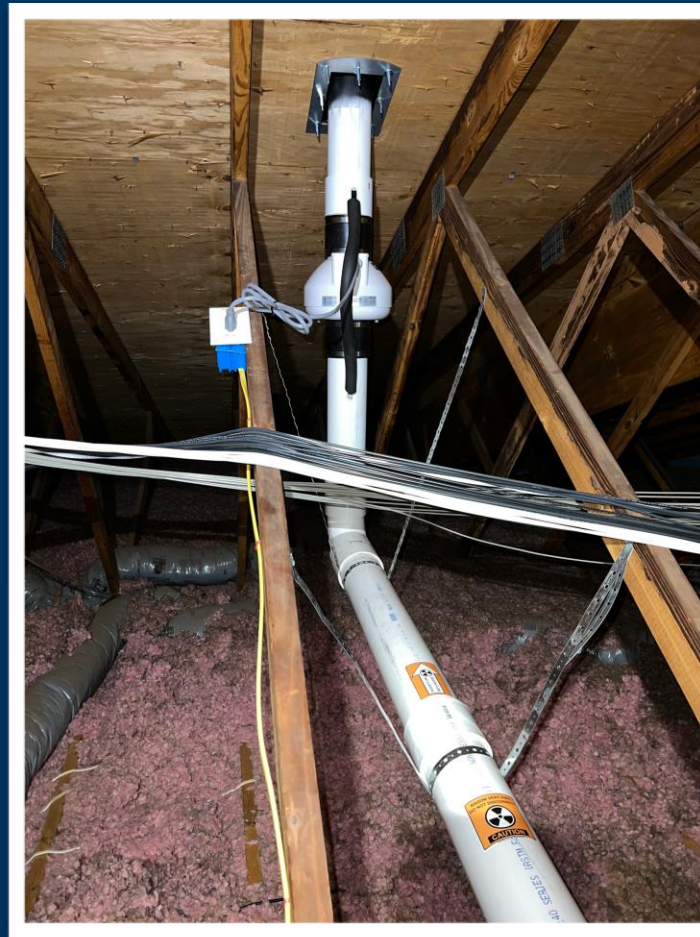
4. The Installation

- After the fans were determined and ordered, a local electrician installed the electrical receptacles for each fan.
- There were no house panels.
- Electricity had to be pulled from the individual units.
- The electrical costs were calculated using the fans wattage and each tenant was prorated for the additional electricity.
- This was documented in the OM and M.

