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SURVEY OF ENVIRONMENTAL
RADIOACTIVITY

by

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SURVEY OF ENVIRONMENTAL RADIOACTIVITY

Milo D. Voss[†]

I. SUMMARY

This is the environmental monitoring program of the Ames Laboratory of the USAEC for the Ames Laboratory Research Reactor (ALRR).

The environmental program consists of gross alpha and beta determinations of air, soil, vegetation, river water, ALRR outfall, bottom sediment, precipitation, well water, and pond samples.

The ALRR reached full power as of 7/12/65. As of 12/31/66 the ALRR had generated 11,927 megawatts of heat. A total of 31,930 megawatts of heat was generated in 1967.

The data indicate that the ALRR has not contributed a significant amount of radioactivity to the environment in the Ames area. The conclusion is reached that radioactivity levels recorded for environmental samples represent background conditions from atmospheric fallout and naturally occurring radioactivity.

The following average levels of radioactivity were recorded for 1967:

Sample Media	Individual Samples	Beta Activity	Alpha Activity
Air	275	0.12 $\rho\text{Ci}/\text{M}^3$	0.004 $\rho\text{Ci}/\text{M}^3$
Soil	25	13.83 $\rho\text{Ci}/\text{g}$	0.99 $\rho\text{Ci}/\text{g}$
Vegetation	13	20.61 $\rho\text{Ci}/\text{g}$	0.21 $\rho\text{Ci}/\text{g}$
River Water	283	11.46 $\rho\text{Ci}/\text{l}$	0.74 $\rho\text{Ci}/\text{l}$
ALRR Outfall	249	11.22 $\rho\text{Ci}/\text{l}$	0.48 $\rho\text{Ci}/\text{l}$
Bottom Sediment	51	11.70 $\rho\text{Ci}/\text{g}$	0.76 $\rho\text{Ci}/\text{g}$
Precipitation	52	75.49 $\rho\text{Ci}/\text{l}$	3.54 $\rho\text{Ci}/\text{l}$
Well Water	36	8.61 $\rho\text{Ci}/\text{l}$	0.74 $\rho\text{Ci}/\text{l}$
Pond Water	31	15.24 $\rho\text{Ci}/\text{l}$	1.07 $\rho\text{Ci}/\text{l}$

II. SAMPLE INFORMATION

A. Air Samples

Daily air samples are taken at a location on top of the Ames Laboratory Research Building. Samples are collected on Whatman #41 filter paper with a Gast pump at the flow rate of 3.75 cfm. The filter samples are held for seven days to allow short-lived activities to decay. The samples are then placed directly in a Sharp Low Beta-Matic three-inch system and counted for gross alpha and beta activity.

Beta Activity Range ($\rho\text{Ci}/\text{M}^3$)

	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>
Average	3.40	3.86	1.26	0.30	0.15	0.12
High	22.40	13.50	5.95	1.50	2.34	0.92
Low	0.50	0.21	0.05	0.01	0.01	0.005

Alpha Activity Range ($\rho\text{Ci}/\text{M}^3$)

	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>
Average	0.05	0.11	0.0139	0.0068	0.0025	0.004
High	0.40	0.73	0.1135	0.0760	0.030	0.050
Low	0.01	0.10	0.0004	0.00012	0.001	0.001

B. Soil Samples

Soil samples are collected once each year. Circles surrounding the ALRR site were divided into quadrants on the basis of wind frequencies. The annuli were chosen on the basis of simplicity for defining sampling area. One sample was taken in each sector of each annulus (see maps #1 and #2). Reference samples were collected at Fort Dodge, Iowa. The number-letter designations on the data sheets are our codes for sample locations. One-quart samples are collected from the 0-2 inches of top soil. The samples are dried thoroughly in a 100°C drying oven, mixed thoroughly, with large stones and roots being removed. A 3-4 gram counting sample is made from the dried soil, placed in a 3-inch aluminum planchet, and counted directly in the Sharp System for gross alpha and beta activity.

