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# RADON HAZARD ASSESSMENT
# ORIENTATION SURVEY
# CIRCLE HOT SPRINGS AREA, ALASKA
# PHASE I

By

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THIS REPORT HAS NOT BEEN REVIEWED FOR TECHNICAL CONTENT (EXCEPT AS NOTED IN TEXT) OR FOR CONFORMITY TO THE EDITORIAL STANDARDS OF DMGGS.

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## INTRODUCTION

The Circle Hot Springs radon orientation survey was undertaken by the Division of Mining and Geological and Geophysical Surveys (DMGGS) at the request of the Division of Land and Water Management (DLWM). The request was prompted by state concern that state lands scheduled to be offered for sale to the public might harbor abnormally high amounts of radon that could emanate into houses built on the disposed lands. Concern was expressed that if dwellings built on these lands were subsequently found to be contaminated by excessive amounts of radon, the state would be liable for offering unsuitable land for human habitation.

Preliminary correspondence with national laboratories (DOE-Grand Junction, Colorado; DOE-Pacific Norwest Laboratory, Richland Washington) made it apparent that a full rigorous assessment of potential radon hazards on the proposed disposal lands (Fig. 1) was beyond the scope of funding available to meet the DLW request. A modified approach has, therefore, been followed. It should be emphasized that the work done to date, and work that is proposed as a follow-up, is not and will not provide a 100% definitive answer to the question: "Will houses built on the proposed sale lands accumulate an unacceptable internal concentration level of radon?" In fact, there are no known methods that could provide such an answer. There are, however, more complete experiments than are fiscally possible for this study.

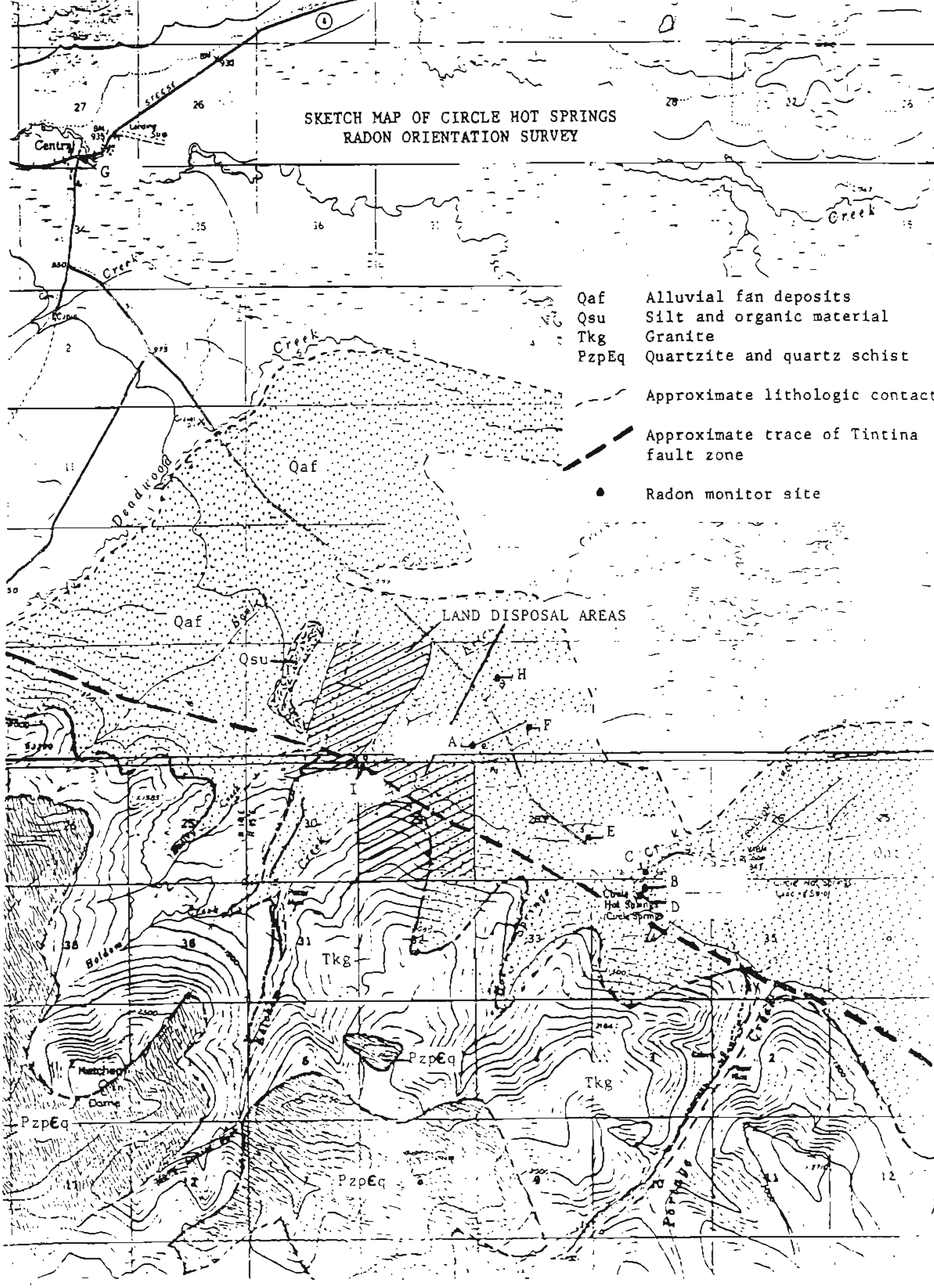
The strategy being followed in this study should, however, provide a very strong <u>indication</u> of whether or not future problems could be expected.