Electrical Costs						
Unit	Fan Used	Watts	Monthly Cost	Yearly Cost	Breaker Location	Prorate Per Month
469	12 cfm/ 1.10" RP145	39	\$ 3.70	\$ 44.41	Unit 470	Unit 474
473	40 cfm/ 0.83" RP145	43	\$ 4.08	\$ 48.97	Unit 474	\$ 8.16
479	40 cfm/ 0.83" RP145	49	\$ 4.65	\$ 55.80	Unit 480	Unit 480
481	33 cfm/ 0.81" RP145	42	\$ 3.99	\$ 47.83	Unit 482	\$ 8.64
483	89 cfm/ 0.77" RP145	65	\$ 6.17	\$ 74.02	Unit 484	Unit 482
487	23 cfm/ 1.54" RP145	42	\$ 3.99	\$ 47.83	Unit 480	\$ 7.97
489	80 cfm/ 1.69" RP145	42	\$ 3.99	\$ 47.83	Unit 482	Unit 484
497	87 cfm/ 0.88" RP145	42	\$ 3.99	\$ 47.83	Unit 506	\$ 6.17
501	2 cfm/ 0.89" RP145	39	\$ 3.70	\$ 44.41	Unit 502	Unit 502
505	22 cfm/ 1.06" RP145	42	\$ 3.99	\$ 47.83	Unit 506	\$ 3.70
507	79 cfm/ 1.61" RP145	59	\$ 5.60	\$ 67.19	Unit 508	Unit 506
513	4 cfm/ 3.89" EE	104	\$ 9.87	\$ 118.44	Unit 514	\$ 7.97
523	48 cfm/ 0.79" RP145	63	\$ 5.98	\$ 71.74	Unit 524	Unit 514
527	45 cfm/ 1.47" RP145	47	\$ 4.46	\$ 53.52	Unit 526	\$ 9.87
529	103 cfm/ 0.86" RP145	39	\$ 3.70	\$ 44.41	Unit 530	Unit 508
533	11 cfm/ 0.89" RP145	40	\$ 3.80	\$ 45.55	Unit 526	\$ 5.60
535	7 cfm/ 0.7" RP145	42	\$ 3.99	\$ 47.83	Unit 526	Unit 554
537	77 cfm/ 1.36" RP145	39	\$ 3.70	\$ 44.41	Unit 530	\$ 5.88
541	2 cfm/ 1.55" RP145	38	\$ 3.61	\$ 43.27	Unit 552	Unit 552
545	53 cfm/ 0.61" RP145	62	\$ 5.88	\$ 70.51	Unit 554	\$ 13.67
547	54 cfm/ 0.61" RP145	44	\$ 4.18	\$ 50.11	Unit 548	Unit 548
551	4 cfm/ 3.89" EE	106	\$ 10.06	\$ 120.71	Unit 552	\$ 4.18
555	45 cfm/ 0.82" RP145	45	\$ 4.27	\$ 51.25	Unit 564	Unit 530
Annual Cost = Watts/1000*8760hrs*0.13\$/kWh						
Electrical Costs Assumes an Average Rate of \$0.13/kWh			\$ 111.32	\$ 1,335.81		\$ 7.40

4. The Installation

- Once the electrical work was completed, the fans were installed in the attic spaces.
- The u-tube manometers were set in the attic space near the fan and the system label.



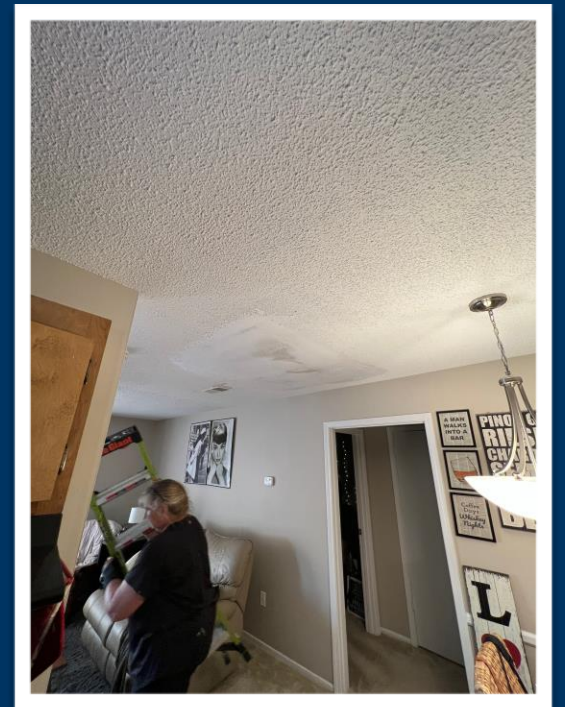
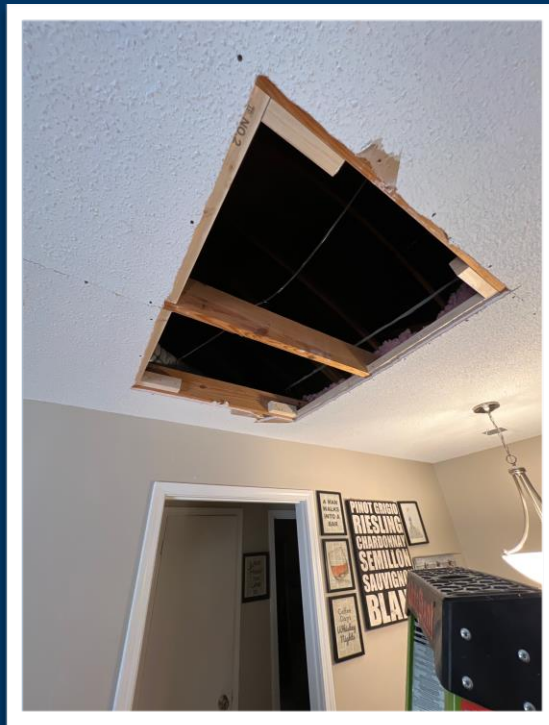
4. The Installation