Beta Activity Range ($\rho\text{Ci/g}$)

	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>
Average	7.57	9.45	19.97	14.45	15.01	13.83
High	9.40	14.00	32.00	20.50	35.30	16.30
Low	5.20	7.80	13.00	3.26	11.00	11.00

Alpha Activity Range ($\rho\text{Ci/g}$)

	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>
Average	0.26	0.56	0.94	0.86	0.68	0.99
High	0.60	1.08	1.31	1.20	1.20	1.81
Low	0.11	0.19	0.53	0.56	0.22	0.38

C. Vegetation

Vegetation samples are collected once each year. Samples are obtained from the same location as soil samples. Date of collection is correlated to maximum growth period which is July to August for this

area. Samples are not collected directly after precipitation of any kind to minimize surface contamination. The type of vegetation is confined to grasses and none of the root systems is included in the sample.

Samples are dried, ground to a fine powder, and made into 3-4 gram counting samples on 3-inch aluminum planchets. Samples are counted for gross alpha and beta activity in the Sharp System.

Beta Activity Range ($\rho\text{Ci/g}$)

	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>
Average	117.30	87.50	73.26	32.49	34.00	20.61
High	181.00	186.00	125.00	43.00	90.00	26.20
Low	10.80	10.50	51.00	26.00	20.00	17.70

Alpha Activity Range ($\rho\text{Ci/g}$)

	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>
Average	1.62	0.96	1.27	0.38	0.13	0.21
High	4.00	4.10	3.24	1.06	0.77	0.71
Low	0.11	0.15	0.35	0.07	0.27	0.21

D. River Water Samples

River water samples are collected weekly and analyzed for gross alpha and beta activity. One liter samples are filtered and counted separately as soluble and insoluble fractions. Samples are obtained from each river or creek in the flow route of the ALRR drainage system. In addition, two samples are obtained from streams outside the ALRR flow route. These constitute control samples and are numbers nine and ten in the data. Samples are obtained at each site until the creeks go dry in late summer and until the rivers are frozen solid in winter. If water is flowing under ice, a sample is obtained by chopping

through the ice. The insoluble portion of the sample is prepared by igniting the filter paper directly on a planchet. The soluble portion is evaporated to near dryness and transferred to a planchet. The planchets are placed directly in the Sharp System for counting.

Beta Activity Range ($\rho\text{Ci/l}$)

	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>
Average	18.09	55.94	18.26	18.12	16.03	11.46
High	118.00	2270.00	273.00	51.97	76.58	17.10
Low	4.50	0.80	0.39	4.68	7.07	7.75

Alpha Activity Range ($\rho\text{Ci/l}$)

	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>
Average	1.01	2.09	0.893	0.83	1.02	0.74
High	9.60	108.00	3.80	1.93	2.06	1.22
Low	0.25	0.06	0.046	0.33	0.57	0.39

E. ALRR Outfall

One liter samples are collected daily from this site and analyzed for gross beta and alpha content. The samples are filtered and counted as soluble and insoluble fractions.

Beta Activity Range ($\rho\text{Ci/l}$)

	<u>1966</u>	<u>1967</u>
Average	12.25	11.22
High	22.44	14.02
Low	5.88	8.89

Alpha Activity Range ($\rho\text{Ci/l}$)

	<u>1966</u>	<u>1967</u>
Average	0.61	0.48
High	1.63	0.84
Low	0.20	0.23

F. Bottom Sediment

Bottom sediment samples are obtained at or near the river water sites on a quarterly basis. Samples are analyzed for gross alpha and beta activity. A one-quart sample is obtained from the top 2-3 inches of bottom sediment in a semiquiescent area. The sample is mixed thoroughly and a 3-4 gram counting sample is prepared. The counting samples are dried thoroughly in an oven and then counted directly in the Sharp System.

	Beta Activity Range (pCi/g)					
	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>
Average	9.88	10.65	11.13	14.64	13.75	11.70
High	22.70	51.00	54.00	34.00	31.70	21.00
Low	0.60	3.90	4.50	7.00	5.50	4.90

	Alpha Activity Range (pCi/g)					
	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>
Average	0.25	0.61	0.47	0.89	0.85	0.76
High	0.94	8.00	3.10	6.70	2.74	2.71
Low	0.09	0.01	0.096	0.08	0.06	0.09

G. Precipitation Samples

Precipitation samples are collected on an "as it happens basis" and analyzed for gross alpha and beta activity. The sampling site is the weather observation tower near the ALRR. The samples are filtered and prepared in the same manner as the river water samples.

