City of Kingston
Information Report to Council
Report Number 19-228

To:	**Mayor and Members of Council**
From:	**Lanie Hurdle, Interim Chief Administrative Officer**
Resource Staff:	**Paige Agnew, Director, Planning, Building & Licensing Services**
Date of Meeting:	**September 3, 2019**
Subject:	**Radon Mitigation Strategy - Overview**

Executive Summary:

Radon is a colourless, odourless and tasteless gas that is formed naturally by the radioactive breakdown of uranium contained in soil and rock. Radon usually escapes from the ground into the air where it mixes with fresh air resulting in concentrations too low to be of concern. However, when radon enters an enclosed space through cracks and holes in floors and foundations in a building, it can accumulate to higher concentrations.

Currently, the Ontario Building Code lists three designated geographic locations in Ontario known to have high radon levels, and in these locations buildings must be designed and constructed to ensure that radon levels do not exceed 200 becquerels per cubic metre. The City of Kingston is currently not one of the three designated locations.

Kingston, Frontenac, Lennox & Addington (KFL&A) Public Health conducted a study from November 2018 to February 2019 within their jurisdiction area, in which they provided free radon tests to residential home owners to collect data on radon levels and gain feedback on radon awareness. Results of this study (Exhibit A), issued through a public advisory on August 12, 2019, show 15.7% of the 615 tested homes within the City of Kingston were found to be above Health Canada's recommended guideline of 200 becquerels per cubic metre.

Based on this new data specific to the City of Kingston, the Building Services Division is responding accordingly with a radon mitigation strategy in compliance with the Ontario Building Code. The Soil Gas Mitigation strategy (Exhibit B) outlines requirements for new construction and additions to low-rise residential buildings, effective September 1, 2019.

Recommendation:

This report is for information only.

Authorizing Signatures:

ORIGINAL SIGNED BY CHIEF ADMINISTRATIVE OFFICER

Lanie Hurdle, Interim Chief Administrative Officer

Consultation with the following Members of the Corporate Management Team:

Peter Huigenbos, Acting Commissioner, Community Services	Not required
Jim Keech, President & CEO, Utilities Kingston	Not required
Desirée Kennedy, Chief Financial Officer & City Treasurer	Not required
Sheila Kidd, Commissioner, Transportation & Public Works	Not required
Deanne Roberge, Acting Commissioner, Corporate Services	

Options/Discussion:

Radon
According to Health Canada, long-term exposure to radon is linked to roughly 16 percent of lung cancer deaths in Canada, and is the second leading cause of lung cancer after smoking. Canada's radon guideline is currently 200 becquerels per cubic metre.

The only way to determine if radon levels are within Health Canada's guideline of 200 becquerels per cubic metre is to test. As testing can only be completed after construction and the dwelling is occupied, Health Canada recommends Radon testing should be conducted for a minimum of 91 days (October to April) during the heating season to ensure an accurate reading of Radon levels.

Where testing indicates radon levels are between 200 becquerels per cubic metre and 600 becquerels per cubic metre, Health Canada recommends action to reduce radon levels within two years, and where radon levels exceed 600 becquerels per cubic metre, action to reduce radon levels within one year.

KFL&A Public Health Study
KFL&A Public Health conducted a study from November 2018 to February 2019 in their jurisdiction area which included the City of Kingston as well as local surrounding municipalities. As part of the study, free radon tests were provided to eligible residential home owners to collect data on radon levels and to gain feedback on the homeowners' awareness of radon as a health risk.

On January 25, 2019 and February 21, 2019, Building Services staff facilitated discussions with a number of the local Chief Building Officials (CBO's) and industry stakeholders to discuss KFL&A Public Health's radon testing study and the implications of potential readings above 200 becquerels per cubic metre. The focus of the discussion was to gather information about radon gas intrusion, discuss various mitigation options, and seek feedback on developing an effective Radon Gas Mitigation Strategy. Attendees included local CBO's and representatives from the Ontario Home Builders Association. A Frequently Asked Questions and Answers (FAQ) document was subsequently prepared and shared with the various stakeholders for review and comment.

Study Findings
The results of the KFL&A Public Health study (Exhibit A), issued through a public advisory on August 12, 2019, show 15.7% of the 615 tested homes within the City of Kingston were found to be above Health Canada's guideline of 200 becquerels per cubic metre.

On August 12, 2019, Building Services staff and staff from KFL&A Public Health jointly met with representatives of local Municipalities and the Kingston Home Builders association to provide further information and answer questions on the radon advisory and summary report for local radon readings, which were made public the same day.

In the recent findings from the study, and based on specific data for the City of Kingston, the City has proactively implemented requirements for soil gas control measures in compliance with the Ontario Building Code. The Soil Gas Mitigation Strategy (Exhibit B) outlines requirements for new construction and additions to low-rise residential buildings.

The City's Soil Gas Mitigation Strategy aims to:

- Create an effective radon gas mitigation strategy;
- Proactively address potential exposure to radon gas; and
- Reduce potential health risks to building occupants.

Ontario Building Code

The Ontario Building Code introduced mandatory heat recovery ventilation (HRV) in all new homes in 2017 to provide air exchange to the exterior to account for air tightness in houses, as well as the requirement to seal sump pit covers in 2014 to maintain continuity of the air barrier system. These two provisions are listed within Health Canada's guidelines as being up to 50 percent effective in reducing radon levels when maintained properly.

Currently, there are three designated geographic locations in Ontario where buildings must be designed and constructed to ensure that radon levels do not exceed 200 becquerels per cubic metre under the Ontario Building Code, and include:

1. the City of Elliot Lake in the Territorial District of Algoma;
2. the Township of Faraday in the County of Hastings; and
3. the geographic Township of Hyman in the Territorial District of Sudbury.

The City of Kingston is currently not listed as one of the three designated radon mitigation locations. Where radon gas is known to be a problem, as is the case for these three locations, the Ontario Building Code requires construction to include certain radon mitigation measures, and contains prescriptive requirements for radon mitigation in low-rise residential buildings.

The Ontario Building Code provides builders with three options for radon mitigation and depending on the soil gas control option chosen; a dwelling may be subject to either mandatory or voluntary radon gas testing. All radon gas testing is recommended by Health Canada to be carried out by a Canadian National Radon Proficiency Program (C-NRPP) certified professional. There are currently three certified mitigation professionals in the Kingston area: Haven Home Climate Care, Pinchin Ltd. and Mr. Radon/Safe Air Solutions.

Radon mitigation requirements for multi-residential, commercial, institutional and industrial buildings are not explicitly outlined in the Code, and are the responsibility of design professionals, such as architects and professional engineers. Due to the variability in the design and construction of these types of buildings, radon gas testing is the responsibility of the building owner and is not covered in this strategy.

Effective September 1, 2019, all new construction and additions of low-rise residential buildings in the City of Kingston require radon gas mitigation measures to be implemented, in compliance with the Ontario Building Code.

Existing Buildings
The radon mitigation strategy does not contain provisions for existing buildings. The Ontario Building Code regulates new construction and does not contain retrofit requirements for radon gas. Therefore, the strategy is only able to address radon gas mitigation in new construction.

New homes in Ontario are backed by a Tarion new home warranty program that is provided by the registered builder and covers radon gas levels exceeding 200 becquerels per cubic metre for seven years from the date of occupancy. Brochures with information on Tarion coverage are provided by the builder to new home owners at the time of occupancy.

Owners or occupants of existing buildings should contact KFL&A Public Health, Tarion or Health Canada to learn more about the health effects of radon gas, or to learn more about their options for radon gas testing and mitigation.

Corporate Communications, with the assistance of Building Services, have developed a communications plan to inform stakeholders through various communication methods which include media relations and a dedicated webpage for radon at https://www.cityofkingston.ca/resident/building-renovating/radon-gas-mitigation.

Existing Policy/By-Law:

Ontario Building Code

Notice Provisions:

Not applicable

Accessibility Considerations:

Not applicable

Financial Considerations:

Not applicable

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Exhibits Attached:

Exhibit A	KFL&A Public Health Radon Study Phase 1
Exhibit B	Soil Gas Mitigation Strategy

KFL&A Public Health's Radon Testing Study

Summary Report
Phase 1 (Winter 2018/2019)

Allison Maier, MPH, Research Associate
Knowledge Management
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Chronic Disease Prevention
With support from the Radon Working Group

July 2019

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Acknowledgements

KFL&A Public Health would like to thank the other public health units in Ontario who provided them with their material from similar studies as a basis for this study, especially Windsor Essex County Health Unit and Thunder

Bay District Health Unit. This material provided the basis for the promotional material, distribution and communication regarding the radon tests.

