OBTAINING ADDITIONAL INDOOR RADON MEASUREMENTS IN UNDER SERVED AREAS OF NEW YORK STATE

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ABSTRACT

Approximately 45,000 spatially-located indoor radon concentrations from basement charcoal detectors have been mapped for every town and city in New York State to produce radon risk maps on the township level. For many rural towns there are few indoor radon measurements, thus radon risk estimates for these towns included correlations to surficial geology. A project to obtain additional measurements in towns considered to have above average levels of indoor radon, based on the surficial geology of the town, were completed. The projects' intent were to obtain 20 or more additional measurements in 44 targeted towns and to compare measurement results with predictions based on geology correlations. The procedures used to obtain the additional measurements and a comparison of measurement and predicted results will be discussed.

INTRODUCTION

Over the past 12 years the New York State Department of Health has accumulated basement short-term (2-4 day) measurement data using charcoal canisters. From these data and digitized surficial geologies, radon risk maps have been produced for each town and city in the State, one showing estimated geometric means and two providing the percent of homes with $\geq$ 4 pCi/L of indoor radon in basements and first-floor living areas. The methodology for estimating radon potential from a combination of measurements and surficial geology has been presented previously (Kunz et al 1996, ibid. 1997). While previous publications have discussed various aspects of the relationship of the surficial geology to indoor radon concentrations in the State (Laymon et al. 1990, Kunz et al. 1988), the two factors that are most important in controlling radon entry from soil into homes and buildings are the soil source strength for emanating radon and the permeability of the soils for gas flow.

Despite efforts to increase indoor radon measurements throughout the State, many towns have an insufficient number of measurements to confirm our estimates of radon levels. Obtaining additional measurements for these towns would provide a valuable comparison to the radon levels estimated based on surficial geology. While dozens of towns in the State have less than five measurements, scores more have less than the 30 measurements necessary to obtain a standard error of about 20% in the calculated geometric means. An objective of this study was to obtain additional measurements in 44 towns considered to be at high risk for indoor radon to corroborate our estimates.

PROCEDURES

Using our database of nearly 45,000 measurements, a list was compiled of towns with few measurements (usually $\leq$5) but estimated to have above average geometric mean basement concentrations (usually above 3 pCi/L) in the homes. As these towns have few measurements, current estimates of radon risk are based primarily on surficial geology correlations. The 44 selected towns reside in 25 counties distributed over a broad region of the State (Figure 1). Information on single-family homes in each town was extracted from the Real Property tax database. Homes located in the town but with a tax-database mailing address located outside the town were excluded, as these homes are often camps, part-time residences, or rental properties. As several post offices often served a single town and could not be used to confirm home locations, the Real Property addresses were necessary to verify the location of each home in the town. Though 100 participants were sought for each town, low populations of eligible homeowners resulted in the number of applications to be as low as 65. On the average, 96 homes per town were targeted. Mailing addresses were printed from the Real Property database directly to the envelopes. The study is comprised of three mail out campaigns: 16 towns in February 1998; 15 towns in October 1998, and 13 towns in January 1999.

Each targeted home received a package containing a cover letter explaining the study, a page describing radon and its' risks, and a dated detector application. Participants returning the applications were sent a 3" charcoal detector which, following exposure, was sent by the homeowner to the contracted laboratory (RTCA) for analysis. Due to the poor measurement completion rate during round 1, applicants in round 2 were sent a follow-up letter emphasizing the importance of completing the measurements. This resulted in a substantial increase in completed testing. In round 3 a statement stressing the importance of completing the measurements was included in the initial cover letter.

RESULTS

Of the 1448 detector applications sent to homes located in the initial 16 towns, 84 letters were returned due to delivery problems and 603 requests for detectors were received. Of these, only 236 detectors were returned by participants for measurement by the contracted laboratory, resulting in 44% and 17% return rates for the applications and detectors, respectively. Of these 154 detectors were placed in basements and are included in the comparison part of this study. The number of detectors (367) requested but not returned to the laboratory for analysis was substantial and costly. This resulted in a follow-up letter being sent to applicants in round 2.

In the second round, 1651 detector applications were sent to homes located in the 15 towns. As in round 1 about 6% of the letters were returned due to delivery problems. In this round 629 radon detectors were mailed to responding participants. Only 355 detectors were returned by participants for measurement by the contracted laboratory, resulting in 41% and 23%

return rates for the applications and detectors, respectively. Of these 232 detectors were placed in basements and are included in the comparison.

