



RADON: KNOW YOUR LEVEL 2015-2018

REPORT

**WINDSOR-ESSEX COUNTY
HEALTH UNIT**





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Executive Summary

Background

Radon is a naturally occurring, odourless and colourless gas produced by the radioactive decay of uranium. In outdoor air, radon is harmless but can accumulate indoors to high concentrations and cause an increase in lung cancer risk (Health Canada, 2014). The Government of Canada Radon Guideline recommends that if the annual average indoor radon concentration in a home's normal occupancy area is greater than 200 Becquerel's per cubic metre (Bq/m³) then steps are necessary to decrease the radon level (Health Canada, 2014). The Windsor-Essex County Health Unit (WECHU) began a 3-year Radon: Know Your Level study and awareness campaign in 2015. As a part of this campaign, home owners of detached and semi-detached homes were recruited to determine indoor radon levels in the areas of Windsor-Essex County (WEC).

Purpose

The purpose of the Radon: Know Your Level Study was to:

- Increase awareness and inform the public about the risk of radon.
- Determine radon levels and areas of highest risk in WEC.
- Provide the public with radon reduction resources.

Methods

- Allocate radon test kits proportional to WEC municipality population size.
- Determine radon concentrations and home characteristics.
- Use a statistical model to analyze radon levels in each municipality and associated home characteristics.

Conclusion

- When combining study data from all three years, 11% of homes in WEC had indoor radon levels above the Canadian guideline of 200 Bq/m³.
- Essex County had a significantly greater proportion of homes with levels above 200 Bq/m³ (18%) compared to the City of Windsor (6%).
- The average indoor radon level for WEC combining all 3 years of study data was 94.1 Bq/m³.
- Amherstburg, Kingsville, Leamington and Tecumseh had average radon concentrations 12 to 26 Bq/m³ higher than WEC.

- Newer builds (2011 or after) had the highest average indoor radon concentrations in this study¹.
- Homes with two levels (i.e. basement and main floor) had 24% and 19% higher average radon levels compared to three and four-level homes¹.

¹ Results do not include data from study year one (2015/16) as consent was not given by participants to use home characteristics data as part of the analysis.

Introduction

According to Health Canada (2014), long-term exposure to radon is the second leading cause of lung cancer after smoking and the primary cause for non-smokers. It is recommended by Health Canada that if a home tests at 200 Bq/m³ or higher, it should be remediated to reduce levels as low as physically possible. Unfortunately, many homeowners are not aware of radon and its risks, nor their level of radon exposure within their homes. A local telephone based survey found the majority of respondents (62.3%) had no plans to have their dwelling tested with 17.0% of them believing radon testing is not important and there is no risk. In addition, 7.5% did not know how to test their home (RRFSS, 2017). In a Cross-Canada study released by Health Canada in 2012, 13.8% of homes tested in Windsor- Essex County had radon levels at or above 200 Bq/m³ (Health Canada, 2012). In comparison, in our neighbouring health unit areas of Sarnia-Lambton and Chatham-Kent, the proportion of homes above the recommended levels in were 8.5% and 18.4% respectively.

Methods

The study methods used during each year of the 3-year study were similar, with small changes made between study years for the purpose of improving the workflow process for WECHU staff and improve the participant experience. During each study year, the Radon: Know Your Level project spanned over an approximately 6-month time period and can be broken down as follows: study promotion, application process, radon test kit distribution and collection and post study communication.

Study Promotion

Promotion of the Radon: Know Your Level study focused on raising awareness about radon, encouraging homeowners to test their homes, and promoting the launch of the study and free radon test kits. Marketing methods included the use of WECHU social media accounts (Facebook and Twitter), on-hold phone messaging, emails to local workplaces, posters in health unit offices, and information on the WECHU website homepage. Posters were also displayed at local grocery stores, libraries, and arenas (distributed by Public Health Inspectors). Articles were published in Windsor Parent magazine, and a radio segment was aired as part of the AM800 CKLW Healthy Active Living Segment. Media releases were sent out to all local outlets with widespread coverage each year.

Application Process

In early November during each year of the study, homeowners in Windsor-Essex County were invited to apply to be part of the study. The application survey was available for completion online, over the phone, or in-person at any one of the three WECHU offices (Windsor, Essex, and Leamington).

Applicants were first asked give consent to participate in the study (see Appendix A for consent form used during 2017/2018 study) and answer seven eligibility questions. The eligibility questions are as follows:

- 18 years or older.
- Homeowner.
- Resident of Windsor- Essex County.
- Not testing a condominium or apartment.
- Not renovating the home in the next 6 months.
- Not moving in the next 6 months.
- Not an employee of WECHU.

Applicants who did not meet any one of these requirements were redirected from the survey to a WECHU webpage explaining why they were ineligible for the study. Information on where to purchase their own test kit was provided.

If all eligibility criteria were met, applicants were prompted to complete a survey that asked questions about their home characteristics and their current knowledge level of radon (Appendix B).

It should be noted that the consent form used for study year one (2015/2016) was modified for study year two (2016/17) and study year three (2017/18) because the format required that separate check boxes be checked to allow the different types of data collected to be used in statistical analysis and reports. Many participants did not check off all required boxes, and therefore portions of their data were not eligible for use in the study. The consent form was revised for study year two to allow for all data collected to be used for analysis and reports. The consent form was further revised in study year three to use plain language and less technical terminology.

Radon Test Kit Distribution

There were 1000 radon test kits purchased by WECHU for each study year, for a grand total of 3000 available kits over the duration of the study. In study year one, to minimize biased sampling and increase regional representation across WEC, qualified applicants were selected based on where their home was located in a Forward Sortation Area (FSA). A FSA is defined as a geographical region in which all postal codes start with the same three characters. Kits were allocated proportional to the number of households in each FSA.

In study years two and three, kits were allocated proportional to the number of homes in each of the 9 municipalities in WEC. For those municipalities where applicants exceeded the target number (e.g. City of Windsor), acceptance was given on a first-come, first served basis.

Applicants were notified of their acceptance by email or phone call depending on their preferred method as indicated in the study application. Kits were distributed during a two-week time period in November of each study year. Table 1 shows the actual number of kits distributed during each study year.