1.0 Introduction

Radon is the second leading cause of lung cancer.[1] It is linked to approximately 16% of all lung cancer deaths in Canada.[2] Radon is a colourless, odourless gas produced by the decay of natural uranium in rocks and soils throughout the earth's crust.[1] Outdoors, radon is quickly diluted by atmospheric mixing and is of no concern. However, in confined spaces, such as residential homes, radon can accumulate to harmful levels.[3] Cancer risk from radon is directly related to radon concentration and length of exposure.[4] A person with long-term exposure to high levels of radon has a 1 in 20 lung cancer risk, while a smoker who is also exposed to long-term high levels of radon has a 1 in 3 risk.[5] There is no known safe level of radon exposure and all homes are exposed to some level of radon.[5] Health Canada's radon guidelines indicating when mitigation is required is 200 Bq/m^3, whereas the World Health Organization's (WHO) recommended guideline is 100 Bq/m^3.[3]

The only way to determine if a home has high radon levels is to test. Testing is safe and simple. Long-term tests recommended by Health Canada[6] involve placing a radon detector in the lowest lived level of a building for a minimum of 91 days. These detectors use a small piece of special plastic enclosed in a chamber. When the radon in the air enters the chamber, the alpha particles produced by decay leave marks on the plastic. At the end of the test the detector is sent to the laboratory for analysis, and the average radon concentration is calculated, based on the imprints in the plastic .[7]

From 2009 to 2011, Health Canada surveyed households across the country to assess radon levels in residential dwellings. In the KFL&A region, 99 homes were tested and of those, 11.1% had radon levels above Health Canada's guideline of 200 Bq/m^3.[6] In the winter of 2018/2019, KFL&A Public Health began conducting a study to develop a deeper understanding of radon in the region. Specifically, there are three objectives to the study: (1) to assess the frequency of high residential radon levels in the KFL&A region; (2) to understand the variation in perceptions and beliefs in regards to radon testing in the region's residents; and (3) to understand the extent to which homes determined to have high radon levels get mitigated. The study results for the first two objectives are presented within this report; data collection for the third objective is ongoing. This report serves as a high-level summary of the methodology and results to-date from this study. The full detailed report is also available.

2.0 Methods

The KFL&A Public Health Radon Testing Study is a multi-phase, multi-pronged mixed-methods study. It uses a combination of quantitative chemical testing for radon and qualitative survey tools based on theoretical models. Specifically, there are three components to this study (the first two of occurred concurrently):

1) A survey to understand perceptions and beliefs around home radon testing and mitigation within the general population of KFL&A who identify as being aware of the health risk posed by radon, but have not tested (and are not currently testing) their homes for radon.
2) Testing of volunteer households in KFL&A for radon and a survey by these participants to understand their perceptions and beliefs around home radon testing and mitigation.
3) Of those volunteer households whose radon tests determine their homes have levels above health guidelines (WHO and Health Canada), a follow-up survey investigating their perceptions and beliefs around mitigation post-test result and follow-up for up to two years to determine if they took action to lower radon levels in their home. This phase of the study is ongoing and is therefore not included in this report.

Participants in the first component are referred to as general population participants, while volunteer testing households will be referred to as radon testing study participants. To be eligible, both groups of participants had to be:

- 18 or older; read and follow instructions in English;
- be a homeowner of their primary residence in the KFL&A region;
- not be planning to renovate or sell in the next six months;
- have a ground floor or basement in their home;
- not have tenants, customers, clients, colleagues or employees spend four or more hours per day in their home; and
- not have already tested or currently be testing their home for radon.

Additionally, general population participants had to be aware of radon as a health risk.

The study is being conducted by KFL&A Public Health with support of one-time funding from the Ontario Ministry of Health and was approved by the Queen's University Health Sciences and Affiliated Hospitals Research Ethics Board (HSREB).

2.1 Survey Methodology

The purpose of the survey component of the study is to support development of future messaging campaigns based on perceptions/attitudes most likely to be the underlying reasons for not testing. Two theoretical behavioural models were used in combination as the basis of the survey design and analysis, the Precaution Adoption Process Model (PAPM) and the Health Beliefs Model (HBM). The PAPM is intended for newly identified health hazards and is a stage-based model beginning with a stage where individuals are unaware of the health hazard (in this case radon), and moving through awareness and attitudes towards acting on the hazard (in this case both testing for radon and mitigation).[8] The stages of the PAPM model relevant to this study are shown in the Results section in Figure 1. The HBM is a model for health concerns based on six constructs[8] and here is used to assesses perceptions and attitudes around testing and mitigation:

- perceived susceptibility to having high levels of radon in ones' home and illness from radon,
- perceived severity of illness due to radon,
- perceived benefits of mitigating homes with high levels of radon,
- perceived barriers to testing for radon and to mitigating homes with high levels of radon, and
- self-efficacy in testing and mitigating ones' home for radon.[i]

Both of these models have been applied (explicitly or implicitly) to radon testing and mitigation in the literature,[9-14] including examples of when the models have been used in conjunction.[10-11] Specifically, it is hypothesized in the literature that the different components of the HBM will have different levels of importance for individuals in different stages of the PAPM.[10-11] This study was designed to compare HBM perceptions across general population and study participants who represent most of the stages of PAPM to inform future messaging campaigns.

Survey questions were designed to capture each of the HBM constructs on a 7-point Likert scale. Many questions were adapted from surveys found in the literature.[8,10,11,13,16-18] When participants had low or high level of agreement to specific statements, they were asked to explain their responses in an open-ended format. Based on radon risk factors, a few key demographic questions (i.e., age of youngest person residing in home)

[i] The sixth construct of the HBM (cues to action) is not used in this study.

and behavioural questions (i.e., smoking status) were asked. General population participants were asked to characterize their current thoughts on testing their homes for radon, which allowed them to be categorized into PAPM stages. Study participants were categorized as having tested or not depending on if they completed the study (i.e., returned a test kit). Finally, all participants were asked to explain their current decision on radon testing in an open-ended question.

Recruitment for the Radon Testing Study was conducted in October and November 2018 through a variety of outlets (i.e., social media, newspapers, mailed post cards to homes in the region). Recruitment material directed potential participants to an online survey with the eligibility criteria and consent information. Recruitment for the general population survey was conducted through social media in February 2019 and potential individuals were referred directly to the survey and its eligibility criteria.

Quantitative survey data was analyzed descriptively and statistically where appropriate; details of the statistical methodology are reported alongside the results in Section 3.2.2. The open-ended data was categorized into major themes and sub-themes which are summarized in Section 3.3, with insightful quotations selected to demonstrate the rich information collected.

2.2 Radon Testing Methodology

The purpose of the radon testing component is to determine if radon is a local priority and to inform local public health, municipal and individual action. After study participants completed the survey and provided their contact information, quota sampling was used to allocate radon tests to ensure geographic representation from all regions of KFL&A. Participants from regions whose quota was already filled were waitlisted. Selected participants were contacted by email to pick up the tests at any KFL&A Public Health office during regular or limited extended hours offered for three weeks in November 2018. Given the high interest in the study, additional test kits were purchased and, by the end of the recruitment period, all interested participants were selected for participation.

In total, there were 1,400 AccuStar Alpha Track AT-100 long term radon tests available for the study, with some tests reserved for quality assurance testing. Study participants were instructed to place the radon test for a minimum of 91 days in the room on lowest level lived in for four or more hours per day. At the end of this period, participants returned the test to any KFL&A Public Health office. All tests were sent to the laboratory for analysis by the agency.

KFL&A Public Health emailed all participants their radon levels when results were available. Participants whose homes had tested higher than the WHO or Health Canada guidelines were advised to remediate and given contact information for certified radon mitigation specialists. Specifically, participants whose homes tested between 100-200 Bq/m^3 were advised to consider remediating. Participants whose homes tested between 200-600 Bq/m^3 were advised to remediate within two years while those with levels above 600 Bq/m^3 were advised to remediate within one year.[19]

Radon test results were analyzed at the regional and township level (where possible). The percentage of households above the WHO and Health Canada guidelines of 100 Bq/m^3 and 200 Bq/m^3, respectively, are reported. Additionally, radon test results were assessed in relationship to survey data.

