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PRELIMINARY DESCRIPTION OF DATA COLLECTED DURING THE STATE-EPA HOME RADON SURVEY

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Introduction

Within the last 5 years it has become increasingly clear that radon can accumulate in homes in concentrations which present a substantial health risk. This has precipitated an intense nationwide effort to document the exact magnitude of the radon problem. Cooperative statewide surveys between the Environmental Protection Agency (EPA) and individual states are one part of this effort. EPA has been conducting statistically valid statewide home radon surveys in cooperation with state agencies for the last 3 years. These surveys have provided estimates of home radon concentrations in 25 states. In many states, including Alaska, these surveys have provided the first estimates of the true proportion of homes with elevated radon concentrations.

The Alaska/EPA statewide survey was planned and conducted during the fall of 1988 and winter of 1989. EPA provided and analyzed the radon detectors and, through their contractor, Research Triangle Institute (RTI), provided details of the survey design such as questionnaires and sample lists, and statistical consultation and analysis. Alaska, through the Division of Geological and Geophysical Surveys (DGGS), provided demographic, geologic, and geographic information; screened households; and distributed the canisters and results. DGGS, RTI and EPA jointly designed general aspects of the survey, such as the boundaries of subregions within the state.

The purpose of this report is to present the basic data and first-order conclusions from the survey. A more detailed report which includes a thorough description of survey procedures and more complete data analysis is in preparation.

Methods

Alaska was divided into 5 subregions for this survey (Figure 1). The subregions were chosen to reflect major geographic, geologic and demographic divisions within the state. The number of subregions was kept small to maximize the number of homes tested in each region. This minimizes the error associated with percentage estimates of the number of homes with radon screening measurements within certain value ranges.

All radon measurements were made with charcoal detectors exposed for 48 hours. The detectors were placed during the winter in the lowermost liveable area of a home. Both of these factors can result in radon readings higher than the year-long integrated average for a given home. Thus the results obtained probably overestimate the average radon concentration in a house. Measurements of this type are referred to as screening measurements, and are designed to quickly and easily detect homes with potentially high year-round radon concentrations.

The type of detector and placement protocol were chosen by EPA and are designed to maximize comparability between the results from the states surveyed during the past year and previous years.

Urban areas and most towns located on road systems were covered by a conventional telephone survey. This will be referred to as the "telephone portion" of the survey. For these areas telephone lists were obtained and sampled by RTI. DGGS interviewers called the homes and screened them for eligibility. At least seven