- The system alarm (RadonAway RSA1) was set on the vent pipe, in the ground floor unit, toward the ceiling.
- The attics were extremely difficult to access.



4. The Installation

- During the fan installations, I tripped and went through the ceiling.
- Cost time and money to fix.

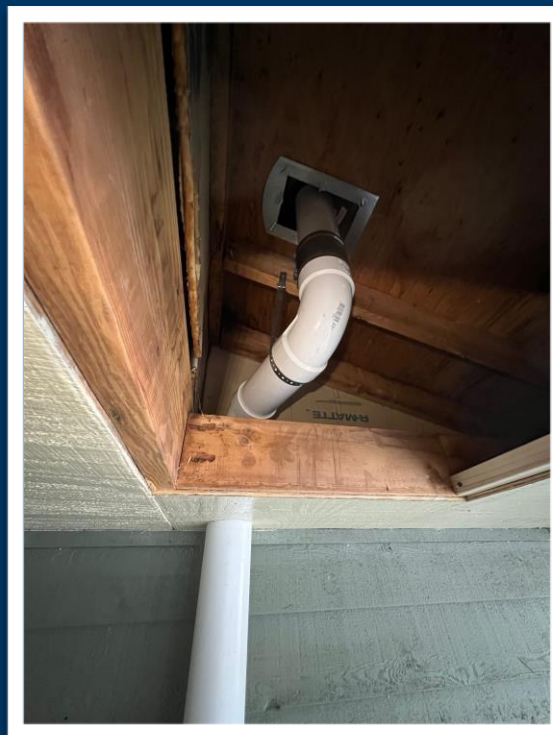
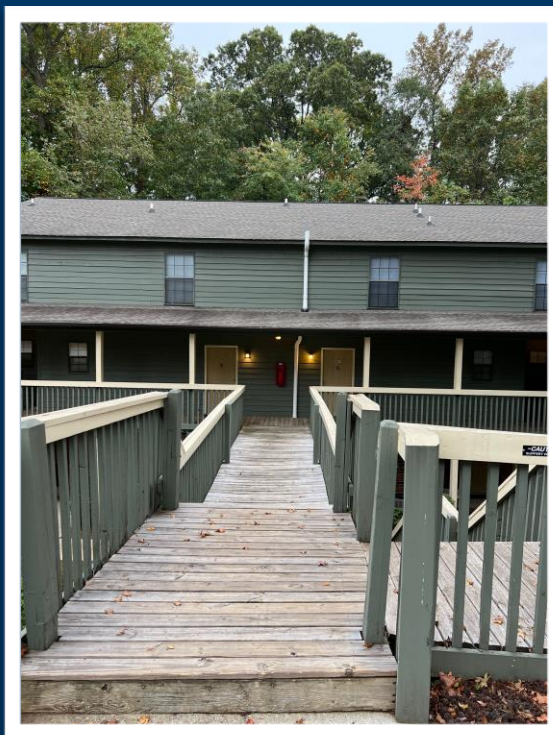


4. The Installation

- Three of the units had very unique layouts and had to be installed from the exterior.
- Where do you route the pipe to ensure it is compliant?