To date, approximately 5 field days have been expended to deploy and collect 11 ambient-air radon detectors, 17 living-area radon detectors, and 17 basement/crawl spacer radon detectors.

During the period of July 1 - September 9, 1986. Track-etch radon detectors were deployed at 9 housing locations in the Circle Hot Springs - Central, Alaska area. Table 1, (Fig. 1). At each of these sites one type F and 4 type SF detectors were emplaced to measure respectively: ambient radon level in the air on site, radon level in the crawl space or basement of the house on site, and radon level in the living area of the house on site. Duplicate SF detectors were emplaced at each crawl space and living area installation. A duplicate F type ambient-air radon detector was installed at the Central Post Office and the Johnson, Ketchum Creek sites. Of the detectors deployed, 2 SF detectors were destroyed on site, and 10 of the 11 ambient-air detectors failed. The ambient-air detectors appear to have been defective and Terradex has agreed to replace them at no cost to the state if future monitoring is conducted.

## LOCATION AND ACCESS

The land disposal areas of concern are located in the Circle B-2 quadrangle, Alaska, Township 8N., Range 15E., Section 29, and portions of Sections 19 and 20 (Fig. 1). Ketchum Creek road provides access to the disposal area in Sections 19 and 20. There is no road access to the internal area of Section 29, although the road to the Johnson mining camp allows vehicular access to the NW corner of Section 29.



SKETCH MAP OF CIRCLE HOT SPRINGS
RADON ORIENTATION SURVEY
Qaf Alluvial fan deposits
Qsu Silt and organic material
Tkg Granite
PzpEq Quartzite and quartz schist
Approximate lithologic contact
Approximate trace of Tintina fault zone
Radon monitor site
LAND DISPOSAL AREAS
Central
Deadwood
Creek
Qaf
Qsu
Tkg
PzpEq
A
B
C
D
E
F
G
H
I

Table 1. List of radon-monitoring sites in the Circle Hot Springs area. Serial numbers refer to the identification number of the radon monitor deployed. Exposure levels are reported in pico-Curies per liter (pCi/l). Standard deviation is a measure of error in the reported results attributable to counting statistics. Compiled by Terradex Corporation.