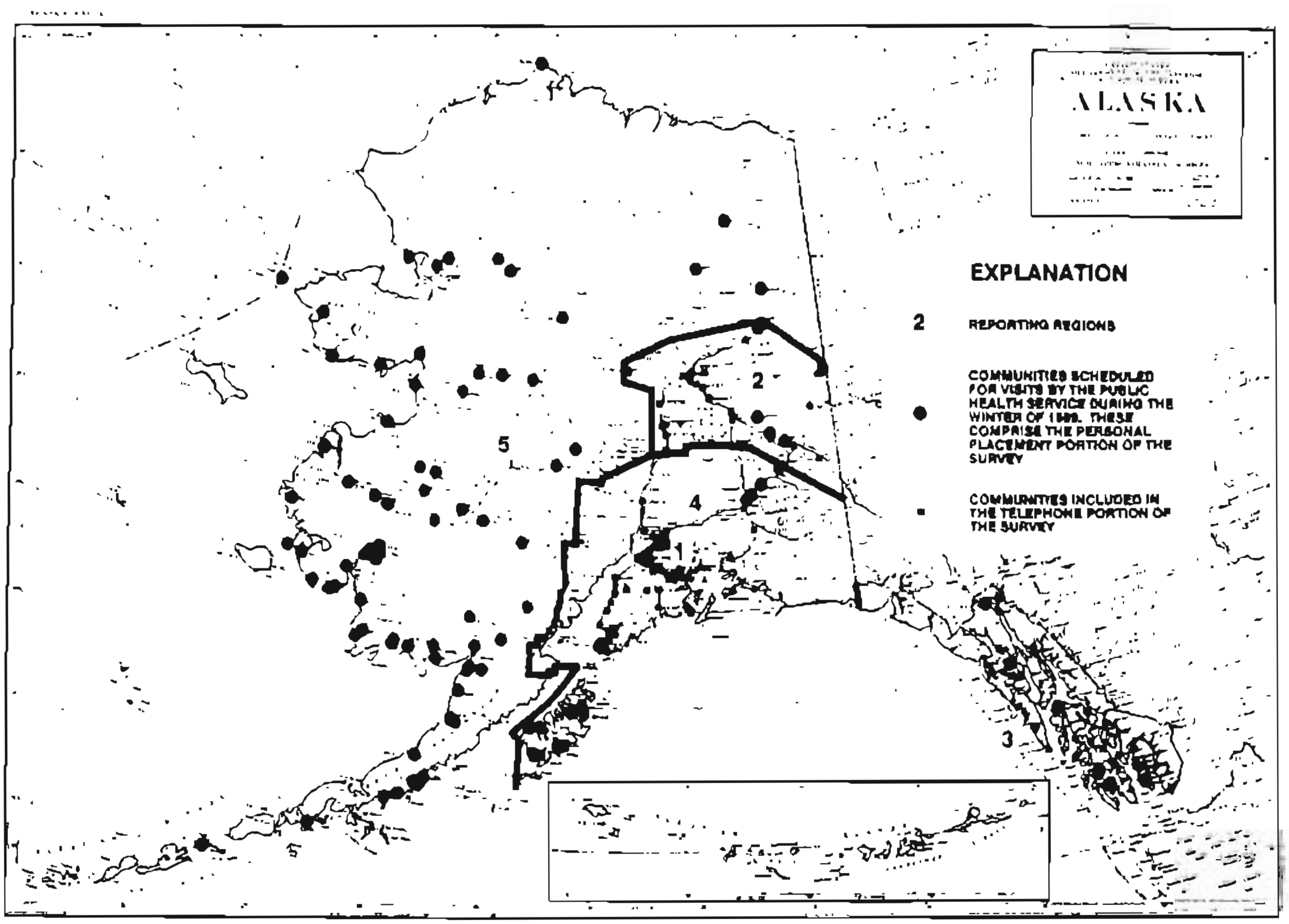

Figure 1. Map of Alaska showing reporting regions and survey method for different communities.

attempts were made to contact each telephone number over a period of several days and at different times of the day. We failed to contact only 6.5% of the telephone numbers.

If the homes that were contacted were eligible the homeowners were offered a free radon detector. The detectors were mailed to participating homeowners, who placed them in their homes according to EPA protocol and returned them to EPA for measurement. The results were sent to the Department of Health and Social Services, who forwarded them to DGGS, who in turn informed homeowners of their results. Regions 1-4 were sampled at different rates so that approximately the same number of canisters were placed in each region. Within a given region canisters were distributed in proportion to the number of listed telephone numbers, which was assumed to be proportional to population.

In that part of Alaska away from the major population centers and road systems detectors were placed in person by members of the Public Health Service (PHS), rather than by telephone interview. This portion of the survey will be referred to as the "personal placement portion" of the survey. Most remote communities are visited regularly by PHS sanitarians. In communities which were visited by the PHS during the survey period homes were chosen at random and screened for structural suitability. If the homes qualified (i.e. were tightly coupled to the ground) PHS sanitarians interviewed the occupants and provided the detectors. PHS then shipped the detectors to EPA for analysis.

The advantages of this survey technique were that all homes were included in the sample population, whether or not they had a telephone; correct detector placement was insured; and prompt shipment of detectors to EPA was facilitated. The detectors which were used needed to be returned to the laboratory for analysis within a week of exposure. Unpredictable mail service to many of the smaller communities made a telephone/mail survey unadvisable. The main disadvantage of this technique was that not all remote villages were visited during the winter, thus some communities were excluded from the survey.

Sample Population

The sample population is the subset of the total population which is sampled during a survey. Statistical estimates derived during a survey only apply to that sample population, and cannot be extrapolated precisely to the entire population.