4. The Installation



5. The Results


- Success! All Units Were Lowered below 2.0 pCi/L



Radon Testing Report

Oct 25-27, 2022			
Blgd 10, Unit 337	779967	1.3 pCi/L	
Oct 25-27, 2022			
Blgd 10, Unit 339	779947	0.6 pCi/L	
Oct 25-27, 2022			
Blgd 10, Unit 364	779965	0.4 pCi/L	
Oct 25-27, 2022			
Blgd 11, Unit 367	779968	0.6 pCi/L	
Oct 25-27, 2022			
Blgd 11, Unit 369	779975	0.3 pCi/L	
Oct 25-27, 2022			
Blgd 11, Unit 373	779972	0.5 pCi/L	
Oct 25-27, 2022			
Blgd 11, Unit 381	779976	0.8 pCi/L	
Oct 25-27, 2022			
Blgd 11, Unit 383	779966	0.7 pCi/L	
Oct 25-27, 2022			
Building 11, Unit 385	779945	INVALID	Door open
Oct 25-27, 2022			
Blgd 11, Unit 385	779990	0.4 pCi/L	
Nov 21-23, 2022 Retest			
Blgd 12, Unit 391	780003	0.6 pCi/L	0.6 pCi/L
Oct 25-27, 2022	780004	0.5 pCi/L	
Blgd 12, Unit 393	780001	0.7 pCi/L	
Oct 25-27, 2022			
Blgd 12, Unit 399	779974	0.5 pCi/L	
Oct 25-27, 2022			
Blgd 12, Unit 401	779949	0.7 pCi/L	
Oct 25-27, 2022			
Blgd 13, Unit 403	779930	INVALID	Hole in ceiling
Oct 25-27, 2022			
Blgd 13, Unit 403	779992	0.9 pCi/L	
Nov 21-23, 2022 Retest			
Blgd 13, Unit 405	779997	1.0 pCi/L	
Oct 25-28, 2022			
Blgd 13, Unit 409	772001	0.9 pCi/L	
Oct 25-28, 2022			
Blgd 13, Unit 413	779973	0.6 pCi/L	
Oct 25-28, 2022			
Blgd 14, Unit 419	779954	1.0 pCi/L	1.1 pCi/L

Greenville Radon Specialist
304 D Boyd Ave. Simpsonville, SC
864-416-1721
Confidential Information