3.0 Results

3.1 Participant Demographics

There were 1,568 radon testing study participants of whom 1,118 picked up a test from a KFL&A Public Health office.[ii] Of those, 1,049 participants returned a test for a total response rate of 93.7%.[iii] Additionally, there were 146 participants in the comparative general population study.

There were over two thousand more participants who were interested in the Radon Testing Study but were ineligible; the most common reasons for being ineligible were: having customers, clients, or employees spend four or more hours per day in their home (23.8%), planning to renovate or sell their home within the next six months (21.9%), and having tenants (13.7%). There were over three hundred ineligible participants for the general population survey. 44.1% were ineligible because they had never heard about home radon testing, while 17.0% were ineligible because they had already tested their home for radon.

Demographic questions specific to risk factors related to radon were asked of participants. The majority of participants for both surveys (63.8% for study and 54.1% for general population) had no children living in the home. More general population participants had a current smoker in the household (13.7% compared to 8.0%), and about one-third of both groups of participants had a former smoker in the household (30.0% for general population and 29.5% for study).

The general population participants were designated into PAPM stages (2 through 5) based on their responses to a question specific to this purpose. Study participants who agreed to participate but did not reach completion of the study (i.e., did not return a test) were designated as having "Decided to test" (Stage 5), while those who did return a test were designated as "Tested" (Stage 6). The final participation numbers by PAPM stage are shown in Figure 1. As there was only one participant who identified as having "Decided not to test" (Stage 4), for analysis purposes Stages 3 and 4 were combined.

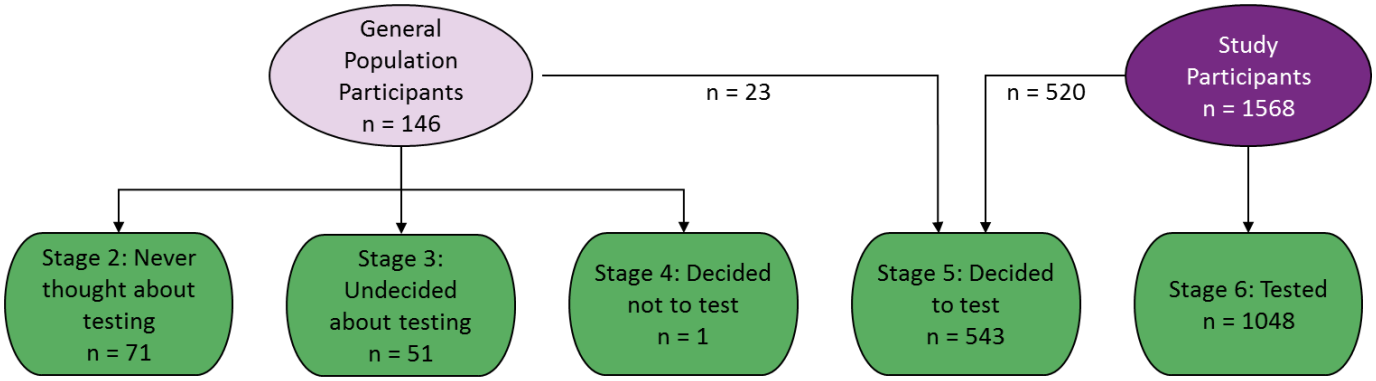

Figure 1. Summary of participants by PAPM stage.

Study participants were asked if they intended to test their home for radon within the next year before the KFL&A Public Health study offered free radon tests. Only 16.6% of participants stated that they were planning to, with 50.6% not planning on testing. Additionally, study participants were asked if they intended to mitigate if their homes had high levels of radon; almost all (92.3%) participants agreed with this statement, with 57.9% strongly agreeing. In the ongoing portion of the study, participants whose homes test above either the WHO or

[ii] Three study participants returned a radon test without having completed the radon survey.
[iii] Radon results were not available for three tests: two were returned after the collection period and one had a lab error.

Health Canada guidelines will be asked the question again (as well as other mitigation-specific attitude questions). This will help determine if intentions to mitigate change once an individual knows what is recommended for their home (i.e., to remediate if their home tested above 200 Bq/m^3 or to consider remediating if their home tested between 100 – 200 Bq/m^3).

3.2 HBM and PAPM Data

3.2.1 Overall HBM Data

Both the Radon Testing Study survey and the general population survey were asked questions related to the constructs of the HBM model; the responses to these questions can be seen in Figures 2 (page 8) and 3 (page 9). For Figure 2, the first three questions (top to bottom) relate to the construct of perceived susceptibility, the next to perceived benefits, and the last to perceived severity. In general, respondents were neutral to perceived susceptibility to radon in their area or home (i.e., had no opinion on whether radon was a problem in their area/neighbourhood or home). The majority believed they or their household were susceptible to illness from radon, perceived that illness from radon would be severe, and believed that there were benefits to mitigation. Conversely, as a supplementary question, general population participants were asked which illness(es) were associated with radon; 65.8% of respondents were not sure, while only 36.3% correctly identified lung cancer (the question included incorrect options like headaches and asthma, and respondents were allowed to select multiple options) (data not shown).

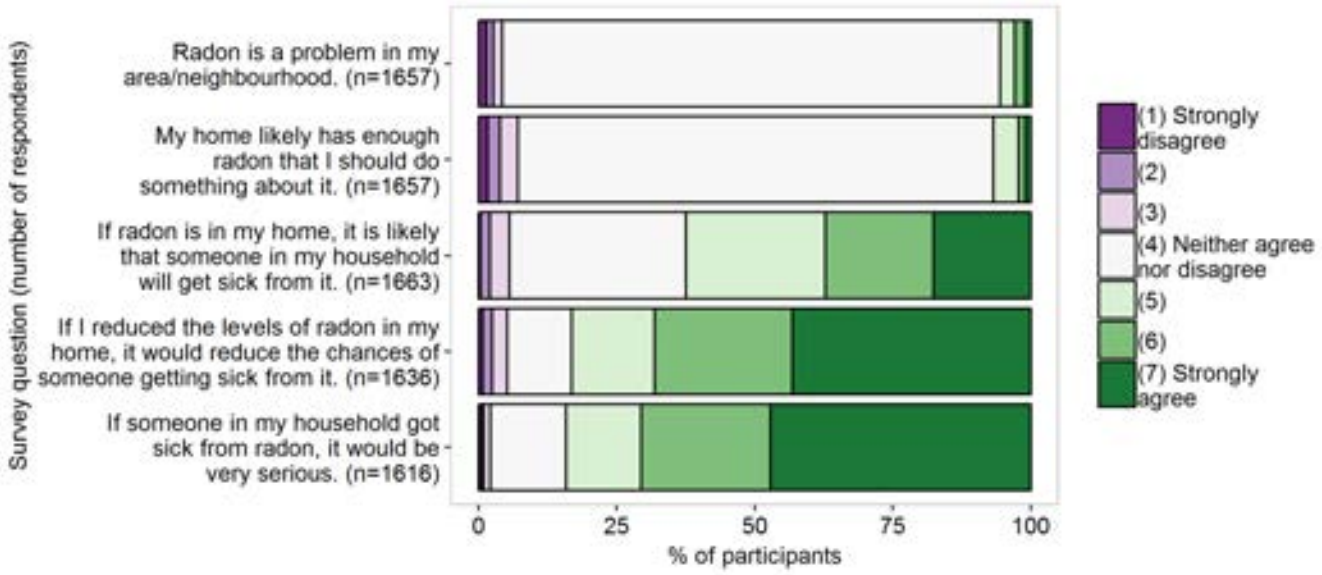

Figure 2. Radon testing study and general population survey responses to Health Belief Model constructs (excluding barriers and self-efficacy).

A total of 13 specific barrier/self-efficacy questions related to testing and mitigation were asked of participants (five of which were only appropriate to ask of general population participants). The most prevalent barriers were related to knowledge (not knowing how to test, not knowing where to buy a test, and not knowing how to find an experienced radon contractor), followed by financial impact (believing that it would make selling one's home harder in the future, it would be too expensive to remediate, and one's home would be worth less even after remediation). There was also a lack of knowledge on the costs for remediation; when asked what they believed the costs would be to remediate 30.1% of general population participants believed the costs were

higher than the Health Canada estimates of $1,500 to $3,000[1] while 58.2% were unsure of the costs (data not shown). About 40% of general population participants also felt that radon was not a priority.