For the portion of the survey conducted by telephone, the sample population consists of owner-occupied homes with at least one listed telephone number and with the lowermost liveable level on or below grade, or tightly coupled to the ground with weatherproof, permanent skirting. Homes not in contact with the ground (e.g. homes built on pilings or apartments or condominiums with the lowest level on the second floor or above), rental homes, and commercial buildings are not part of the sample population and were not included in this survey.

The sample population for the personal placement portion of the survey consisted of homes which are tightly coupled to the ground, either because the lowest level is on or below grade, or because the crawl space is skirted with weather-tight, permanent skirting.

Results

Results of this survey are tabulated in Appendix 1 and shown graphically in Figure 2. Our results confirm previously noted distribution patterns of homes with high radon concentrations and provide quantitative estimates of the proportion of such homes. The following paragraphs briefly describe the most important relationships defined by the data, and present some plausible geologic hypotheses which may explain the observed distribution of home radon concentrations. In most cases the geologic hypotheses remain to be tested, and represent our preliminary estimate of the geologic factors governing home radon concentrations.

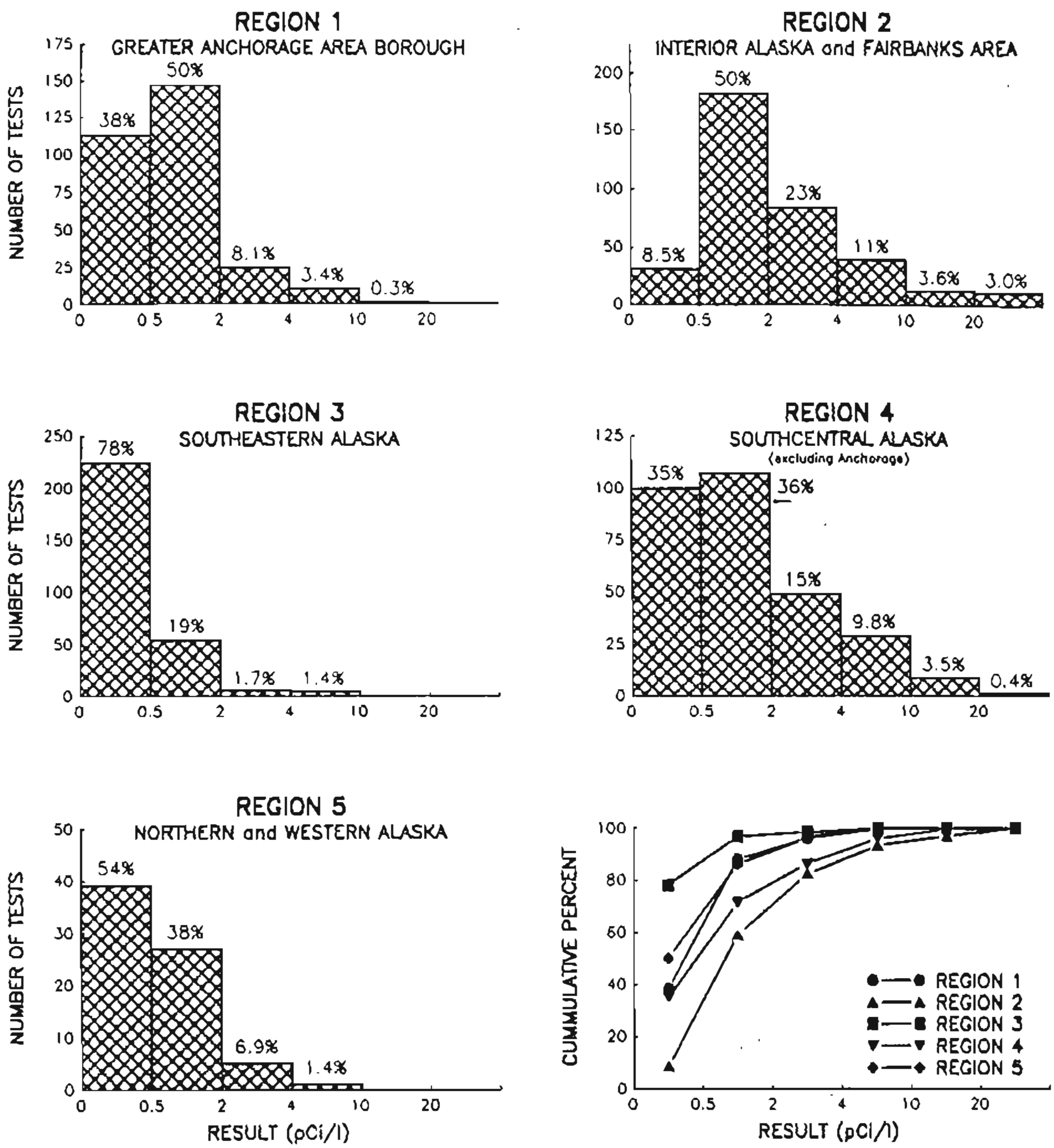

Figure 2. Histograms summarizing results of radon screening measurements.

Interior Alaska has the highest proportion of homes with elevated radon concentrations as well as the individual homes with highest concentrations. In the interior, 3% of homes within the sample population had screening levels higher than 20 pCi/l and 17.6% of homes had radon screening levels that were higher than 