Beta Activity Range (pCi/l)

	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>
Average	2018.17	1360.00	366.23	714.94	217.15	75.49
High	4288.00	7000.00	2520.00	19500.00	3240.00	670.00
Low	922.00	20.00	20.00	8.70	4.30	4.20

Alpha Activity Range (pCi/l)

	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>
Average	65.90	39.20	12.67	3.95	9.21	3.54
High	97.00	234.00	53.00	32.80	55.00	26.00
Low	13.50	0.28	3.50	0.17	0.15	0.18

H. Well Water Samples

Well water samples are obtained monthly from City of Ames wells, Iowa State University (ISU) campus wells, and from a personal farm well at a location two miles north of the ALRR. The sample size is one liter and is filtered and prepared for counting in the same manner as the river water samples.

Beta Activity Range (pCi/l)

	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>
Average	4.01	4.78	6.83	6.80	6.93	7.20
High	6.78	16.40	12.90	22.80	13.00	15.10
Low	2.75	1.18	2.60	2.04	2.30	2.70

Alpha Activity Range (pCi/l)

	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>
Average	0.31	1.04	1.42	1.08	1.14	1.07
High	0.90	5.69	20.90	5.20	4.00	4.10
Low	0.17	0.10	0.046	0.12	0.18	0.18

I. Pond Water

Pond water samples are collected monthly from three sites: the George Todd site three miles northeast of the ALRR; the Izaak Walton League site three miles east of the ALRR; and the Kelly site five miles south of the ALRR. The sample size is one liter and is filtered and prepared for counting in the same manner as the riverwater samples.

Beta Activity Range (pCi/l)

	<u>1966</u>	<u>1967</u>
Average	16.30	15.24
High	30.40	30.70
Low	5.10	5.40

Alpha Activity Range (pCi/l)

	<u>1966</u>	<u>1967</u>
Average	0.86	1.07
High	2.50	3.80
Low	0.09	0.36

J. Detection Limits

Detection limits are by definition only.

III

ENVIRONMENTAL
RADIOACTIVITY
DATA

Air Samples (pCi/M³)

1967

<u>Date</u>	<u>Beta Conc.</u>	<u>Alpha Conc.</u>
January (23)	0.48	0.013
February (23)	0.17	0.004
March (25)	0.18	0.011
April (22)	0.12	0.006
May (25)	0.11	0.003
June (24)	0.05	0.0027
July (26)	0.04	0.0029
August (26)	0.05	0.003
September (21)	0.03	0.002
October (22)	0.10	0.004
November (20)	0.05	0.002
December (18)	0.05	0.002
Average	0.12	0.004
High	0.92	0.050
Low	0.005	0.001

Detection Limits - 0.0066 pCi/M³ β
0.0026 pCi/M³ α

Soil Samples

pCi/g

	Date	Beta Conc.	Alpha Conc.
1S-SE1	9-5-67	14.40	1.81
2S-SW1	"	14.20	1.17
3S-NW1	"	14.40	0.83
4S-NE1	"	16.10	1.10
5S-SE2	"	12.80	1.72
6S-SW2	"	11.60	1.20
7S-NW2	"	13.70	0.62
8S-NE2	"	13.50	0.73
9SV-SE3	"	14.00	0.81
10SV-SW3	"	13.10	0.38
11SV-NW3	"	15.50	0.41
12SV-NE3	"	12.30	0.71
13SV-SE4	"	14.00	1.22
14S-SW4	"	14.10	0.74
15SV-NW4	"	12.50	1.01
16S-NE4	"	15.00	0.73
17SV-NE5	"	11.50	1.16
18S-SW5	"	13.30	1.46
19SV-NW5	"	13.20	1.08
20S-NE5	"	16.30	0.67
21SV-SE6	"	11.00	0.76
22SV-SW6	"	14.40	1.27
23S-NW6	"	15.30	0.89
24SV-NE6	"	13.40	0.83
Ft. Dodge	"	16.20	1.51
Average		13.83	0.99
High		16.30	1.81
Low		11.00	0.38