Table 1. Number of test kits distributed by study year.

Study Year	Total kits
2015/2016	1,000
2016/2017	985
2017/2018	960
TOTAL	2,945

Radon Test Kit Collection

The long-term radon test kits used in the study required a minimum of 91 days of testing time. Radon test kit collection began in the following March of each study year. Study participants received email or phone call reminders when it was time to return their kit. These reminders

also included information about specific return dates, times, and locations and instructions for ending the test.

Overall, each study year had a kit return rate of over 80%. Despite the high rate of return, not all returned kits were used for the statistical analysis and reports. See Table 2 for return rates and number of kits used in the analysis by study year. Kits were excluded in the analysis if:

- They were returned after the deadline.
- They were not deployed for a minimum of 91 days.
- They were damaged, or otherwise deemed void by the Accustar testing lab.

Table 2. Test kit return rate and number of kits included in analysis by study year.

Study Year	Return Rate	Total number of kits used in study analysis
2015/2016	80%	657
2016/2017	92%	886
2017/2018	88%	821

Post Study Communication

There were two follow-up emails sent to participants after kit drop off. The first email was sent 2 weeks after kits were returned, and the second email was sent after all results were received by WECHU and study participants (approximately 6 weeks later). Both emails included information about radon and a link to a survey.

The first email included a link to complete a survey that asked participants about their overall experience as a study participant. The second email contained a link to complete a survey that asked participants specific questions about their radon test results, intentions to mitigate, preferred method of mitigation (contractor or do-it-yourself) and to identify any barriers that would prevent them from mitigating (see Appendix C for survey questions).

Results

When combining results from all three study years, a total of 11% of homes in WEC had indoor radon levels above 200 Bq/m³. Essex County had a significantly greater proportion of homes with levels above 200 Bq/m³ (18%) compared to the City of Windsor (6%) (Figure 1). Radon levels ranged from a low of 14 to a high of 784 Bq/m³ with a median of 114 Bq/m³ (Figure 2).

Figure 1. Proportion of homes exceeding indoor radon concentration guidelines (200 Bq/m³) in City of Windsor and Essex County, 2015-2018.

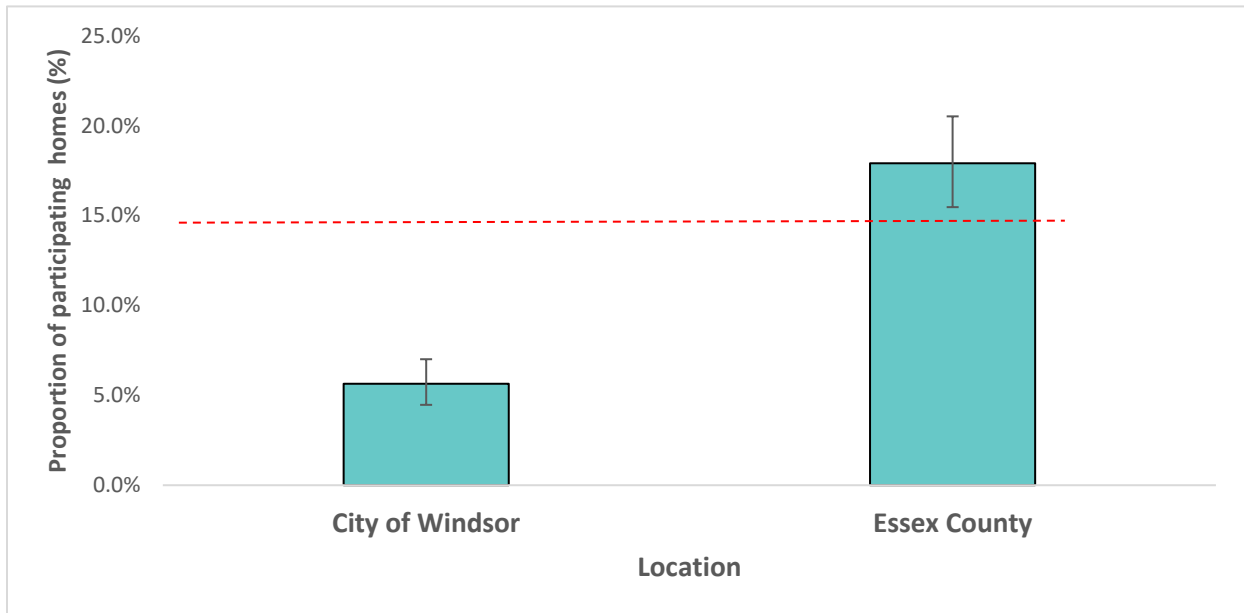
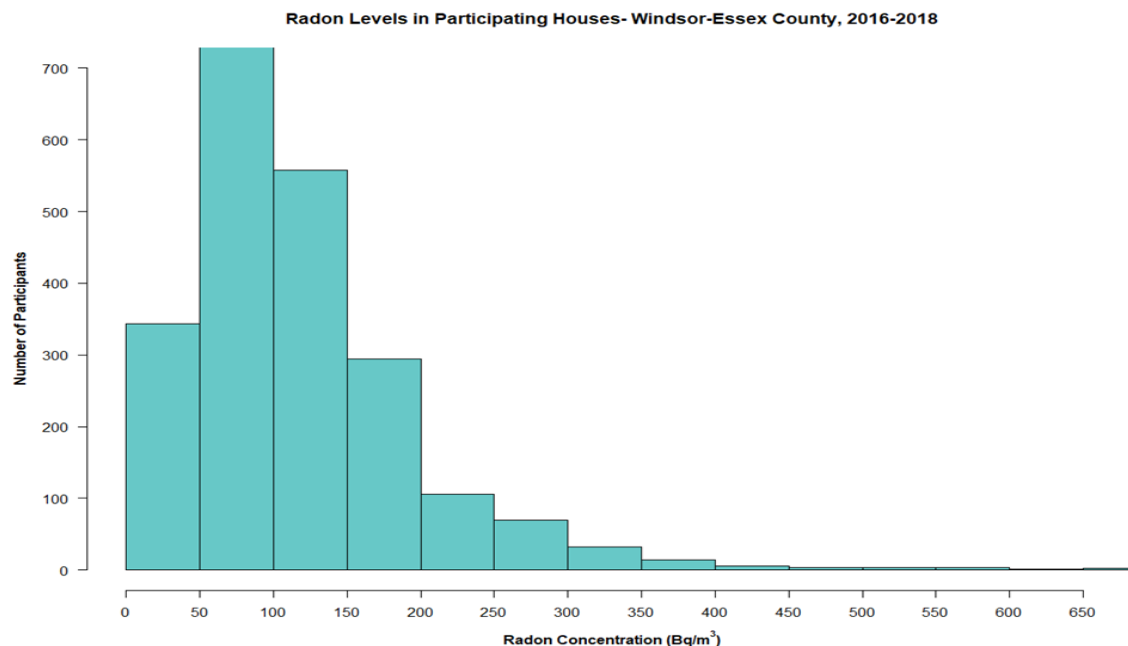