4 pCi/l. Figure 3 summarizes the responses to a request for home site geographic information which was included with the report of test results that was sent to participants in the survey. This figure shows that 30 to 35% of homes built in the hills around Fairbanks have elevated radon concentrations.

In the Fairbanks area homes built in the hills surrounding town with concrete slabs or basements in contact with bedrock yielded the highest radon screening levels. These areas also had the highest proportion of homes with high radon screening levels. We do not yet know the proportion of homes with basements in contact with bedrock that do not have elevated radon concentrations. The data shown in Figure 3 for homes located on hillside sites, includes homes which are built on thick accumulations of windblown glacial silt (loess). Thick accumulations of loess appear to be an effective barrier to radon migration. Homes built on alluvium from the Tanana and Chena Rivers are also much less at risk. High radon concentrations in homes in contact with bedrock are likely to result from high fracture permeability of the bedrock as well as relatively high uranium concentrations in the schist which comprises local bedrock. Low radon concentrations in homes built on loess and alluvium may reflect low soil gas permeability, low uranium concentrations of soils, or both.

Throughout interior Alaska homes constructed on bedrock seem to be at higher risk for elevated radon concentrations. Homes built on coarse glacial outwash deposits which are well drained can also have high radon concentrations, however. Outwash gravel may have sufficient porosity and permeability to allow significant amounts of soil gas to migrate into overlying structures. Outwash gravel may also contain abundant pebbles and boulders of rock types with high uranium concentrations, such as granite.