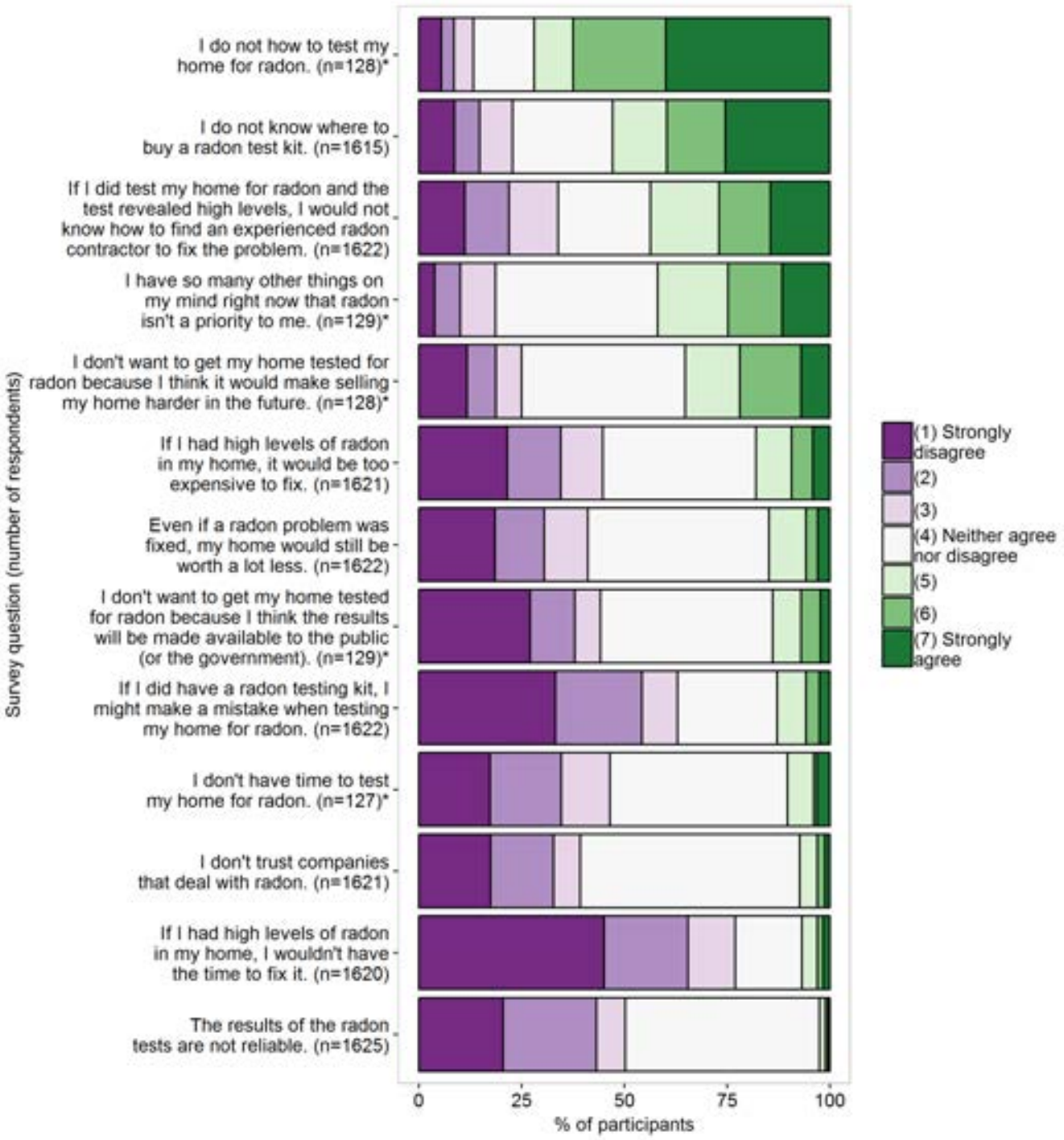

Figure 3. Radon testing study and general population and survey responses to barriers to and self-efficacy on testing and mitigation.

* indicates only asked of general population participants.

3.2.2 HBM Data by PAPM Stages

The variation in responses to each of the HBM survey questions was investigated by PAPM stage, both descriptively and statistically. The objective of the statistical modelling was to identify which, if any, constructs and/or specific barriers were associated with a change from one stage to another. To do this, a stepwise logistic regression model was built comparing one stage to all the stages above it, for a total of three models. In addition to the HBM questions asked of all participants, the three demographic variables (time spent on the lowest floor, age of youngest household member, and smoking status) were included in the model as potential factors. The 7-point Likert scale responses were grouped into three response categories: disagree, neutral and agree. Notable results are presented as odds ratios between the lower and higher stages with 95% confidence intervals included in brackets.

When investigating differences between respondents who had never thought about testing their home for radon (Stage 2) and all participants who thought about it (Stages 3 and above), cost to remediate was the most important factor. Respondents who identified this as a barrier were 14.1 (3.6 – 94.3) times more likely to have never thought about it. Additionally, time to remediate was another barrier that separated this group from the others, with participants who agreed with the statement being 2.8 (1.1 – 7.3) times more likely to be in Stage 2. Perceived susceptibility to radon in one's home may have also had an impact on thinking about testing.

The most important factor in the differences between participants who were undecided about testing (or had decided not to – Stages 3 and 4) and those who had decided to test (Stages 5 and 6) was again cost to remediate. In this case, participants who identified this as a barrier were 7.8 (2.5 – 29.5) times more likely to be undecided about testing compared to having decided to test. Statistically significant differences were also found between these groups for time to remediate and perceived susceptibility to high radon in one's home.

Finally, responses between those who had decided to test but have not yet tested (Stage 5) were compared to those had tested. As with all the other comparisons, the association with cost to remediate was statistically significant, though in this case the impact might be lower. Those who identified this as a barrier were 2.1 (1.5 – 3.0) times more likely to have not yet tested. As well, perceived benefits were significant in this model, with participants who believed reducing the radon levels in their home would reduce their risk of illness were 2.0 (1.1 – 3.4) times more likely to have tested. This was the only model where some of the demographic factors were statistically significant. Former and never smokers were more likely to have tested, while households with younger members were less likely to have tested.

The statistical analysis investigated variations in constructs dichotomously but had limited ability to detect broader trends. For both perceived severity of illness and perceived benefits of mitigating, there were consistent trends of increased agreement across the four stages, with an increase between 8% to 14% between each stage.

3.3 Qualitative Data

All study participants were asked why they decided to test their home for radon (1,429 responses) and if they had ever decided not to test, why and what changed their minds (150 responses with information) in open-ended questions. For the latter question, some participants explained what changed their mind, while other participants explained that they had previously decided to test but hadn't gotten around to it and included what had prompted their action now. General population participants were asked an open-ended question specific to their PAPM stage - why they were unsure about testing (26 responses), had decided not to test (1 response) or hadn't yet tested (16 responses). In addition to the overall open-ended questions, participants who strongly disagreed (1 or 2) or strongly agreed (6 or 7) with some of the HBM construct questions were asked to explain

why.[iv] All of the major themes from the responses to these questions aligned with the themes from the general open-ended questions captured below. The following section provides a high-level summary of the qualitative sub-themes of responses. A few quotations that provide rich information on perceptions are included. In general, the major themes relating to reasons for testing/not testing correspond to different interpretations of the questions asked.

Health risks and other generic motivations (e.g., general interest) were the most common response. Often, the response was a general statement (e.g., avoiding health hazards), while some included specific information about the health risk posed by radon, or personal or familial medical histories that they believed put them at greater risk of illness from radon. Within the broader health theme, some participants made specific reference to health protection of children in their homes. Four sub-themes of general motivations were identified:

1. Worry and concern – participants who were driven to test from fear.
2. Keeping healthy – participants who chose to test as part of a broader healthy lifestyle.
3. Sensible – participants who tested because they thought it was a good idea.
4. Curiosity – participants who chose to test because they found it interesting.

Additionally, there were a number of participant comments related to testing and mitigating; for example, discussing that radon is colourless and odourless and therefore testing is required or specifically noting that they planned to remediate their homes if they tested high.