Figure 2. Frequency of radon concentrations in participating WEC homes, 2015-2018



Homes tested in the Town of Amherstburg had the highest average radon levels (119.8 Bq/m³) followed closely by Kingsville (118.7 Bq/m³). Compared with all other municipalities, the City of Windsor had the lowest average indoor radon concentration (86.4 Bq/m³) (Table 3 and Figure 3). These levels are further broken down by Forward Sortation Area (FSA) as shown in Figure 4.

Table 3. Radon levels in participating homes by municipality, 2015-2018.

Region	Average radon level	95% Confidence Interval
Amherstburg	119.8	106.4-134.9
Essex	98.2	86.7-111.2
Kingsville	118.7	103.2-136.4
Lakeshore	96.9	87.8-106.9
LaSalle	94.7	88.7-101.1
Leamington	107.2	89.9-127.8
Tecumseh	105.6	97.4-114.4
City of Windsor	86.4	83.3-89.5
Windsor-Essex County	94.1	94.0-94.1

Figure 3. Radon concentration (Bq/m³) by municipality.

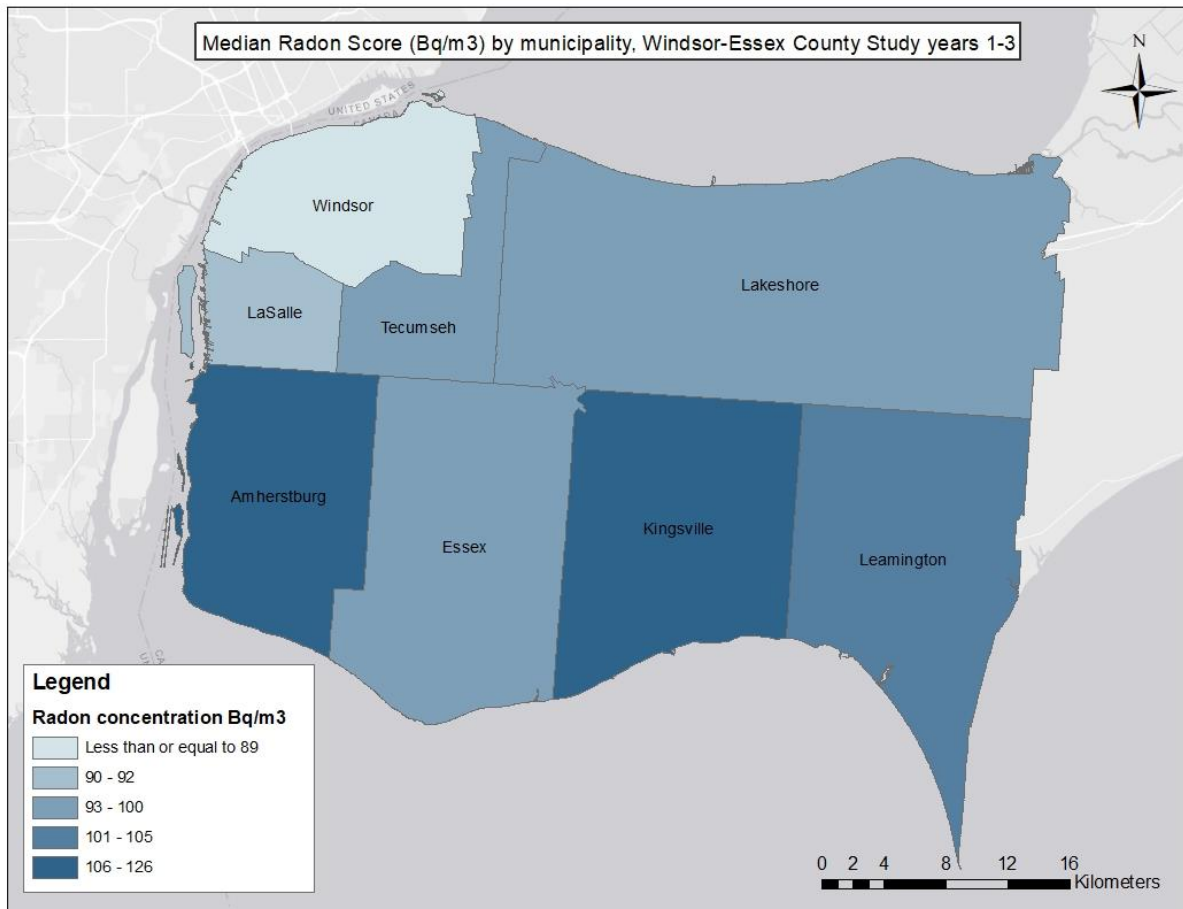
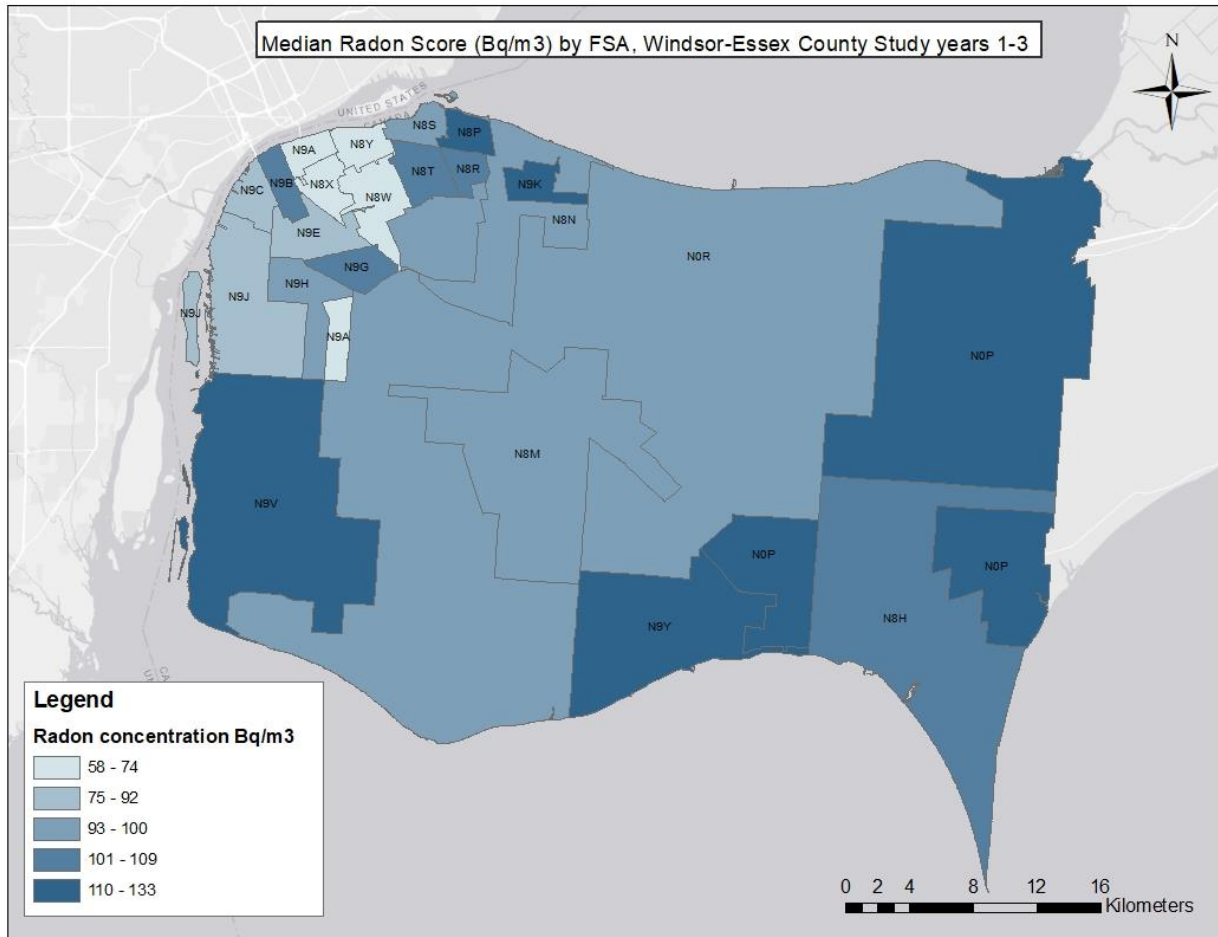