Detection Limit - 0.25 pCi/g β
0.10 pCi/g α

Vegetation Samples

pCi/g

	Date	Beta Conc..	Alpha Conc.
3SV-NW1	9-5-67	20.50	ND*
9SV-SE3	"	26.20	ND
10SV-SW3	"	24.20	0.29
11SV-NW3	"	22.00	ND
12SV-NE3	"	19.60	ND
13SV-SE4	"	21.70	0.71
15SV-NW4	"	19.30	0.26
17SV-NE5	"	18.90	0.48
19SV-NW5	"	17.70	0.23
21SV-SE6	"	17.90	ND
22SV-SW6	"	16.60	0.21
24SV-NE6	"	23.80	ND
Ft. Dodge	"	19.50	0.61
Average		20.61	0.21
High		26.20	0.71
Low		17.70	0.21

Detection Limit - 2.07 pCi/g β
 0.78 pCi/g α

* Not detectable

River Water Samples (pCi/l)

January 1967

<u>Location</u>	<u>Beta Activity</u>		<u>Alpha Activity</u>	
	<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
1-DD-U	No Sample	-----	-----	-----
3-On-U	No Sample	-----	-----	-----
4-On-D	No Sample	-----	-----	-----
5-Sq-U	No Sample	-----	-----	-----
6-Sq-D	No Sample	-----	-----	-----
7-Sk-U	19.30	0.54	0.18	0.54
9-CC	No Sample	-----	-----	-----
10-DM	10.45	1.59	0.64	0.38
11-Sk-S	18.06	1.34	0.43	0.36
Average	15.94	1.16	0.42	0.43
High	19.30	1.59	0.64	0.54
Low	10.45	0.54	0.18	0.36

Detection Limit 1.00 pCi/l β
0.39 pCi/l α

River Water Samples (pCi/l)

February 1967

<u>Location</u>	<u>Beta Activity</u>		<u>Alpha Activity</u>	
	<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
1-DD-U	No Sample	-----	-----	-----
3-On-U	No Sample	-----	-----	-----
4-On-D	No Sample	-----	-----	-----
5-Sq-U	No Sample	-----	-----	-----
6-Sq-D	No Sample	-----	-----	-----
7-Sk-U	No Sample	-----	-----	-----
9-CC	No Sample	-----	-----	-----
10-DM	9.68	3.84	0.23	0.55
11-Sk-S	17.90	0.81	0.18	0.36
Average	13.79	2.33	0.21	0.46
High	17.90	3.84	0.23	0.55
Low	9.68	0.81	0.18	0.36

Detection Limit 1.00 pCi/l β
0.39 pCi/l α

River Water Samples (pCi/l)

March 1967

<u>Location</u>	<u>Beta Activity</u>		<u>Alpha Activity</u>	
	<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
I-DD-U	No Sample	-----	-----	-----
3-On-U	21.90	4.70	0.72	ND*
4-On-D	No Sample	-----	-----	-----
5-Sq-U	8.83	1.72	0.60	0.36
6-Sq-D	9.10	1.50	0.24	0.30
7-Sk-S	7.17	1.52	0.30	0.24
9-CC	9.90	1.08	0.12	0.12
10-DM	12.80	2.83	0.59	0.32
11-Sk-S	18.63	1.89	0.41	0.36
Average	12.62	2.18	0.43	0.24
High	21.90	4.70	0.72	0.36
Low	7.17	1.08	0.12	0.12

Detection Limit 1.00 pCi/l β
0.39 pCi/l α

* Not detectable

River Water Samples (pCi/l)