The third round of applications, sent to 1104 homes located in the 13 towns, had 66 letters returned due to delivery problems and 399 radon detectors were mailed to responding participants. Only 196 detectors were returned by participants for measurement by the contracted laboratory, resulting in 38% and 19% return rates for the applications and detectors, respectively. Of these, 165 detectors were placed in basements and are included in the comparison.

The basement measurements were log-normally distributed (Figure 2) with geometric and arithmetic means of 4.0 and 8.0 pCi/L, respectively, and a maximum of 180 pCi/L. First-floor living-area radon concentrations up to 73 pCi/L were determined at the 260 participating homes, with 19% of the homes exceeding 4 pCi/L on the first floor. As shown in Figure 3, though the data are limited to less than the desired $\geq$30 participants for each town, for many cases there was fairly good agreement between estimated and measured radon concentrations. Discrepancies can be expected for towns located in high-risk counties (e.g., Cattaraugus), where the estimated radon potentials are based on correlations to surficial geology units in neighboring towns of high mean concentrations. A similar discrepancy is observed (Table 1) for towns with high measured GMs located in lower-risk counties (e.g., Dutchess and Oneida). For counties with high variability in permeability or soil source strength, radon estimates based on geologies in one town may not be applicable to all towns in the county.

CONCLUSIONS

This study used analyses of surficial geologies to identify towns with few measurements which are estimated to have a large percentage of homes with $\geq$4 pCi/L of indoor radon. A mail out campaign targeting 16 towns in 11 counties was conducted in early 1998 to obtain additional measurements for comparison to estimated radon concentrations. An additional 15 towns in nine different counties are targeted for late 1998 and in early 1999 another 13 towns in seven counties were targeted. The targeting methodology utilized tax addresses from the Real Property database, thus assuring location of the homes in the targeted town. On average, the study gained 19 additional measurements in each targeted town. The response from the initial mail out campaign indicates that additional efforts must be made in the ensuing mail out to encourage residents to expose and return the requested detectors to assure a statistically-significant number of measurements are obtained.

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Table 1. Geometric mean indoor radon concentrations (pCi/L) estimated for 44 targeted towns compared to measured values from this study.

County Name	Town Name	Previous No. Measurements	Additional No. Measurements	Estimated GM	Measured GM
Allegany	Willing	7	10	10.7	12.6
Cattaraugus	Machias	3	29	7.1	4.7
Cayuga	Sempronius	3	28	3.9	3.4
Chautauqua	Cherry Creek	2	17	5.1	2.9
Chemung	Ashland	3	11	6.8	2.5
Chemung	Caitlin	9	12	5.4	5.5
Chenango	Coventry	6	22	3.1	2.3
Chenango	McDonough	1	12	3.3	2.7
Columbia	Clermont	12	18	4.5	3.8
Columbia	Gallatin	5	14	3.8	3.7
Columbia	Taghkanic	15	25	4.6	3.2
Cortland	Cuyler	2	5	3.1	2.6
Cortland	Harford	3	14	3.9	2.0
Delaware	Kortright	3	22	3.6	4.5
Delaware	Tompkins	2	35	4.5	5.1
Dutchess	Pine Plains	12	16	5.1	10.2
Genesee	Alexander	13	18	2.8	2.3
Genesee	Pavilion	10	22	3.4	3.3
Greene	Lexington	1	12	4.6	3.2
Herkimer	Webb	6	17	2.5	2.2
Livingston	Ossian	2	28	4.0	6.4
Livingston	Sparta	6	29	2.7	3.5

Table 1. Continued.

County Name	Town Name	Previous No. Measurements	Additional No. Measurements	Estimated GM	Measured GM
Madison	Lincoln	3	15	4.1	2.7
Oneida	Bridgewater	2	28	4.0	5.6
Oneida	Western	2	30	2.8	8.9
Otsego	Pittsfield	4	18	3.5	5.8
Otsego	Plainfield	2	12	3.0	3.2
Otsego	Roseboom	2	21	3.4	4.5
Rensselaer	Berlin	8	10	3.8	5.7
Rensselaer	Grafton	12	12	3.0	3.0
Rensselaer	Petersburg	11	9	3.7	3.4
Rensselaer	Stephentown	14	13	3.9	3.7
Saratoga	Hadley	3	25	2.2	2.5
Schoharie	Broome	2	18	2.8	2.4
Schoharie	Fulton	10	25	3.3	4.0
Schuyler	Cayuta	1	11	3.0	9.0
Steuben	Bradford	1	18	9.6	11.0
Steuben	Fremont	5	28	7.4	6.1
Steuben	Troupsburg	3	26	2.9	1.8
Tioga	Berkshire	8	17	4.9	6.0
Washington	Granville	6	9	3.4	3.7
Washington	Hampton	0	13	2.6	3.9
Wyoming	Middlebury	4	28	3.9	3.8
Wyoming	Pike	1	27	5.0	5.0