Another common theme of responses was the role of individuals and organizations (including the media and KFL&A Public Health) in convincing participants to test or not to test. Increasing knowledge about radon was a common reason for testing. Participants pointed to having heard about radon in the media recently (both local, likely due to the study, and more broadly) and having seen the study's campaign material.

> *Information received from the kfl&a Public health unit made me question the issue. Also I had variously heard about radon through newspaper and media, but had not thought it might be a problem in our area, as no one talks about it. I also then read another article subsequent to the card from the health unit explaining more about radon. This gave me the impetus to try to join the study!*

KFL&A Public Health's Radon Testing Study had a major impact on participants deciding to test their homes for a variety of reasons. Some participants felt that if public health was promoting testing, then it was important to test. The agency providing the test was also a motivating factor both in terms of cost and access, with some participants noting that the free test changed their mind. Other participants had previously decided to test but did not know how or had not been able to find a test. Overall, the convenience of the study, especially the

[iv] Some of these questions had participants write in that they must have answered the previous Likert question in reverse (e.g., disagreed with "it is likely someone will get sick from it" instead of agreed with it). Specifically, 8 answers from individuals for the question "If radon is in your home, why do you think it is not likely someone will get sick from it?", 55 for the question "Why do you think it would not be serious if someone in your household got sick from radon?", and 32 for the question "Why do you think reducing the levels of radon in your home would not reduce the chances of getting sick?". These responses were removed from the quantitative analysis.

support provided by KFL&A Public Health that participants knew was included in the study, was influential in the decision to test. Overall, the convenience of public health doing the study was valuable to participants, especially the support throughout the process. Several participants noted that they had been thinking about testing and that the KFL&A Public Health study prompted their action. Finally, trust in the public health agency was also important to participants. They felt they could have greater faith in the results with Public Health coordinating the study than if they had gone to radon contractors.

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have been hearing a lot about Radon but I haven't been able to find the tester. When I got this in the mail It was a great opportunity to get it finally tested.

The time & cost of seeking a test and/or remediation on my own recognizance was enough that I was unlikely to do much about it over the short term (a I'll get around to it one day kind of thing). Therefore, the study (expectation of shared results) and possible free test kit is enough of an incentive to prompt me to take action.

Testing / remediation businesses seemed like the latest money making gimmick. Participation by KFL&A validates the concern of having a potentially toxic gas in my home.

Other participants had received recommendations to test for radon from their family and friends, building professionals, and occasionally their health care providers. Some participants noted they had family, friends, or neighbours who had tested for radon and sometimes needed to remediate due to high levels. However, other participants noted that they had previously been told by friends or professionals (including building professionals like real estate agents and contractors/builders) that radon wasn't a problem locally.

The final major theme of responses was information provided by participants about their home or region that they felt was either protective or increased their risk from radon and therefore was related to their decision to test. Wide-ranging beliefs were evident, and most characteristics provided were thought to be protective by some participants and of increased risk by others. Common characteristics mentioned included:

- age and ventilation of the home;
- foundation of the home, specifically the type of underlying bedrock, construction methods and foundation material and condition;
- use of their home, especially their basement; and
- perceived radon levels in their region.

4.5 Radon Test Results

The results of the radon testing are shown in Table 1, with 95% confidence intervals provided for the overall percentages. Overall, 21.3% (18.9 – 24.0) of participating households tested above the Health Canada guidelines of 200 Bq/m^3 and 52.4% (49.3 – 55.4) tested above the WHO guidelines of 100 Bq/m^3.

Fifty-five participants tested duplicate tests for quality assurance. All but one of these was within the allowable variance, with the remaining sample falling within the warning range. Additionally, there were seven blanks tested as part of quality assurance; all of these blanks tested below the limit of detection of 15 Bq/m^3.

Table 1. Radon Test Results

Radon Level Range	# of Participants (n=1046)	% of Participants
Less than 100 Bq/m^3	498	47.6%
Between 100 and less than 200 Bq/m^3	325	31.1%
Between 200 Bq/m^3 and less than 600 Bq/m^3	202	19.3%
600 Bq/m^3 or more	21	2.0%
Above WHO guidelines	**548**	**52.4% (49.3 – 55.4)**
Above Health Canada guidelines	**223**	**21.3% (18.9 - 24.0)**

The radon results were grouped into regions based on township and having a sufficient sample size to report the results within a 10% error. Table 2 shows the detailed breakdown of radon levels by region, specifically by township/township groupings and by county (95% confidence intervals provided for overall proportions in brackets). Figure 4 shows the proportions above the WHO guidelines and above the Health Canada guidelines on a map. In general, the City of Kington, and Loyalist Township and Greater Napanee have fewer households above the Health Canada guidelines than South Frontenac and Frontenac Islands, and Central Frontenac, North Frontenac, Stone Mills and Addington Highlands. The latter regions are statistically significantly higher than Kingston. South Frontenac and Frontenac Islands have a higher proportion of households that tested above the WHO guidelines than the other regions, with a statistically significant difference compared to Kingston. It is important to note that all regions within KFL&A had high proportions of households above both the Health Canada and WHO guidelines.

Table 2. Summary of radon levels by region.

Region (number of samples)	Less than 100 Bq/m^3	Between 100 and less than 200 Bq/m^3	Between 200 Bq/m^3 and less than 600 Bq/m^3	600 Bq/m^3 or more	Above WHO guidelines	Above Health Canada guidelines
City of Kingston (n=615)	52.4%	31.9%	15.0%	0.7%	**47.6% (43.6 – 51.6)**	**15.7% (12.9 – 18.8)**
South Frontenac and Frontenac Islands (n=152)	31.1%	33.1%	31.8%	4.0%	**68.9% (60.8 – 76.0)**	**35.8% (28.2 – 44.0)**
Loyalist Township and the City of Greater Napanee (n=174)	45.7%	32.9%	19.7%	1.7%	**54.3% (46.6 – 61.9)**	**21.4% (15.7 – 28.4)**
Central and North Frontenac, and Stone Mills and Addington Highlands (n=105)	45.7%	20.0%	26.7%	7.6%	**54.3% (44.3 - 63.9)**	**34.3% (25.4 – 44.2)**
County of Frontenac (n=819)	**47.7%**	**31.5%**	**19.1%**	**1.7%**	**52.3% (48.8 – 55.7)**	**20.8% (18.1 – 23.8)**
Lennox and Addington County (n=227)	**46.9%**	**29.6%**	**20.4%**	**3.1%**	**53.1% (46.3 – 59.7)**	**23.5% (18.2 – 29.6)**

Radon test data sheets with information regarding where the test was placed were returned by 980 participants; of these, 59.6% (n=584) tested in their basement. Participants were informed to test in a room on the lowest floor where someone in their home typically spends four or more hours per day. Based on information collected from the survey and then the data sheet, only 70.9% of participants tested on the lowest floor they reported