Figure 4. Radon concentration (Bq/m³) by Forward Sortation Areas (FSA).



Home characteristics

A statistical model (multivariable linear regression model) compared radon levels by municipality while accounting for confounding home characteristic variables. The majority of homes (72%) participating in study year two and three were built between 1951-2010. Almost half (47%) of homes had two levels; 36% had three levels including the basement and almost three-quarters (73%) of homes had a partial basement (Table 4). The most common material reported for the foundation walls was cinder block (58%) or poured concrete (36%). Basement floors were mostly made from poured concrete (87%) (Table 5).

Homes built from 1941-1950 onwards had significantly higher radon levels than homes built in 1920 or earlier ($p < 0.001$) with newer builds (2011 or after) having the highest average indoor radon concentrations in this study (Figure 5). Homes with two levels (i.e. basement and main floor) had 24% and 19% higher average indoor radon levels compared to three and four-level homes ($p < 0.000$) (Figure 6). Homes with concrete floors had 1.3 times higher radon levels ($p = 0.001$). Earth/dirt basement floors displayed 14% lower radon ($p = 0.026$). Floor cracks resulted

in a small increase in radon levels compared to homes without floor cracks but was not significant ($p = 0.159$). Homes with basement vents had 8.0% lower radon levels than homes without them ($p = 0.004$). Sump pumps in homes resulted in a non-significant 6% radon level increase in the adjusted model ($p = 0.136$).

Table 4. Structural characteristics in participating homes, study years two and three.

Home Characteristics	Frequency	Percent (%)
Year Built		
1920 or before	88	5.2
1921-1930	102	6
1931-1940	41	2.4
1941-1950	108	6.3
1951-1960	199	11.7
1961-1970	193	11.3
1971-1980	183	10.7
1981-1990	137	8
1991-2000	277	16.2
2001-2010	245	14.4
2011 or after	110	6.4
Unsure	24	1.4
Number of levels¹		
1	98	5.7
2	809	47.4
3	615	36
4 or more	185	10.8
Underground area		
No basement	17	1
Crawl space or partial basement	177	10.4
Crawl space	122	7.1
Partial basement	148	8.7
Full basement	1,243	72.8

¹Number of levels in home includes basement.

Table 5. Floor and foundation construction in participating homes, study years two and three.

Construction Type	Frequency	Percent (%)
Foundation Wall		
Poured Concrete	610	35.7
Cinder block	997	58.4

Construction Type	Frequency	Percent (%)
Brick	124	7.3
Stone	19	1.1
Wood	28	1.6
Unsure	121	7.1
Other	21	1.2
Basement Floor		
Poured concrete	1,474	87.2
Earth/dirt	193	11.4
Rock/stone	15	0.9
Unsure	58	3.4
Other	31	1.8

Figure 5. Radon Levels by original build year of home, study years two and three.