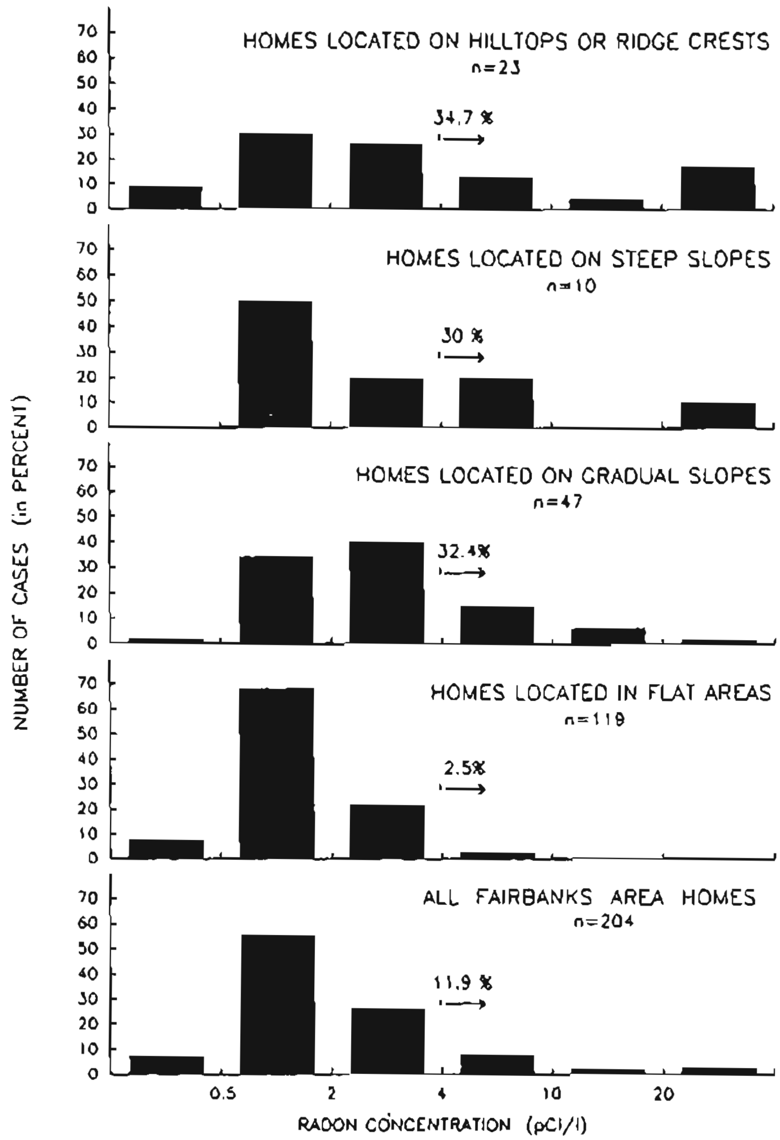

Figure 3. Histograms summarizing radon screening measurements and local geography of Fairbanks area homes.

Soil gas derived from such gravel may have elevated radon concentrations.

Based on survey data, southcentral Alaska also contains communities with a significant proportion of homes with elevated radon concentrations. The maximum radon concentrations detected in southcentral Alaskan homes, however, are not as high as those measured in the Fairbanks area. The geologic setting of southcentral Alaskan homes with elevated radon concentrations appears to be diverse. In some cases high radon screening levels can probably be attributed to the presence of coarse, well-sorted, granite-rich outwash. In other cases such concentrations appear to reflect proximity to bedrock.

Survey data indicate that Anchorage, southeastern Alaska, and northern and western Alaska have very few homes with elevated radon concentrations. In Anchorage this may reflect the abundance of fine-grained glacio-fluvial and glacio-marine sediments which underlie most of the borough. Fine-grained sediments such as these have low permeability, make soil-gas transport slow, and drastically reduce the reservoir volume of soil gas, and thus the amount of radon, which can be drawn into a home. Some of the homes included in the survey must have been in the hills surrounding Anchorage. The fact that these homes also have low radon concentrations suggests that local bedrock has low concentrations of uranium. The lack of homes with high radon in Anchorage thus probably reflects both low gas permeability and pore volume of local soils and low source strengths of radon.

The low concentrations of radon in homes throughout southeastern Alaska are not well understood geologically. Many of the underlying bedrock types should have sufficient uranium to produce a significant amount of radon, and many homes are built on extremely porous soils and fractured bedrock. These include homes in Juneau built on coarse talus fans and homes in the Mendenhall Valley built on coarse outwash of with a high proportions of cobbles of granitic composition. Such substrates should have sufficient gas permeability for significant radon migration, and sufficient uranium to produce high radon concentrations. It may be that throughout southeastern Alaska ground-water tables are high enough to prevent radon migration, especially during the winter season when most of our measurements were made. A high proportion of southeastern homes are built on pilings. Since these homes were structurally ineligible for the survey they do not influence the data presented here.

The small number of homes with elevated radon concentrations in northern and western Alaska may be due to several factors. Among these are local soil conditions such as shallow permafrost coupled with high water tables. Also, most communities included in this survey are sited on fine grained alluvial deposits such as overbank silt, rather than in upland areas where bedrock is exposed at or near the surface. Additionally, air exchange is probably more efficient in small homes during routine entry and exit. The data presented in Appendix 1 and Figure 2 do not reflect the fact that most homes in rural Alaska were structurally ineligible for this survey because they are built on pilings. Also, there are many Alaskan communities which do not include homes which were eligible for this study under EPA guidelines. The data produced in this study thus overestimate the true proportion of all homes in western and northern Alaskan communities with high radon.