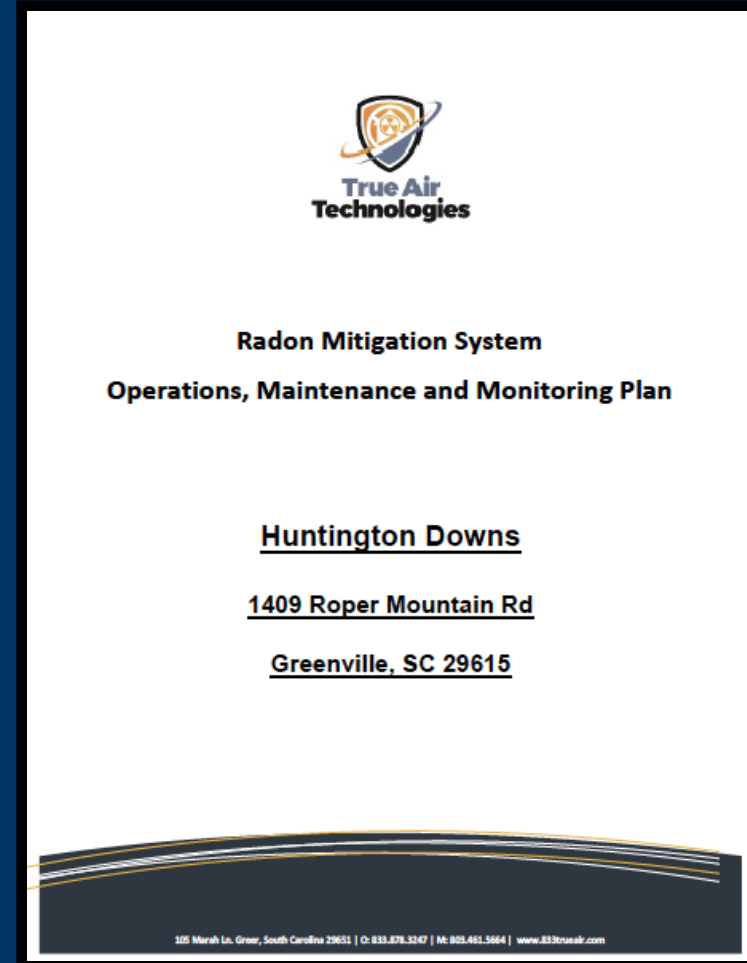
Radon Testing Report

Oct 25-28, 2022	779955	1.1 pCi/L	
Blgd 14, Unit 421	779948	0.8 pCi/L	
Oct 25-28, 2022			
Blgd 14, Unit 425	779952	0.9 pCi/L	
Oct 25-28, 2022			
Blgd 14, Unit 427		Not Tested	COVID
Oct 25-27, 2022			
Blgd 14, Unit 427	780026	0.7 pCi/L	
Nov 21-23, 2022 Retest			
Blgd 14, Unit 429	772005	0.7 pCi/L	
Oct 25-28, 2022			
Blgd 14, Unit 431	779953	INVALID	Canister was moved
Oct 25-28, 2022			
Blgd 14, Unit 431	779987	1.1 pCi/L	
Nov 21-23, 2022 Retest			
Blgd 14, Unit 433	771967	0.4 pCi/L	
Oct 25-28, 2022			
Blgd 15, Unit 435	771998	0.4 pCi/L	0.4 pCi/L
Oct 25-27, 2022	771997	0.4 pCi/L	
Blgd 15, Unit 437	772000	INVALID	Fan on, no a/c
Oct 25-27, 2022			
Blgd 15, Unit 437	779989	0.5 pCi/L	
Nov 21-23, 2022 Retest			
Blgd 15, Unit 439	771945	INVALID	Fan on
Oct 25-27, 2022			
Blgd 15, Unit 439	779991	0.9 pCi/L	
Nov 21-23, 2022			
Blgd 15, Unit 441	768497	0.4 pCi/L	
Oct 25-27, 2022			
Blgd 15, Unit 443	771944	0.5 pCi/L	
Oct 25-27, 2022			
Blgd 15, Unit 445	771926	0.8 pCi/L	
Oct 25-27, 2022			
Blgd 15, Unit 447	771999	0.6 pCi/L	
Oct 25-27, 2022			
Blgd 15, Unit 449	768524	0.7 pCi/L	
Oct 25-27, 2022			
Blgd 16, Unit 451	769910	0.8 pCi/L	
Oct 25-27, 2022			
Blgd 16, Unit 457	771946	1.0 pCi/L	
Oct 25-27, 2022			

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6. Post Mitigation Documentation A.K.A OM and M

- All of the documents and data collected throughout the installation process were used in formulating the final OM&M packet.
- The OM&M was very large because the project was very large.



7. The Results Continued

- What about these units?
- A month after we completed the project, the lender requested that the following units be tested as well.
- They were originally tested.
- All parties involved had missed these units in the original proposal/bid.

Building	Unit
3	194
13	417
21	553

7. The Results Continued

- Thankfully, some inadvertant collateral mitigation existed and the radon was lowered in these units as well.

Building	Unit
3	194
13	417
21	553

7. What We Learned

- It pays to double check. Double check EVERYTHING...the units to be mitigated, your processes, etc.
- If your not getting PFE, you are possibly leaking air somewhere. Find the leak(s) and seal it (Under the tub showers)
- Nothing was built similarly in these apartments. We had to get creative and find solutions to work around the obstacles presented. (We also got good at repairing drywall)
- Slow down and take your time so that you do not make costly mistakes (like falling through a ceiling)



QUESTIONS

Contact Information:



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