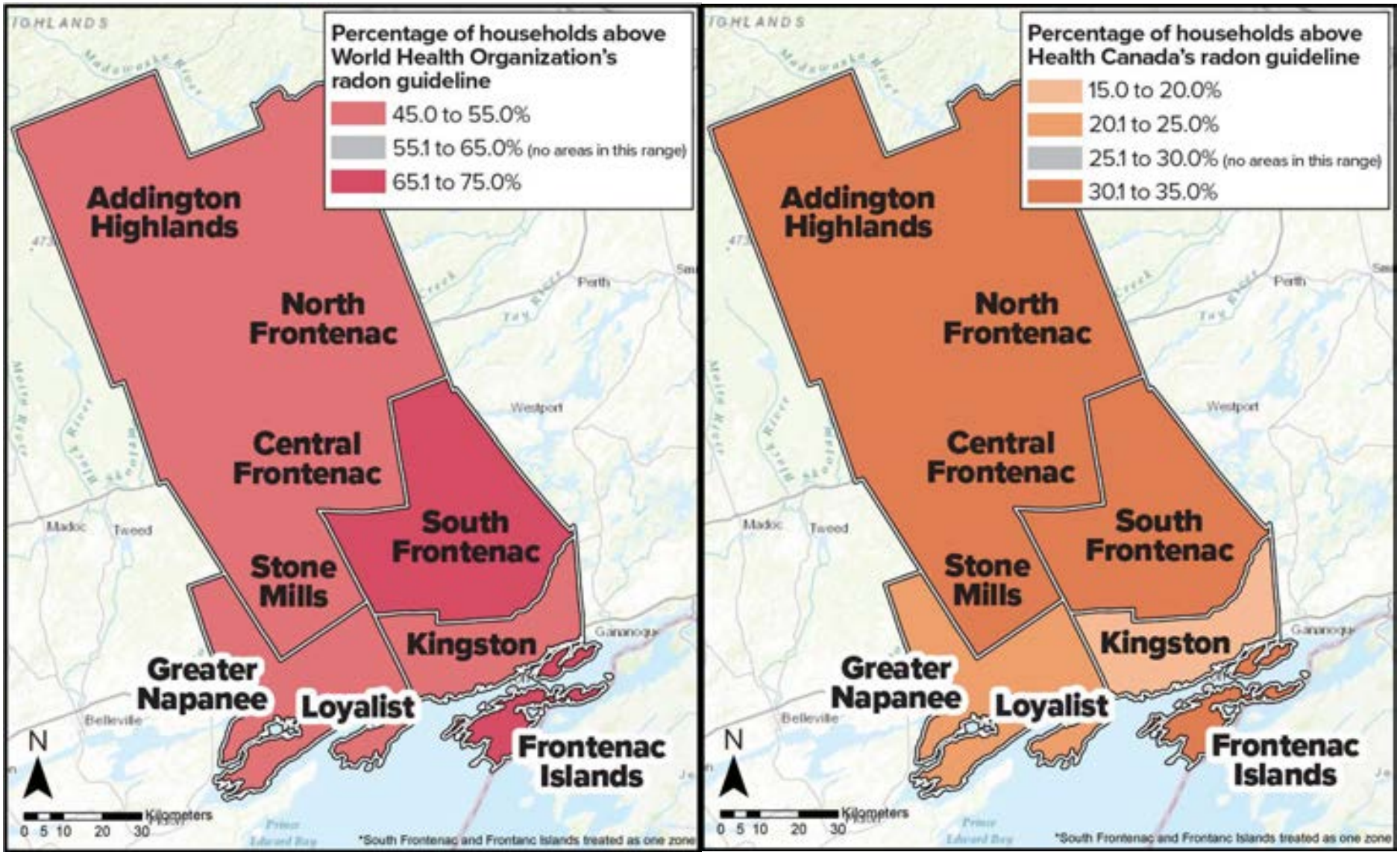


Figure 4. Maps of percentage of households above WHO and Health Canada guidelines

spending this amount of time on. As expected, radon levels were higher on the lowest floor of a home; 59.9% of homes tested on the lowest floor were above the WHO guidelines compared to 41.1% of homes tested on other floors.

4.0 Discussion

Overall, this study had higher participation and response rates than expected. Notably, nearly 94% of tests were returned for testing compared to the 85% predicted based on similar studies by other local public health agencies. The increase in the number of survey and testing results increases the usability of the findings. However, there were still insufficient numbers of radon tests conducted in the central and northern regions of KFL&A to provide radon prevalence at the township level, and so townships had to be aggregated. Additionally, there were some barriers to participate in the study. Eligible participants had to be able to pick up and drop off a test at one of the KFL&A Public Health offices and not all radon study participants had equal time to pick up a test (many participants were contacted to pick up tests during the last week of recruitment, due to being placed on the waitlist). There was also significant interest from individuals who did not meet study eligibility criteria.

4.1 Perceptions and Beliefs

A lack of awareness and knowledge on radon was observed in KFL&A residents. Based on open-text responses from participants, it is also possible that this lack of awareness and knowledge also exists in housing industry professionals (e.g., real estate agents, builders). General population participants demonstrated a lack of knowledge both on the health impacts of radon and the costs for remediation (question not asked of study participants). In the open-ended survey data, when explaining their motivations for testing, both testing and general population respondents often highlighted factors that they believe to be protective or increase the risk; often these do not align with what is known in the evidence. Finally, many respondents from both the radon testing study and general population noted that they had never heard of radon before, and approximately 90% of respondents were unsure if their area or home was at risk for radon. Actions related to sharing the results of this study, especially KFL&A's high radon prevalence may help to address this lack of awareness.

The survey results, specifically the variations observed for some HBM constructs and barriers by PAPM stage, supports the use of the PAPM model for radon testing and mitigation, which is in line with what was found in the literature.[11,14] Notably, a clear distinction between Stage 5 (decided to test) and Stage 6 (tested) was evident from both the quantitative results (in the number of participants who did not complete testing) and the qualitative results (in the many respondents who noted had previously decided to test but had not yet). It is important to note that it is possible that the proportion of these individuals might be higher in the sample than the broader population. Another related finding was that participants with younger individuals living in the home were less likely to move from having decided to test to tested. This is of special concern given the additional vulnerability of the youngest age groups to exposure to radon.

The descriptive and statistical results of this study can be used to prioritize health messages and/or other public health interventions for the entire population and also tailored messages to move between different stages. The two most consistently important constructs are barriers – one related to self-efficacy and testing (not knowing where to buy a test) and one related to mitigating (the cost to remediate). In terms of buying a test, even participants who tested their home as part of the study did not know where to buy a test, which is important since testing is supposed to be repeated after any mitigation. In terms of cost of remediating, there were statistically significant associations between each of the three stages in the PAPM model. This suggests that addressing remediating costs could create a positive impact on individuals moving through all stages. Other

important constructs are self-efficacy barriers of making a mistake while testing, not knowing how to test, and not knowing how to find an experienced contractor, as well concerns about selling one's home after testing for radon (even if they mitigated). Additionally, for tailored messages, participants in Stages 2, 3 and were less likely to perceive themselves susceptible to radon in the home's and illness from radon.

Studies have been done in other regions related to the HBM constructs and barriers related to radon testing and mitigation. Often, the most important reason in these studies for not testing was perceived susceptibility (not perceiving their home and/or area had a radon problem).[10,15,17,20] Other key factors were not knowing how to have the test carried out and perceived severity of illness out as a barrier.[10,15,20] While this study did find perceived susceptibility to be an important factor, it was not the most important.

Throughout the quantitative and qualitative survey results, the impact of the public health study on radon testing behaviours could be observed. Before the public health study, only 16.6% of radon participants planned on testing their home for radon within the next year. The study increased the knowledge of many participants with many having never heard of radon before the study and the associated advertising and media. Many of the most important barriers identified by participants (not knowing where to buy a test, not knowing how to test, not knowing how to find an experienced contractor) were included as part of participation in the study. The qualitative themes echo this with participants describing the importance of trusting the agency and how the study prompted action and addressed previous barriers. While it is beneficial that there was a population health impact from the study, the sustainability of public health action on the topic of radon has to be considered. Notably, the question becomes the ongoing role of public health in facilitating testing (and mitigation) in terms of the following four themes: (1) awareness to increase knowledge of hazards of radon and prompt action; (2) trust; (3) convenience and access, especially in buying tests; and (4) cost (of testing and mitigation).

There are many limitations to the perceptions and beliefs component of this study (i.e., the surveys and not radon prevalence). Most fundamentally, the survey results should not be considered generalizable as this study used a convenience sample. There are many reasons to believe that the study and general population participants are not representative of all KFL&A residents. For example, the participants likely represent a more engaged population. Of note, only one participant was in Stage 4 (decided not to test), but it is likely this opinion is more prevalent in the community. This one individual would have had limited impact on the results and should not be used to reflect all individuals who have moved through the earlier stages of the PAPM model and made the decision not to test their home. As such, this study provides no information on how to move an individual from Stage 4 ("Decided not to test") to Stage 5 ("Decided to test"). Additionally, the surveys are cross-sectional and so are not able to definitively asses cause and effect on movement between stages It should also be noted that radon testing is a household-level behaviour with potentially multiple individuals involved in the decision, but only one household member completed the survey and so the responses may not reflect the whole household. This limits the interpretation, especially when comparing between households that tested and those that did not. However, the results of this survey do provide the best available evidence on the most important factors to have individuals move through most stages of the PAPM and can still be used to inform future campaign messaging.