Appendix 1. Summary of results of radon screening measurements obtained during the EPA/State indoor radon survey of 1989.

REGION	CITY	ZIP	N	<0.5	0.5-2.0	2.1-4.0	4.1-10	10-20	>20
				CONCENTRATION (picoCuries per liter of air)					
PERCENTAGE OF RESULTS									
1	ANCHORAGE			38	50	8.1	3.4	0.3	0
2	INTERIOR			8.5	50	23	11	3.6	3.0
3	SOUTHEAST			78	19	1.7	1.4	0	0
4	SOUTHCENTRAL			35	36	15	9.8	3.5	0.4
5	WESTERN AND NORTHERN			54	38	6.9	1.4	0	0
NUMBER OF RESULTS									
1	TOTAL		295	113	147	24	10	1	0
2	TOTAL		363	31	183	85	40	13	11
3	TOTAL		287	224	54	5	4	0	0
4	TOTAL		295	100	107	49	29	9	1
5	TOTAL		72	39	27	5	1	0	0
1	ANCH. TOTAL		290	112	147	23	7	1	0
1	ANCHORAGE	99501	18	7	10	1	0	0	0
1	ANCHORAGE	99502	28	16	10	1	1	0	0
1	ANCHORAGE	99503	15	6	7	2	0	0	0
1	ANCHORAGE	99504	52	19	24	6	3	0	0
1	ANCHORAGE	99507	26	9	12	3	1	1	0
1	ANCHORAGE	99508	38	9	22	6	1	0	0
1	ANCHORAGE	99509	3	1	2	0	0	0	0
1	ANCHORAGE	99511	2	0	2	0	0	0	0
1	ANCHORAGE	99514	1	1	0	0	0	0	0
1	ANCHORAGE	99515	34	16	16	2	0	0	0
1	ANCHORAGE	99516	26	5	18	2	1	0	0
1	ANCHORAGE	99517	29	12	17	0	0	0	0
1	ANCHORAGE	99518	14	9	5	0	0	0	0
1	ANCHORAGE	99520	3	2	1	0	0	0	0
1	ANCHORAGE	99523	1	0	1	0	0	0	0
1	EKLUTNA	99567	5	1	0	1	3	0	0
2	ANDERSON	99744	2	0	1	1	0	0	0
2	CENTRAL	99730	2	0	1	0	0	0	1
2	CIRCLE	99733	5	5	0	0	0	0	0
2	DELTA JCT	99737	29	1	5	10	9	3	1
2	DOT LAKE	99737	1	0	0	1	0	0	0
2	EAGLE VILLAGE	99738	5	2	3	0	0	0	0
2	ESTER	99725	6	0	2	1	2	1	0
2	FBKS/ESTER/NP		302	18	167	72	28	9	8
2	FAIRBANKS	99701	80	3	57	17	2	0	1
2	FAIRBANKS	99706	6	0	5	0	1	0	0
2	FAIRBANKS	99707	15	0	10	2	1	1	1
2	FAIRBANKS	99708	17	0	7	6	1	2	1
2	FAIRBANKS	99709	92	13	48	18	9	2	2
2	FAIRBANKS	99710	8	0	2	2	2	2	0