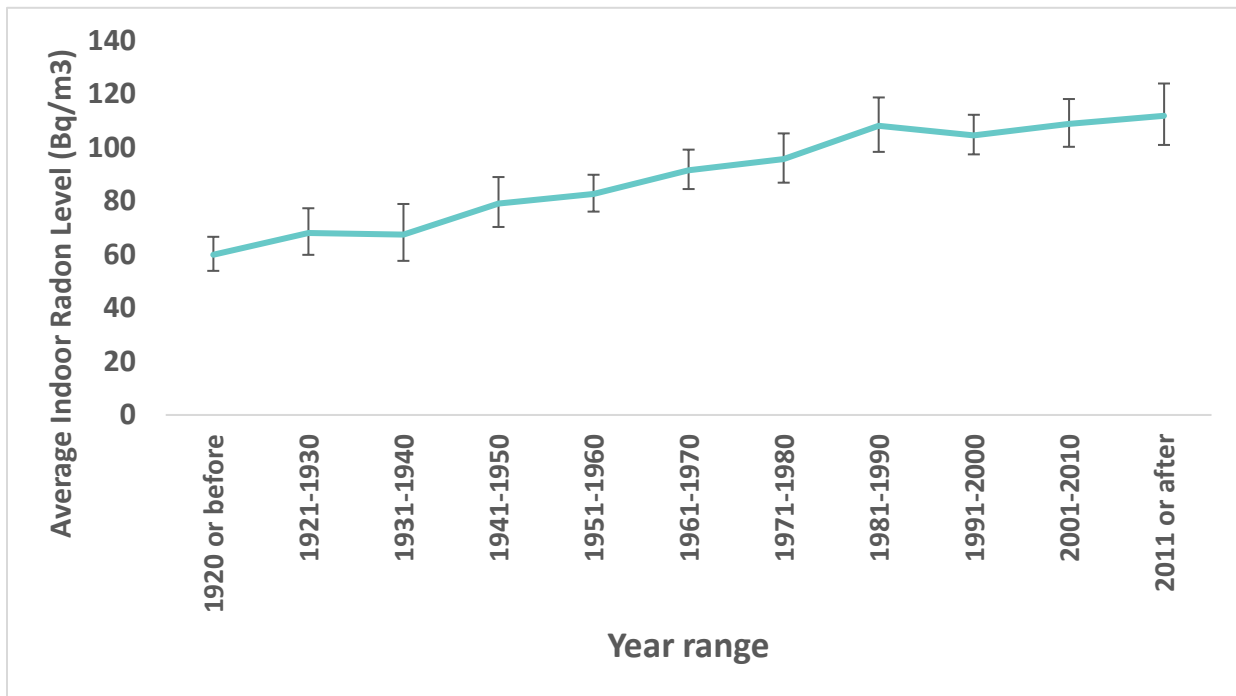
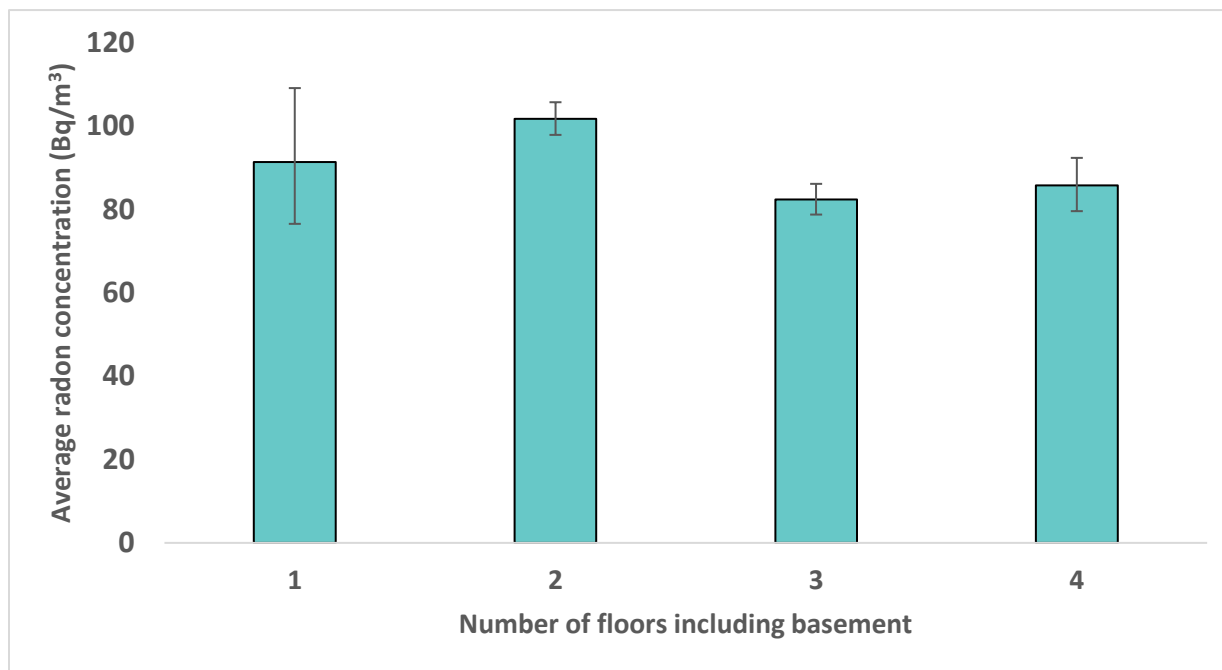


Figure 6. Average indoor radon levels by number of floors, study years two and three.



Process survey responses

Across study years one and three, the majority (94%) of process survey respondents stated that the “Radon: Know Your Level” project improved their knowledge about radon (Table 6). Similarly, almost all respondents (94%) indicated the information resources provided were useful.

Post-results survey responses²

The main barriers for radon remediation cited by respondents of the post-results survey were cost (31%) and time (11%) (Table 7). One in five (21%) respondents indicated they were likely or very likely to take action to reduce radon levels in their homes. Furthermore, less than half (46%) of those intending to pursue radon mitigation said they would contact a professional to address their issue.

Table 6. Process survey responses from study years one to three.

Survey Responses	Participants (%)
Increased knowledge about radon	369 (94%)
Received useful information resources	370 (94%)

² Post-results survey was conducted for study years two and three only.