April 1967

<u>Location</u>	<u>Beta Activity</u>		<u>Alpha Activity</u>	
	<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
1-DD-U	No Sample	-----	-----	-----
3-On-U	8.23	0.51	0.67	0.14
4-On-D	No Sample	-----	-----	-----
5-Sq-U	8.30	0.66	0.50	0.27
6-Sq-D	7.43	0.58	0.58	0.23
7-Sk-U	10.38	0.88	0.27	0.23
9-CC	11.50	0.41	0.57	0.32
10-DM	11.85	2.10	0.55	0.57
11-Sk-S	15.20	0.68	0.18	0.41
Average	10.41	0.83	0.47	0.31
High	15.20	2.10	0.67	0.57
Low	7.43	0.41	0.18	0.14

Detection Limit 1.00 pCi/l β
0.39 pCi/l α

River Water Samples (pCi/l)

May 1967

<u>Location</u>	<u>Beta Activity</u>		<u>Alpha Activity</u>	
	<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
1-DD-U	No Sample	-----	-----	-----
3-On-U	8.03	0.81	0.50	0.09
4-On-D	No Sample	-----	-----	-----
5-Sq-U	8.18	0.82	0.43	0.40
6-Sq-D	7.50	0.75	0.44	0.22
7-Sk-U	8.34	0.76	0.36	0.58
9-CC	7.82	0.30	0.43	0.22
10-DM	9.94	2.26	0.71	0.40
11-Sk-S	16.62	0.27	0.47	0.18
Average	9.49	0.85	0.48	0.30
High	16.62	2.26	0.71	0.58
Low	7.50	0.27	0.36	0.09

Detection Limit 1.00 pCi/l β
 0.39 pCi/l α

River Water Samples (pCi/l)

June 1967

<u>Location</u>	<u>Beta Activity</u>		<u>Alpha Activity</u>	
	<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
1-DD-U	4.57	0.09	0.12	0.12
3-On-U	12.45	0.71	0.50	0.49
4-On-D	No Sample	-----	-----	-----
5-Sq-U	12.35	1.38	0.89	0.23
6-Sq-D	11.05	2.12	0.81	0.50
7-Sk-U	12.56	1.51	1.35	0.50
9-CC	10.25	0.75	1.50	0.18
10-DM	9.38	2.20	1.33	0.50
11-Sk-S	10.00	0.94	0.60	0.27
Average	10.33	1.21	0.88	0.34
High	12.56	2.20	1.50	0.50
Low	4.57	0.09	0.12	0.12

Detection Limit 1.00 pCi/l β
0.39 pCi/l α

River Water Samples (pCi/l)

July 1967

<u>Location</u>	<u>Beta Activity</u>		<u>Alpha Activity</u>	
	<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
1-DD-U	2.80	0.68	0.54	0.18
3-On-U	6.44	0.98	0.25	0.22
4-On-D	6.80	1.07	0.27	0.14
5-Sq-U	5.90	2.14	0.69	0.11
6-Sq-D	6.40	1.68	0.51	0.22
7-Sk-U	6.38	1.44	0.80	0.07
9-CC	6.30	1.31	0.46	0.07
10-DM	8.32	2.95	0.47	0.40
11-Sk-S	12.62	1.15	0.22	0.07
Average	6.88	1.48	0.47	0.16
High	12.62	2.95	0.80	0.40
Low	2.80	0.68	0.22	0.07

Detection Limit 1.00 pCi/l β
0.39 pCi/l α

River Water Samples (pCi/l)

August 1967

<u>Location</u>	<u>Beta Activity</u>		<u>Alpha Activity</u>	
	<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
1-DD-U	No Samples -----			
3-On-U	5.83	0.50	0.42	0.12
4-On-D	6.45	0.07	0.45	0.09
5-Sq-U	6.33	0.51	0.69	0.32
6-Sq-D	5.55	0.57	0.37	0.27
7-Sk-U	5.55	0.79	0.51	0.23
9-CC	5.35	0.68	0.05	0.14
10-DM	8.38	2.50	0.54	0.32
11-Sk-S	12.17	0.76	0.18	0.48
Average	6.95	0.80	0.40	0.25
High	12.17	2.50	0.69	0.48
Low	5.35	0.07	0.05	0.09

Detection Limit 1.00 pCi/l β
 0.39 pCi/l α

River Water Samples (pCi/l)