| Serial number | Radon Exp. rate (pCi/liter) | Std. dev. Pct. | Field notes and data |
|---|---|---|---|
| 31221 | | | A - Ambient - Air - Damaged |
| 31222 | .46 | 26.2 | B - Ambient - Air |
| 31223 | | | C - Ambient - Air - Damaged |
| 31224 | | | D - Ambient - Air - Damaged |
| 31225 | | | E - Ambient - Air - Damaged |
| 31220 | | | F - Ambient - Air - Damaged |
| 31226 | | | G - Ambient - Air - Damaged |
| 31227 | | | G - Ambient - Air - Damaged |
| 31228 | | | H - Ambient - Air - Damaged |
| 31229 | | | I - Ambient - Air - Damaged |
| 31230 | | | I - Ambient - Air - Damaged |
| 440297 | .88 | 34.0 | A - Living room |
| 440298 | .18 | 44.6 | A - Living room |
| 440299 | .87 | 23.2 | A - Crawl space |
| 440300 | .37 | 36.2 | A - Crawl space |
| 440301 | 3.76 | 16.1 | B - Public room |
| 440302 | 3.50 | 19.3 | B - Public room |
| 440303 | 10.26 | 19.4 | B - Basement |
| 440304 | 9.30 | 14.4 | B - Basement |
| 440305 | 1.46 | 26.2 | C - Kitchen |
| 440306 | .70 | 38.8 | C - Kitchen |
| 440307 | 3.76 | 18.6 | C - Crawl space |
| 440308 | 2.23 | 21.0 | C - Crawl space |
| 440309 | 1.18 | 29.3 | D - Office |
| 440310 | 1.18 | 29.3 | D - Office |
| 440311 | 3.12 | 20.4 | D - Crawl space |
| 440312 | 5.29 | 19.1 | D - Crawl space |
| 440313 | .51 | 46.3 | E - Living room |
| 440314 | .79 | 36.2 | E - Living room |
| 440317 | .51 | 37.8 | E - Crawl space |
| 440318 | .57 | 35.6 | E - Crawl space |
| 440315 | 1.24 | 28.2 | F - Living room |
| 440316 | .18 | 68.2 | F - Living room |
| 440319 | .12 | 89.6 | G - Office |
| 440320 | .31 | 49.7 | G - Office |
| 440321 | .70 | 38.8 | G - Crawl space |
| 440322 | .89 | 34.0 | G - Crawl space |
| 440325 | .06 | 151.3 | H - Living room |
| 440326 | .25 | 56.9 | H - Living room |
| 440327 | 1.27 | 28.2 | H - Crawl space |
| 440328 | .60 | 42.1 | H - Crawl space |
| 440329 | 1.65 | 24.5 | I - Crawl space |
| 440330 | 1.08 | 30.7 | I - Crawl space |
| 440331 | .60 | 42.1 | I - Living room |
| 440332 | .51 | 46.3 | I - Living room |

## GEOLOGY

The disposal sites encompass two distinct geologic settings that could affect radon emanations. Sections 19, 20 and the northern part of Section 29 are underlain by surficial deposits comprised of discontinuously frozen or water-saturated loess and organic material (muck) and extensive alluvial-fan gravel derived from the weathering of granite plutons that crop out in the hills to the south. The southern half of Section 29 slopes north and is mantled by loess that is probably underlain by granite.

In general, ice, water, and the fine-grained loess probably impede the flow of radon gas. Thus one might expect that radon emanation in Sections 19, 20 and the lowest portions of Section 29 to be less than on the hillside areas of Section 29.

## METHOD OF STUDY

Soil concentration, does not indicate the presence or absence of a potential radon hazard for dwellings. The rate of emanation of radon out of the soil into the dwelling and the degree of entrapment in the dwelling are of overriding importance. These facts make it impossible to assess potential hazard on the land-disposal site simply by directly measuring soil radon concentrations. A rigorous study requires erecting standardized test structures within the proposed sale area and performing all tests with these standardized structures. This approach was not feasible with the resources allocated to this study.

A modified approach has been undertaken that entails monitoring existing inhabited dwellings in the vicinity of the disposal areas. The same types of measurements have been made and will be attempted on these non-standardized dwellings as would have been made in a more rigorous test. The main objectives of this approach are:

1. to determine the level of radon in the living areas of existing houses on nearby land similar to land in the disposal area;
2. to informally extrapolate expected radon levels in <u>similar</u> houses built within the disposal area.

This can be done by:

1. establishing the level of radon in the existing houses;
2. measuring the rates at radon emanation rate out of the ground at each test-house site and simultaneously measuring the emanation rate of radon at random sites within the disposal area.

This procedure will not provide an absolute answer on the magnitude of any potential radon hazard. Test houses are not standardized and too many variables remain uncontrolled. However, the method will provide a preliminary indication of whether more rigorous testing should be undertaken.

## RESULTS

Analytical data provided by Terradex Corporation summarize the exposure rates encountered by the surviving and operable detectors (Table 1, Fig. 2).

The United States Environmental Protection Agency (EPA) has established no mandatory limits for residential radon exposure rates. The most widely used safety criterium is an exposure rate cited in units of "working level" (WL), (Table 2).

$$WL = \frac{WLR \times Rn}{100}$$

WL = working level
WLR = working level ratio
Rn = Radon concentration in pCi/l

Working-level ratios must be empirically derived for the structure in question but typically range from 0.3 to 0.7 (Oswald, et al., 1982). If one assumes the most extreme condition (WLR=0.7) and applies it to the Circle Hot Springs data (Table 1, Fig. 2), the maximum WL measured last summer by the orientation survey is $9.78 \times .7 \div 100 = .07$. This level was encountered in the fully enclosed concrete basement of the Site B. However, the living quarters in that building had a WL of only .03, just barely exceeding the DOE and Commonwealth of Pennsylvania's lowest level of concern for worst case WLR (Table 2). Radon concentration in the interior of the building did not exceed DOE, EPA, or Pennsylvania recommendations if the data are expressed as pCi/l and no WLR assumptions are made. The only other set of readings that exceeded recommended minimum levels under a worst case scenario were obtained from the tightly enclosed, earth-bounded crawl space beneath building D (Table 1, Figs. 1,2).