Table 7. Post-results survey from study years two and three.

Survey Results	Participants (%)
Intention for radon mitigation	157 (21%)
Intention to consult professional	71 (46%)
Barrier for radon mitigation	
Comfortable with current radon level	232 (77%)
Knowledge	112 (31%)
Cost	35 (11%)
Time	28 (9%)
Resource access	10 (3%)
Belief that radon is not a health risk	232 (77%)

Discussion

Results from the Radon: Know Your Level 3-year study showed evidence that certain home characteristics and locations are associated with higher indoor radon levels. Results also revealed specific geographic locations within Windsor-Essex County that had homes with higher levels.

While all ages, types, and locations of homes in this study had detectable levels of indoor radon, results showed that newer homes (built after 2011) had significantly higher indoor radon levels than older homes (built in 1920 or before). A possible explanation for this difference could be related to the quality of the seals in windows and doors and/or the level of insulation in the home. Less air flow between inside and outside air could prevent radon from escaping to the outside during the winter months. .

It should be noted that overall radon levels were found to be 37% lower in study year three compared to study year two ($p < 0.000$). A possible explanation for this difference could be the level of the home where study participants chose to place their test kit despite instructions remaining the same (i.e. keep kit in the lowest lived-in level). In study year two, more test kits (64%) were placed in the basement compared to study year three (55%). Radon levels are known to be higher in the lowest levels of a home. This difference in kit placement could be due to the intense rainfall that occurred on August 31, 2017, which flooded thousands of basements in WEC. The flooding and subsequent damage to basements could have prevented homeowners from using it as a living space during study year three.

Future Considerations

Further examination of the literature regarding radon and its impact on human health is recommended along with continued research into effective and affordable mitigation strategies for existing homes and buildings, and for all new construction. Data from this study could be used to advocate for change to national and provincial buildings codes, as well as local municipal by-laws.

Residents of WEC should continue to receive education about radon and its risks, where to purchase testing kits, as well as information about mitigation options for homes with high radon levels. This information is currently available on the WECHU website. In addition, homeowners who build new homes should be informed of the TARION new home warranty which covers radon-reducing repairs up to \$15,000. Building contractors should be made aware of simple radon mitigation strategies that could be roughed-in during the building phase which could reduce overall long-term mitigation costs.

References

Health Canada. (2014). *Radon- reduction guide for Canadians*. Retrieved from <https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/radiation/radon-reduction-guide-canadians-health-canada-2013.html>.

Health Canada. (2012). *Cross-Canada survey of radon concentrations in homes: Final report*. Retrieved from http://www.hc-sc.gc.ca/ewh-semt/alt_formats/pdf/radiation/radon/survey-sondage-eng.pdf.

Rapid Risk Factor Surveillance System (RRFSS), September 2015 to April 2016 & Jan-April 2017, Windsor-Essex County Health Unit.

Appendix A



KNOW YOUR LEVEL

CONSENT TO PARTICIPATE IN RADON STUDY

Title of Study: 'Radon: Know Your Level' Study

INFORMATION ABOUT THE STUDY

You are asked to be part of a study led by the Windsor-Essex County Health Unit (WECHU). If you have any questions or concerns before taking part in the study, please contact Karen Lukic at 519-258-2146 ext. 1454 or klukic@wechu.org.

The purpose of this study is to:

- Educate the public about the risk of radon.
- Determine radon levels in homes and areas of high risk in Windsor-Essex County.
- Give information to the public on how to reduce the amount of radon in their homes.

PROCEDURES

There are a limited number of radon test kits available. Not everyone who applies for a kit will receive one. Eligible participants who fill out the application survey will be chosen on a first come first serve basis by municipality. Only those chosen will be contacted to pick up their free radon test kit.

If you are eligible and volunteer to participate in this study, you agree to:

- Complete a radon test kit application survey online or in-person.
- Pick-up a free radon test kit from a WECHU office during the scheduled pick-up week.
- Follow the instructions to set up your radon test kit the day you pick it up.
- Place the radon test kit in the lowest lived-in level of your home for at least 91 days. The test kit must not be moved or touched during the test period.
- Return the radon test kit to a WECHU office during the scheduled drop-off week.
- Allow WECHU to mail your radon test kit along with your name, home address, and email address to Accustar Labs in Massachusetts to be processed.
- Allow WECHU to use your radon results and link them to your survey responses in publications (no names or addresses will be used).
- Allow WECHU to communicate with you throughout this study by the email address or phone number you provide.

- Complete a follow-up survey after dropping off the radon test kit, and again once the study is complete.

CONFIDENTIALITY

Any of the information you give us as part of this study will not be shared unless you tell us otherwise.

You will be able to see your radon test results on the Accustar website 6 to 8 weeks after dropping off the test kit. WECHU will also be able to see your radon test results.

If you pick up a radon test kit and decide not to perform the test, please contact Karen Lukic (519-258-2146 ext. 1454 or klukic@wechu.org) and return the kit to a WECHU office. Once you have completed testing and the radon test kit has been returned to WECHU for mailing to the lab, you can no longer quit the study.

HOW WE WILL PROTECT YOUR INFORMATION

Information about you will be stored separately from your survey responses. Your survey responses and information about you will only be known by the project team. We will not publish any information about you. During the study, WECHU will have information about you, such as your email, name, home address, and radon results so that they can answer any questions you might have. Any information about you will be destroyed 2 years after we have finished the study.

Your survey responses and radon results will be linked for reporting; but, will not include any information about you. Only postal codes will be used for narrowing of general radon result locations. We will keep the study results, without any information about you, for at least 7 years.

WECHU may remove you from this study if there is a reason to do so (e.g., if the radon test kit is not returned during the drop-off week, or if the test kit was not set up according to the instructions given). If you do not contact WECHU to withdraw yourself from the study, your survey responses will be kept.

Your name, home address, email address, and device number will be released to the lab testing company (Accustar Labs) for them to analyse the radon test kit. Where required by law, the lab has a duty to report this information with radon test results to the Provincial and Federal Governments.