4.2 Radon Prevalence

The only previously available radon prevalence data for the KFL&A region came from a 2009 to 2011 cross-Canada survey. As part of that study, Health Canada tested 99 homes in the KFL&A region and found that 11.1% had radon levels above their recommended 200 Bq/m^3.[6] This study, having tested 1,046 residential homes, found a rate nearly twice that of 21.3%. The variation between the two studies is likely due to the low sample

size of Health Canada's study; the high sample size of this study means that there is a 95% chance that the true prevalence of residential radon above 200 Bq/m^3 is between 18.9% and 24.0%. Overall, a high risk of exposure to radon in homes in KFL&A was found by this study, with over half of homes testing above the WHO's radon guideline. The rural regions of KFL&A were found to be at an even higher risk with one-third testing above Health Canada's guideline, and for South Frontenac and Frontenac Islands, two-thirds testing above WHO's guideline. The convenience sample of households tested in the KFL&A region was representative (by size of population) to the underlying KFL&A population and there are no other expected biases from a convenience sample that could impact the radon test results. As such, the estimates provided for the proportion of households who tested above WHO and Health Canada guidelines are generalizable.

5.0 Recommendations

Based on the results of this phase of the KFL&A Public Health Radon Testing Study, the following seven recommendations have been made for public health action in the future. These actions encompass the four themes identified above (awareness, trust, convenience, and cost). They also highlight opportunities for prioritizing interventions with regions identified to be at the highest risk for residential radon.

1. Based on the high prevalence of residential radon in the KFL&A region, local health promotion to increase radon testing and mitigation is a priority. Health messaging campaigns should be informed by the survey results. Specifically, five key messages have been developed (found below). Consideration should be given to augment advertising to residents of South Frontenac and Frontenac Islands, as well as the more northern regions of KFL&A.
2. KFL&A Public Health should become a hub for distribution of radon tests (i.e., for any resident not just study participants). The study showed that participants entered the study because they trust the agency and because it was easy and convenient to pick up a test from one of the agency offices. Hardware stores in the region may not stock the tests and the quality and price of tests sold in stores can be significantly different. The tests should be sold at cost. They should be available at all KFL&A Public Health offices, ideally with extended hours during the start of radon testing season (October and November). KFL&A Public Health should also continue to support access to Canadian – National Radon Proficiency Program listed testing devices.
3. In addition to providing tests, residents should be able to return their radon test to KFL&A Public Health at the end of the testing period where the agency will ship the tests in bulk to the laboratory on behalf of the residents. This would continue to increase the convenience of radon testing. Unlike the study, the agency would not collect the results of the tests, those would go directly to participants by email.
4. KFL&A Public Health should encourage all residents to contact the agency for support in interpreting radon results, and, as needed, provide the list of local certified mitigation specialists.
5. KFL&A Public Health should use the opportunity presented by the release of the study results to provide presentations on radon information and study results to any interested community/municipal groups.
6. KFL&A Public Health should work with building and real estate professional organizations to ensure accurate information is being communicated to the public.
7. KFL&A Public Health should use the high radon prevalence to continue advocacy efforts. These include advocacy for local and provincial building code changes, incentives for mitigation costs, and federal advocacy to have Health Canada decrease its radon guidelines to 100 Bq/m^3, especially given that half of KFL&A households tested were above this limit.

Based on the results of this study, a list of key messages related to radon has been proposed. These key messages will inform future health promotion campaign messages.

- KFL&A has high levels of radon. The only way to know your home's radon level is to test.
  - This key message addresses perceived susceptibility and is in line with the Health Canada recommendation that every home needs to test.
- Radon is the second leading cause of lung cancer, only behind smoking.
  - This key message addresses perceived susceptibility and, specifically, the lack of awareness that the health risk from radon is lung cancer.
- It is possible to lower your homes radon levels and the cost to do so is approximately $1500-$3000.
  - This key message addresses perceptions around the cost barriers to remediation.
- KFL&A Public Health can help you test your home for radon. You can buy a test from any KFL&A Public Health office at cost. We can also provide information on how to test, how to interpret and act on radon results.
  - This key message addresses some of the most important barriers, specifically regarding self-efficacy, as well as trust in the agency compared to other sources.

6.0 Conclusions

The results of the first phase of KFL&A Public Health's Radon Testing Study clearly demonstrate that residents in the region are at risk of exposure to radon. KFL&A Public Health must make continued radon work a priority, and the results from the surveys provide a basis for ongoing work. This report summarizes the results available to-date. Future phases of the study will provide insight into perceptions and opinions on mitigation in individuals whose homes have tested above acceptable limits, as well as potentially providing information on the frequency of mitigation.

For a copy of the full detailed report, please email radon@kflaph.ca.

References

1. Health Canada. Radon reduction guide for Canadians. [Internet]. 2014 [cited 2018 May]. Available from: https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/ewh-semt/alt_formats/pdf/pubs/radiation/radon_canadians-canadiens/radon_canadians-canadien-eng.pdf
2. Zeeb H, Shannoun F, World Health Organization. WHO Handbook on indoor radon: A public health perspective. World Health Organization. [Internet]. 2009 [cited 2018 May]. Available from: http://apps.who.int/iris/bitstream/handle/10665/44149/9789241547673_eng.pdf?sequence=1
3. Chen J. Canadian lung cancer relative risk from radon exposure for short periods in childhood compared to a lifetime. Int J Environ Res Public Health [Internet]. 2013 [cited 2018 May]; 10(5): 1916-1926. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3709356/
4. Cancer Care Ontario. Ontario cancer facts: Risk of residential radon exposure varies geographically. [Internet]. 2017 [cited 2018 May]. Available from: https://www.cancercareontario.ca/en/cancer-facts/risk-residential-radon-exposure-varies-geographically
5. Health Canada. (2014)/ Radon- Another Reason to Quit. Retrieved from: https://www.canada.ca/content/dam/hc-sc/documents/services/health/publications/radon/27-P_1107-Another-Reason-to-Quit-Jan2018-EN-FINAL.pdf
6. Health Canada. Cross-Canada survey of radon concentrations in homes; Final report. [Internet]. 2012 [cited 2018 May]. Available from: https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/ewh-semt/alt_formats/pdf/radiation/radon/survey-sondage-eng.pdf
7. Health Canada. (2014). Radon Reduction Guide for Canadians. Retrieved from: https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/ewh-semt/alt_formats/pdf/pubs/radiation/radon_canadians-canadiens/radon_canadians-canadien-eng.pdf
8. Weinstein ND, Sandman PM, Blalock SJ. The Precaution Adoption Process Model. [Internet]. 2008 [cited 2018 Aug 1]. Available from: http://www.psandman.com/articles/PAPM.pdf
9. National Cancer Institute. Theory at a Glance: A Guide for Health Promotion Practice. 2005.
10. Weinstein ND, Sandman PM, Roberts NE. Perceived Susceptibility and Self-Protective Behaviour: A Field Experiment to Encourage Home Radon Testing. Health Psychology. 1991;10(1):25-33.
11. Weinstein ND, Sandman PM. A Model of the Precaution Adoption Process: Evidence From Home Radon Testing. Health Psychology. 1992;11(3):170-180.
12. Sandman PM, Weinstein ND. Predictors of Home Radon testing and Implications for Testing Promotion Programs. Health Educ Q. 1993;20(4):471-487.
13. Peterson EW, Howland J. Predicting radon Testing Among University Employees. J Air & Waste Manage Assoc. 1996;46:2-11.
14. Weinstein ND, Lyon JE, Sandman PM, Cuite CL. Experimental Evidence for Stages of Health Behaviour Change: The Precaution Adoption Process Model Applied to Home Radon Testing. Health Psychology. 1998;17(5):445-453.
15. Rinker GH, Hahn EJ, Rayens MK. Residential Radon Testing Intentions, Perceived Radon Severity, and Tobacco Use. J Environ Health. 2014;76(6):42-47.
16. Weinstein ND, Klotz ML, Sandman PM. Optimistic Biases in Public Perceptions of the Risk from Radon. AJPH. 1988;78(7):796-800.
17. Kennedy CJ, Probart CK, Dorman SM. The Relationship between Radon Knowledge, Concern and Behaviour, and Health Values, Health Locus of Control and Preventive Health Behaviours. Health Educ Q. 1991;18(3):319-329.

18. Duckworth LT, Frank-Stromborg M, Oleckno WA, Duffy P, Burns K. Relationship of Perception of Radon as a Health Risk and Willingness to Engage in Radon Testing and Mitigation. ONF. 2002;29(7):1099-1107.
19. Take Action on Radon. Guidance document: Recommended strategic direction for supporting radon mitigation. [Internet]. 2016 [cited 2018 May]. Available from: https://www.takeactiononradon.ca/file/take-action/pdf/Guidance-Document---Recommended-Strategic-Direction-for-Supporting-Radon-Mitigation.pdf
20. Clifford S, Hevey D, Menezes G. An investigation into the knowledge and attitudes towards radon testing among residents in a high radon area. J Radiol Pot. 2012;32:N141-N147.

