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# Radon in indoor air and well proximity: Could unintended radon gas migration be a vector?

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## Summary

Radon, a colorless, odorless, and tasteless radioactive gas, is the leading cause of lung cancer in people who have never used tobacco. Although it universally accepted that radon originates in the subsurface from the uranium decay chain, the neither the uranium source(s), nor its depth, nor the pathways by which radon reaches the subsurface are well understood. Nonetheless, radon is ubiquitous in the natural environment, with higher concentrations typically measured at greater depth. A recent analysis of more than 40,000 measurements of radon concentrations in indoor residential air found that residents in rural and lower density centres were exposed to ~30% higher radon. A correlation between radon and water well proximity in Alberta suggests wells could be a pathway for radon. Since well water radon concentrations were too low for groundwater use to be a vector, unintended radon gas migration outside the well casing was implicated. This work extended the analysis between radon concentrations (in Bq/m3) from Alberta 22,116 residences to included oil and gas wells. The similarities and differences between the distribution of radon in indoor air and proximity to different well times will be presented and discussed.

## Theory / Method

Radon gas inhalation is the major cause of cancer in non-smokers [1]. Owing to its odorless, colorless and tasteless nature, radon gas could pose a significant threat to individuals as it could be inhaled without being aware of its presence [1]. The recommended level of indoor radon gas in Canada by Health Canada is set at 200 becquerels per cubic metre ($Bq/m^3$) [3]. Radon originates from the decay chain of uranium in the subsurface [1] and its concentrations are normally higher at greater depths. Radon gas typically migrates from the subsurface having higher air pressures to enclosed spaces such as buildings having lower air pressures [1]. Its concentrations in buildings could be due to its local geological conditions, radon gas migration routes, and indoor and outdoor air exchange rates [2]. Early detection of radon concentrations in buildings through testing is a proven way to act swiftly to mitigate elevated radon levels.
Radon concentration levels (bq/ml) in 22,116 residences in Alberta were measured and each residence was classified based on its municipalities ranging from cities, large towns, small towns and villages. The measured radon concentrations were compared with water well data, and energy well information derived from Geoscout. Both water and energy well densities around radon concentration measured residences within 1.6km, and distances of wells from residences were compared with the measured radon concentrations.

## Results

Overall, a distinct trend was revealed as radon concentrations in residences consistently decrease with increasing municipality class, with villages having the highest geometric mean of radon gas concentration while cities having the least geometric mean (figure 1). This indicates

that there is a possible relationship between indoor air quality in terms of the presence of radon gas and the municipality type. We hypothesize that this could be attributed to the higher energy well densities in rural areas as compared to urban areas.
There also appeared to be an overall decreasing trend in the geometric radon concentrations per distance of residences to energy wells (figure 2). Higher mean radon concentrations were associated with houses proximal to energy wells while distant houses from energy wells had lower mean radon concentrations. We also hypothesize that energy wells could serve as direct or indirect migration pathways for radon gas to migrate to soils and subsurface formations.

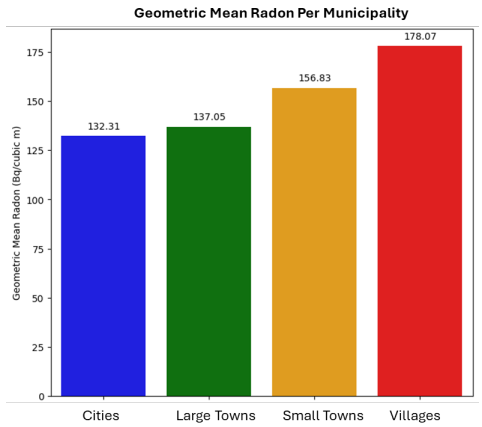


*Figure 1: A plot of geometric mean radon concentration per each municipality class.*

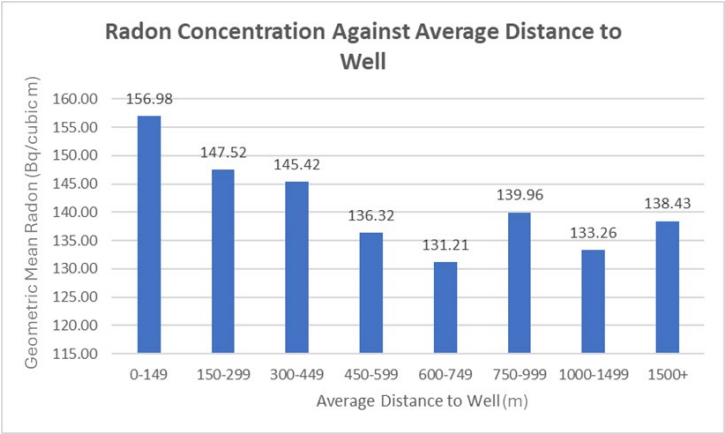


*Figure 2: A plot of geometric mean radon concentration against distance from nearest energy well.*

## Conclusions

Radon gas is the leading cause of cancer in non- tobacco smokers. Based on the analysis of the over 22,000 levels of radon concentrations in residences across Alberta, radon concentrations tend to be higher in rural areas as compared to urban areas. We hypothesize that higher energy well densities and proximity of energy wells to residential buildings could be a contributing factor to elevated radon concentrations in residences. Further works will be required to develop a radon migration pathway model from energy wells to residential buildings to confirm this hypothesis.

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### References

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