## DISCUSSION OF RESULTS

Clearly, the data collected so far indicates there is little, if any, summer radon hazard in existing lowland dwellings in the vicinity of the state's land-disposal sites. The test buildings are situated above a variety of surficial materials and represent building styles that range from a fully enclosed concrete basement to completely open crawl spaces beneath houses supported on pilings. Because of the close proximity of Circle Hot Springs, one might expect the highest ground concentrations of radon at sites closest to the hot springs, and this was the case, but even those levels were low.

It should be noted that DMGGS has not monitored any buildings on hillside sites in the area and has not monitored the sites reported here in the winter. It is possible that the interior radon levels in the test houses will be higher during winter than the summer because radon may migrate laterally beneath the seasonal frost into the thaw bulb under a heated house. From there vapor gas can be sucked up into the crawl space or basement and through the floor into the living area.

Table 2. Radon concentration levels of concern proposed by various government agencies.

| EPA[1] | Commonwealth of Pennsylvania[2] | Bonneville Power Authority[3] | Sweden[4] |
|---|---|---|---|
| 4 pCi/l or .02WL | .02WL | 5 pCi/l or .025WL | .019 WL new dwelling<br>.054 WL rebuilt dwelling<br>.108 WL existing dwelling |

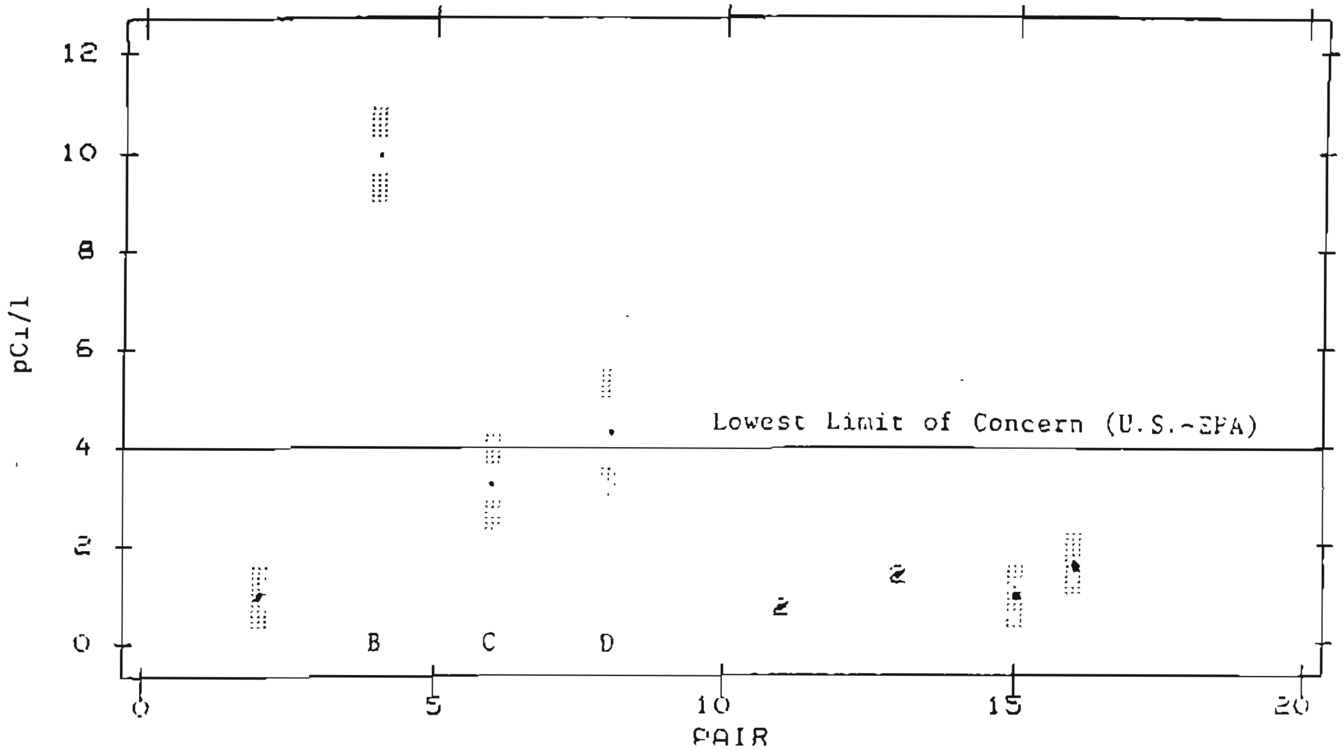
[1] William D. Lilley, Consulting Geologist, 19104 Heritage Hills Drive, Brookeville, Maryland 20833.