Soil Gas Mitigation Strategy

Due to recent findings from a study conducted by Kingston, Frontenac, Lennox and Addington (KFL&A) Public Health, the City of Kingston is implementing soil gas control measures in new construction and additions of low-rise residential buildings. This strategy applies to new building permits applied for after August 31, 2019.

Health Canada guidelines dictate that radon gas concentrations above 200 Becquerel's per cubic metre (Bq/m3) require remediation. As such, this strategy requires soil gas control requirements as per the Ontario Building Code (OBC) subsection 9.13.4., and SB-9 (Requirements for Soil Gas Control).

Construction Requirements

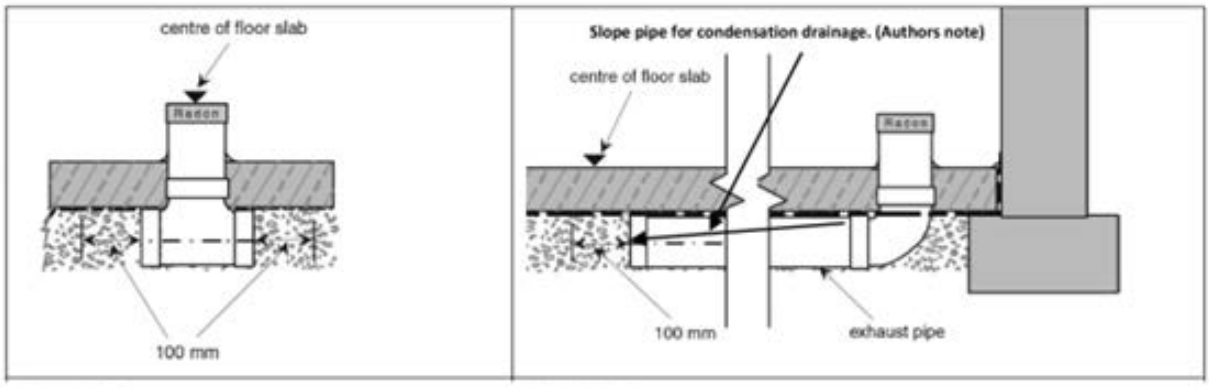
Building permit drawings shall clearly indicate details associated with one of the following three radon gas mitigation options to be constructed on site:

Option 1

1. A 100mm diameter PVC pipe rough-in through the floor slab adjacent an exterior wall extending under the slab and terminating at or near the center in conformance with Subsection 3.2, Sentences (1) through (5) of SB-9,
    a. Minimum 150mm granular material for a radius not less than 300mm centered on the pipe, with the bottom of the pipe open to the granular, and
    b. The upper end of the pipe shall be provided with a removable seal, and labeled to indicate for "soil gas removal only".
2. Mandatory radon gas testing in conformance with Subsection 3.2, Sentence (6) of SB-9.

Please note: where concentration levels exceed 200 Bq/m3, a subsoil depressurization system is to be installed in conformance with Subsection 3.2, sentence (9) of SB-9.

Option 1: Sub-Slab depressurization rough-in



Option 2

1. A soil gas barrier on the foundation walls (bituminous dampproofing) in conformance with Division B, 9.13.4.2 (3), and
2. under the basement floor slab using 6 mil polyethylene lapped not less than 300mm in conformance with Figures SB-9A or SB-9B of SB-9, and
3. sealing along the perimeter of the basement floor slab and at all penetrations using flexible sealant (polyurethane caulking) in conformance with Division B, 9.13.4.2.(4)(a) and SB-9.

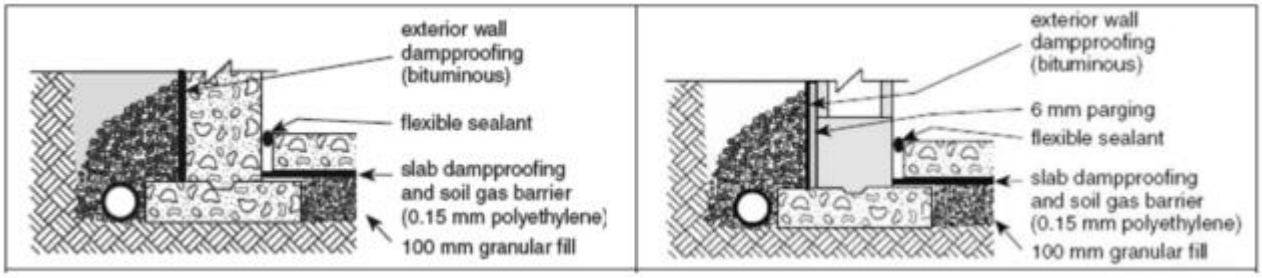
Please note: spray foam can be substituted as a radon gas barrier under basement floor slabs where installed in conformance with CCMC Evaluation Report 14073-R.

Option 3

1. A soil gas barrier on the foundation walls (bituminous dampproofing) in conformance with Division B, Sentence 9.13.4.2 (3) and Figure SB-9A or SB-9B of SB-9.
2. Installation of a sub slab depressurization system installed in accordance with Health Canada guideline "Reducing Radon Levels in Existing Homes: A Canadian Guide for Professional Contractors".
    a. A properly labelled 100mm PVC pipe shall be installed through the floor slab adjacent an exterior wall extending under the slab into a centrally located 150mm thick bed of granular material. In accordance with Subsection 3.2, sentences (1) through (5) of SB-9, and
    b. Above the slab, 100mm grey PVC piping shall be installed, extending either through the roof or the rim joist, and shall have a continuous duty centrifugal inline radon fan.

Please note: where an ICF foundation is being used, and radon option 2 or 3 is chosen, replace “bituminous dampproofing” with “waterproofing membrane” approved for installation over ICF foundations.

Option 2 and 3: Damproofing and Soil Gas Control at floor and wall junctions



SB-9A – Solid Wall **SB-9B – Hollow Wall**

Required Inspections

The owner of a property on which construction takes place or their authorized agent shall arrange for the following inspections:

1. The installation of the rough-in soil gas pipe, and granular material prior to pouring the basement slab,
2. The installation of soil gas barrier on foundation wall (bituminous dampproofing) and under floor slab (6 mil polyethylene) prior to covering or pouring the basement slab, and
3. Sealing of the perimeter of the slab adjacent to the foundation wall and any slab penetrations (polyurethane caulking) prior to covering.
4. Pipe cap and labelling, and inline fan (where required) prior to occupancy.

Testing

Depending on the radon gas mitigation option chosen by the builder, the building may be subject to mandatory radon gas testing.

It is the Owners responsibility to conduct the radon test to determine the radon concentration in the building, and submit the results to the City of Kingston at **buildingpermits@cityofkingston.ca**

All radon testing will consist of long-term tests (minimum 91 days) completed during the winter season, when windows and doors are generally closed, and are recommended to be carried out by a **Canadian National Radon Proficiency Program (C-NRPP)** certified professional.

Testing Results and mitigation

The following is required where mandatory radon gas testing results come back over 200 Becquerel's per cubic metre (Bq/m3):

1. The Owner is responsible for mitigation and installation of a subfloor depressurization system.
2. Measures shall be taken to ensure that any resultant decrease in soil temperature will not adversely affect the foundation, and documentation to this affect is to be provided by a qualified person.
3. After installation, the Owner is to submit testing results indicating levels below 200 Becquerel's to the City of Kingston at **buildingpermits@cityofkingston.ca**.

Health Canada recommends that you hire a professional certified under the Canadian National Radon Proficiency Program (C-NRPP) as lowering radon levels in a home requires specific technical knowledge and skills to ensure the job is done properly. To find a list of certified professionals contact the Canadian National Radon Proficiency Program (C-NRPP) at 1-855-722-6777, go to **www.c-nrpp.ca** or email **radon@hc-sc.gc.ca**.

Tarion Warranty

New homes in Ontario come with a new home warranty that is provided by your builder and backed by **Tarion**. This warranty also covers radon gas levels exceeding 200 Bq/m3 in new homes for seven years from the date of occupancy.