REGION	CITY	ZIP	N	<0.5	0.5-2.0	2.1-4.0	4.1-10	10-20	>20
				CONCENTRATION (picoCuries per liter of air)					
2	FAIRBANKS	99711	2	0	1	1	0	0	0
2	FAIRBANKS	99712	41	1	13	18	8	1	2
2	HEALY	99743	9	1	4	1	2	1	0
2	McKINLEY PK	99755	3	3	0	0	0	0	0
2	NORTH POLE	99705	35	1	22	9	2	0	1
2	SALCHA	99714	2	0	2	0	0	0	0
2	TETLIN	99779	1	1	0	0	0	0	0
2	TOK	99780	3	0	0	1	1	0	1
3	AUKE BAY	99821	12	8	4	0	0	0	0
3	CRAIG	99925	1	1	0	0	0	0	0
3	DOUGLAS	99824	10	7	2	1	0	0	0
3	HAINES	99827	13	8	6	1	0	0	0
3	HOONAH	99829	5	5	0	0	0	0	0
3	JUNEAU AREA		143	107	32	3	1	0	0
3	JUNEAU	99801	95	69	23	2	1	0	0
3	JUNEAU	99802	13	10	3	0	0	0	0
3	JUNEAU	99803	13	13	0	0	0	0	0
3	KETCHICAN	99901	51	44	6	0	1	0	0
3	KLAWOCK	99925	5	5	0	0	0	0	0
3	PETERSBURG	99833	17	17	0	0	0	0	0
3	SITKA	99835	25	19	6	0	0	0	0
3	SKAGWAY	99840	3	1	0	0	2	0	0
3	THORNE BAY	99919	1	1	0	0	0	0	0
3	WARD COVE	99928	7	7	0	0	0	0	0
3	WRANGELL	99929	17	12	4	1	0	0	0
4	ANCHOR POINT	99556	11	1	6	2	1	1	0
4	BIG LAKE	99652	6	3	1	1	1	0	0
4	COOPER LNDG	99572	5	0	3	0	1	1	0
4	COPPER CENTER	99573	12	7	5	0	0	0	0
4	GAKONA	99586	12	8	3	1	0	0	0
4	GLENNALLEN	99588	4	0	2	2	0	0	0
4	HOMER	99603	24	17	5	0	2	0	0
4	KASILOF	99610	8	2	3	2	1	0	0
4	KENAI	99611	18	2	9	5	1	1	0
4	KODIAK	99615	27	21	5	1	0	0	0
4	MOOSE PASS	99631	3	0	2	1	0	0	0
4	NINILCHIK	99639	4	0	2	1	1	0	0
4	OLD HARBOR	99643	4	4	0	0	0	0	0
4	OUZINKIE	99644	5	5	0	0	0	0	0
4	PALMER	99645	33	4	11	10	5	3	0
4	PORT GRAHAM	99603	1	1	0	0	0	0	0
4	SEWARD	99664	24	7	7	3	3	3	1
4	SOLDOTNA	99669	30	5	13	7	5	0	0

REGION	CITY	ZIP	N	CONCENTRATION (picoCuries per liter of air) <0.5	0.5-2.0	2.1-4.0	4.1-10	10-20	>20
4	STERLING	99672	14	2	8	2	2	0	0
4	SUTTON	99674	4	2	1	0	1	0	0
4	TALKEETNA	99676	2	0	2	0	0	0	0
4	TRAPPER CREEK	99683	1	0	0	0	1	0	0
4	VALDEZ	99686	21	9	3	7	2	0	0
4	WASILLA	99687	14	1	9	3	1	0	0
4	WILLOW	99688	4	0	2	1	1	0	0
5	AKHIOK	99615	5	4	0	0	0	0	0
5	ALAKANUK	99554	4	4	0	0	0	0	0
5	AMBLER	99786	4	1	3	0	0	0	0
5	ARCTIC VILLAGE	99722	4	1	3	0	0	0	0
5	BARROW	99723	7	7	0	0	0	0	0
5	CHALKYITSIK	99788	4	0	3	1	0	0	0
5	HUGHES	99745	5	2	3	0	0	0	0
5	KALTAG	99748	1	1	0	0	0	0	0
5	KIANA	99749	2	1	0	1	0	0	0
5	KONGIGANAK	99559	3	canisters not analyzed					
5	MANOKOTAK	99628	4	2	1	0	1	0	0
5	MARSHALL	99585	5	5	0	0	0	0	0
5	NOORVIK	99763	3	3	0	0	0	0	0
5	PILOT POINT	99649	5	0	5	0	0	0	0
5	PLATINUM	99651	1	1	0	0	0	0	0
5	QUINHAGAK	99655	1	canister not analyzed					
5	RUBY	99768	4	1	3	0	0	0	0
5	SHUNGNAK	99773	5	4	1	0	0	0	0
5	UNALAKLEET	99684	5	2	2	1	0	0	0
5	VENETIE	99781	5	0	3	2	0	0	0