Web Privacy Statement: <https://www.wechu.org/key-policies/privacy-statement>

POTENTIAL RISKS OF BEING A PART OF THE STUDY

Since radon is a health hazard, it may be concerning to find out that you are living in a home with high levels of radon. However, learning about radon and being aware of the radon levels in your home will give you the knowledge to take the next steps in reducing your home's levels.

A report that highlights high radon levels in certain postal code areas may cause a drop in perceived home value for that area. However, fixing radon problems may actually protect the value of your home.

Making changes to one's home in order to lower radon levels can cost approximately \$500-\$3000 depending on the contractor and the home. Although reducing radon levels is the decision and responsibility of the home owner, WECHU will provide radon reduction information resources to inform you of your options.

POTENTIAL BENEFITS OF BEING A PART OF THE STUDY

Exposure to radon is the second leading cause of lung cancer after smoking. Almost every home has radon in it, and many people don't know their levels. The only way to know your radon level is to test for it. For this study, 1015 radon test kits will be provided to Windsor-Essex County residents to raise awareness of radon and encourage people to know their levels. Being aware of your radon level is the first step towards reducing your levels. Individuals, with homes that have high radon levels, will be provided informational resources in order to take the next steps to lowering radon levels and decreasing their risk of exposure.

Releasing a report to Windsor-Essex County residents discussing areas with high levels of radon will help raise awareness about this health hazard. This project will encourage homeowners across Windsor-Essex County to test their homes and make changes as needed.

If instructions are followed correctly, each selected participant will receive one free radon test kit and have access to their results.

HOW WE WILL SHARE AND USE THE RESULTS OF THE STUDY

A report with the study findings based on survey responses and radon results by geographical area will be released publically and made available on WECHU's website (www.wechu.org) in the Fall of 2018.

These data may be used in subsequent studies, in publications, and in presentations. Data (without information about you) may be shared with other organizations for data pooling.

CONSENT OF STUDY PARTICIPANT/LEGAL REPRESENTATIVE

- I understand the information provided for the study "Radon: Know Your Level" as described in this consent form.
- I understand that WECHU is not responsible for the accuracy of radon results as produced by Accustar Labs (Personal radon results will be available on www.accustarcanada.com).
- My questions have been answered to my satisfaction, and I agree to participate in this study.
- I understand that by completing this consent form, I am not guaranteed to receive a free radon test kit. Only those who are selected for a radon test kit will be contacted by WECHU.

- If I am chosen to be a part of this study and the radon results for my home are high, I understand that it will be my responsibility and decision as a homeowner to take action to lower my levels. WECHU is not responsible in any way for fixing my home.

If you have questions about your rights as a study participant, contact: Research Ethics Board, University of Windsor. ethics@uwindsor.ca, 519-253-3000, ext. 3709.

Please print a copy of this consent form for your records.

Appendix B

Radon: Know Your Level Study Application Survey

The Know Your Level Study is an initiative by the Windsor-Essex County Health Unit (WECHU) to increase public awareness about indoor radon. As part of this study, selected participants will be provided with a radon test kit to determine the radon level within their home.

To be a part of this study, you must agree to the following consent form and complete the following survey. The survey will help to determine your eligibility for this study and will provide us with information on the home you are planning to test. Participation in this study is voluntary. You may choose not to participate.

You may be selected to participate **only** if you meet the eligibility criteria and submit a completed survey. By completing the survey, you are not guaranteed to receive a radon test kit as the number of kits is limited. Radon test kits will be provided to eligible participants on a first-come first-serve basis by municipality until all kits are distributed. **You will receive an email from WECHU if you have been selected to participate.** If you do not receive an email from us, you have not been selected to participate.

Confidentiality Statement: Please note that your online survey responses will be linked to your radon test kit results; however, your responses will be pooled with those of many others and summarized to protect your anonymity. No individual participating in this study will be identifiable from the information in any report that will be produced.

Please answer this survey based on the home you are planning to test for radon.

- 1) Are you 18 years or older?
 - Yes.
 - No.

- 2) Do you own the home that you are planning to test?
 - Yes.
 - No.

- 3) Is the home you are planning to test located in Windsor-Essex County?
 - Yes.
 - No.

- 4) Is the home you are planning to test a condominium or apartment?
 - Yes.
 - No.

5) Do you intend on doing major renovations (within the next 6 months) to the home you are planning to test?

- Yes.
- No.

6) Do you intend on selling (within the next 6 months) the home you are planning to test?

- Yes.
- No.

7) Does a Windsor- Essex County Health Unit employee own or live in the home you are planning to test?

- Yes.
- No.

If inclusion criteria (first 7 questions) are not met, survey will be terminated and participant will be redirected to WECHU website with inclusion criteria listed.

Please tell us a bit more about the home you are planning to test:

8) Approximately what year was this home originally built?

- 1920 or before.
- 1921-1930.
- 1931-1940.
- 1941-1950.
- 1951-1960.
- 1961-1970.
- 1971-1980.
- 1981-1990.
- 1991-2000.
- 2001-2010.
- 2011 or after.
- Unsure.

9) What type of home are you planning to test?

- Single-detached home (A single house on its own property).
- Semi-detached home (A home that shares one or more common walls with another home). This includes townhouse and row house.
- Other _____

10) How many levels does the home have (include basement, if any)?

- 1.
- 2.
- 3.

- 4 or more.

11) What type of foundation walls does the home have? **(SELECT ALL THAT APPLY)**

- Poured concrete.
- Cinder block/Concrete block.
- Brick.
- Stone.
- Wood
- Other, please specify: _____
- Unsure/Don't know.

12) Does the home have a basement or crawlspace?

- Yes, a full basement (underneath the entire home).
- Yes, a partial basement (underneath part of the home).
- There is a crawl space under all or part of the home.
- There is a crawl space and a partial basement.
- No basement (If selected, skip to question about past radon testing).

13) What type of floor is in the basement or crawlspace? **(SELECT ALL THAT APPLY)**

- Poured concrete.
- Earth/Dirt.
- Rock/Stone.
- Other, please specify: _____
- Unsure/Don't know.