[2] Bonneville Power Administration, U.S. Department of Energy, publication: DOE/BP-311.

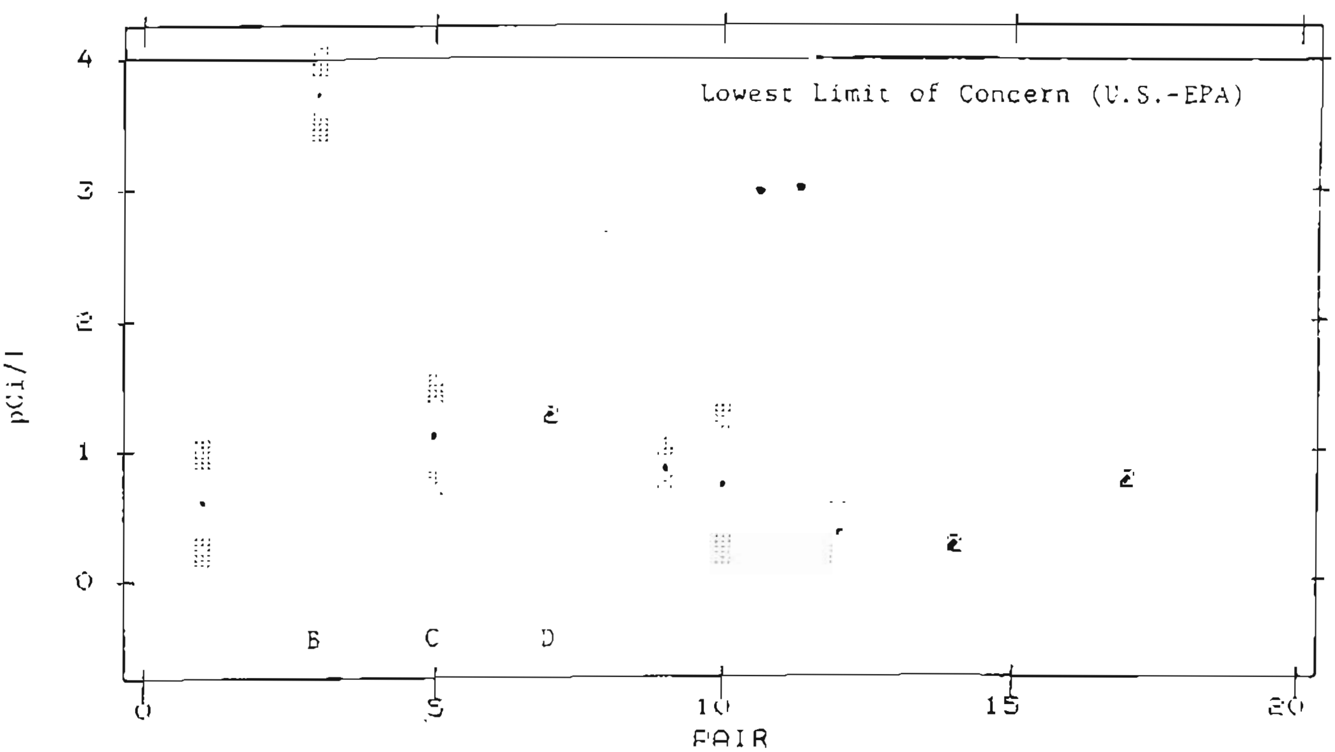
[3] Comment, 1986, Indoor radon is a geologic hazard, Geotimes, v. 31, no. 4, p. 5.

[4] Radon measurements in 12000 Swedish houses: Environment International, v. 8, p. 67-70, 1982.

FOLLOWING RESULTS ARE FOR:
LOCATION$ = CRAWL_SPACE




FOLLOWING RESULTS ARE FOR:
LOCATION$ = INTERIOR



## CONCLUSION

To date, no significant radon hazard has been identified in the living areas of houses tested in the vicinity of the state's proposed land disposal.

## RECOMMENDATIONS

I recommend that the same sites monitored in the summer of 1986 be monitored from January 1987 through April 1987 and that measurements of radon be taken at these same sites in late June or July 1987.