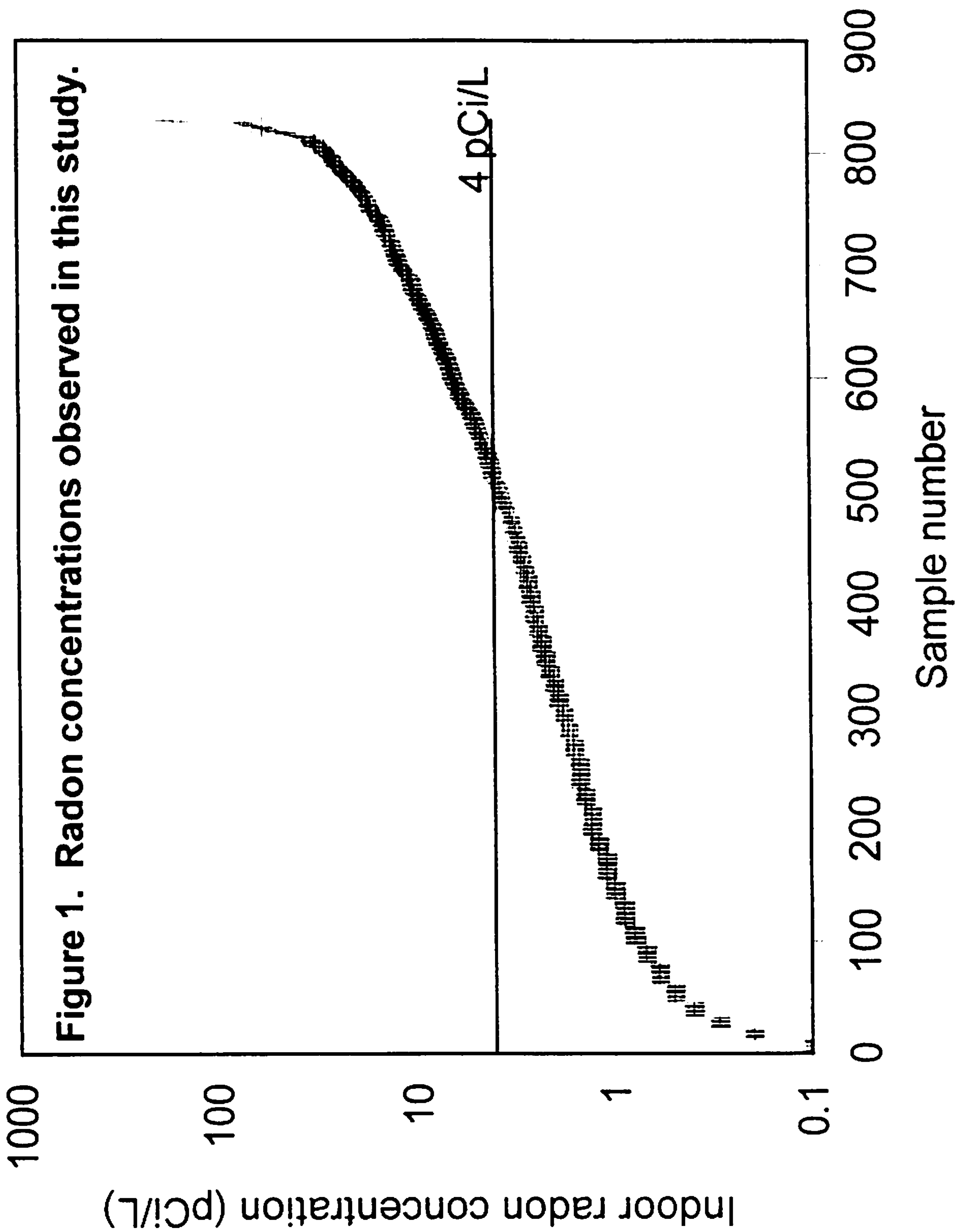

Figure 1. Radon concentrations observed in this study.

Figure 2. Comparison of estimated and measured basement radon concentrations for 44 towns.