14) What types of openings are in the basement? **(SELECT ALL THAT APPLY)**

- Sump pump/sump hole (if selected, show question about sump sealing).
- Cracks in foundation walls.
- Cracks in floor.
- Drains.
- Vents.
- Other, please specify: _____
- Unsure/Don't know.

15) Is the sump pump or sump hole:

- Sealed.
- Unsealed.
- Unsure/Don't know.

16) Has this home been tested in the past to determine the indoor radon levels?

- Yes.
- No.
- Unsure/Don't know.

17) Have steps been taken in the past to reduce radon levels in this home (e.g. installation of depressurization systems, sealing openings, installation of heat or energy recovery ventilator, etc.)?

- Yes.
- No.
- Unsure/Don't know.

Please tell us a bit more about your knowledge and beliefs about radon:

18) Before hearing about this radon study, were you aware that radon could be in your home?

- Yes.
- No.

19) Before hearing about this radon study, how aware were you of the health risks related to radon?

- Very aware.
- Somewhat aware.
- Not at all aware.

20) If your radon test result shows a high level of radon inside your home, how likely are you to take the steps in order to reduce that level?

- Very likely.
- Likely.
- Unlikely.
- Very unlikely.
- Unsure/Don't know

21) What barriers might prevent you from taking steps to reduce the level of radon inside your home? **(SELECT ALL THAT APPLY)**

- Lack of knowledge about how to reduce radon.
- Lack of access to resources (e.g. certified professionals with the knowledge and skills to fix the issue).
- Cost of fixing my home.
- Time needed to fix my home.
- I don't believe that radon is a health risk.
- No barriers will prevent me from taking steps to reduce the radon in my home.
- Other, please specify: _____

22) How did you hear about this study? **(SELECT ALL THAT APPLY)**

- Facebook.
- Twitter.
- Windsor-Essex County Health Unit (WECHU) website.
- Other online source.

- Radio.
- Television.
- Newspaper.
- Word of mouth (e.g., family, friends, co-workers).
- Radon Awareness Booth.
- Other, please specify: _____

Appendix C

Survey #1 Radon After Kit Drop off Process Survey

I agree to participate in this survey

- Yes.
- No.

Where did you pick up your radon test kit?

- Windsor.
- Essex.
- Leamington.

Please select your answer below from Strongly Agree to Strongly Disagree

- The test kit PICK-UP process (in November) was easy.
- I was able to successfully set up my radon test kit when I got home.
- The instructional video (YouTube link) was helpful.
- The test kit DROP-OFF process (in March) was easy.
- Participating in this study has increased my awareness about the risks of radon.
- The emails or phone calls I received during the study were helpful.
- The information resources provided were useful.

Please tell us any other feedback you may have about participating in the 'Radon: Know Your Level' Study.

Survey #2 Radon Results Final Survey

1. What were the radon test results for your home?

- 0 to 100 Bq/m³.
- 101 to 200 Bq/m³.
- Greater than 200 Bq/m³.
- Invalid results.
- I have not received my results yet.
- Prefer not to answer.

2. How likely are you to make changes to your home to reduce radon levels?

- Very likely.
- Likely.
- Unlikely.
- Very unlikely.
- Unsure/Don't know.

3. Will you contact a professional or will you fix your home yourself?

- Contact a professional.
 - Make changes myself.
4. Are there any barriers that would prevent you from fixing your home? Check all that apply
- Lack of knowledge about how to reduce radon levels.
 - Cost of fixing my home.
 - Time needed to fix my home.
 - Lack of access to resources, e.g. certified professional.
 - I don't believe that radon is a health risk.
 - I do not need to make changes, my radon level is low.
 - Other, please specify.

Appendix D

Data Tables for Figures

Table for **Figure 1**. Proportion of homes exceeding indoor radon concentration guidelines (200 Bq/m³) in City of Windsor and Essex County, 2015-2018.

Region	% home exceeding 200 Bq/m ³	Lower bound 95% Confidence Interval	Upper bound 95% Confidence Interval
City of Windsor	5.6%	4.5%	7.0%
Essex County	17.9%	15.5%	20.5%
Ontario	8 %	N/A	N/A

Table for **Figure 2**. Frequency of radon concentrations in participating WEC homes, 2015-2018.

Radon concentration range (Bq/m ³)	Number of participants
0 to 50	265
51 to 100	687
101 to 150	389
151 to 200	210
201 to 250	72
251 to 300	47
301 to 350	20
351 to 400	5
401 to 650	12

Table for **Figure 3**. Radon concentration (Bq/m³) by municipality.

Municipality	Median Radon concentration (Bq/m ³)
Amherstburg	104
Essex	98
Kingsville	110
LaSalle	88
Lakeshore	88
Leamington	106
Tecumseh	90
Windsor	89

Table for **Figure 4**. Radon concentration (Bq/m³) by Forward Sortation Areas (FSA).

Forward sortation area	Median radon concentration (Bq/m ³)
NOP	107
NOR	96

Forward sortation area	Median radon concentration (Bq/m ³)
N8G	81
N8H	96
N8M	100
N8N	96
N8P	122
N8R	107
N8S	89
N8T	104
N8W	74
N8X	65
N8Y	59
N9A	50
N9B	105
N9C	89
N9E	85
N9G	90
N9H	78
N9J	85
N9K	111
N9V	126
N9Y	112

Table for **Figure 5**. Radon Levels by original build year of home, study years two and three.

Year range	Average Radon concentration (Bq/m ³)	Lower bound 95% Confidence Interval	Upper bound 95% Confidence Interval
1920 or before	60	54	67
1921-1930	68	60	77
1931-1940	67	58	79
1941-1950	79	70	89
1951-1960	83	76	90
1961-1970	92	85	99
1971-1980	96	87	105
1981-1990	108	98	119
1991-2000	105	97	112
2001-2010	109	100	118
2011 or after	112	101	124

Table for **Figure 6**. Average indoor radon levels by number of floors, study years two and three.

Number of floors including basement	Average Radon concentration (Bq/m³)	Lower bound 95% Confidence Interval	Upper bound 95% Confidence Interval
1	91	77	109
2	102	98	106
3	82	79	86
4	86	80	92



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