September 1967

<u>Location</u>	<u>Beta Activity</u>		<u>Alpha Activity</u>	
	<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
1-DD-U	No Samples	-----	-----	-----
3-On-U	No Samples	-----	-----	-----
4-On-D	No Samples	-----	-----	-----
5-Sq-U	7.63	1.14	0.24	0.06
6-Sq-D	5.90	1.63	0.09	0.18
7-Sk-U	10.87	1.50	0.24	0.18
9-CC	8.00	0.41	ND*	ND
10-DM	7.63	2.70	0.77	0.30
11-Sk-S	15.40	1.30	0.18	0.09
Average	9.23	1.44	0.25	0.14
High	15.40	2.70	0.77	0.30
Low	5.90	0.41	0.09	0.06

Detection Limit 1.00 pCi/l β
0.39 pCi/l α

* Not detectable

River Water Samples (pCi/l)

October 1967

<u>Location</u>	<u>Beta Activity</u>		<u>Alpha Activity</u>	
	<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
1-DD-U	No Samples	-----		
3-On-U	No Samples	-----		
4-On-D	No Samples	-----		
5-Sq-U	5.86	1.06	0.54	0.36
6-Sq-D	5.08	0.73	0.54	0.23
7-Sk-U	9.38	0.57	0.46	0.29
9-CC	7.93	0.93	0.60	0.32
10-DM	6.16	1.52	0.42	0.54
11-Sk-S	16.16	1.16	0.29	0.29
Average	8.42	1.00	0.48	0.34
High	16.16	1.52	0.60	0.54
Low	5.08	0.57	0.29	0.23

Detection Limit 1.00 pCi/l β
0.39 pCi/l α

River Water Samples (pCi/l)

November 1967

<u>Location</u>	<u>Beta Activity</u>		<u>Alpha Activity</u>	
	<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
1-DD-U	No Samples	-----		
3-On-U	No Samples	-----		
4-On-D	No Samples	-----		
5-Sq-U	5.98	0.68	0.55	0.33
6-Sq-D	5.68	0.58	0.45	0.14
7-Sk-U	7.75	0.45	0.85	0.24
9-CC	6.83	1.21	0.59	0.23
10-DM	8.38	1.39	0.68	0.23
11-Sk-S	17.93	0.88	0.36	0.60
Average	8.76	0.87	0.58	0.30
High	17.93	1.39	0.85	0.60
Low	5.68	0.45	0.36	0.14
Detection Limit	1.00 pCi/l β		0.39 pCi/l α	

River Water Samples (pCi/l)

December 1967

<u>Location</u>	<u>Beta Activity</u>		<u>Alpha Activity</u>	
	<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
1-DD-U	No Samples	-----	-----	-----
3-On-U	No Samples	-----	-----	-----
4-On-D	No Samples	-----	-----	-----
5-Sq-U	8.87	0.67	0.55	ND*
6-Sq-D	6.93	0.78	0.30	0.24
7-Sk-U	10.20	0.63	0.12	ND
9-CC	7.30	0.32	0.54	0.24
10-DM	8.50	1.15	0.42	0.42
11-Sk-S	18.40	0.37	ND	0.24
Average	10.03	0.65	0.32	0.19
High	18.40	1.15	0.55	0.42
Low	6.93	0.32	0.12	0.24

Detection Limit 1.00 pCi/l β
 0.39 pCi/l α

* Not detectable

River Water Samples (pCi/l)
1967 Yearly Averages of Months

	Beta Activity		Alpha Activity	
	<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
Average	10.23	1.23	0.45	0.29
High	15.94	2.33	0.88	0.46
Low	6.88	0.65	0.21	0.14
Detection Limit	1.00 pCi/l β 0.39 pCi/l α			

ALRR Outfall Samples

1967

(pCi/l)

<u>Date</u>	<u>Beta Activity</u>		<u>Alpha Activity</u>	
	<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
January	7.67	3.30	0.17	0.25
February	9.25	1.05	0.22	0.28
March	10.41	1.23	0.15	0.21
April	13.44	0.58	0.48	0.36
May	8.43	0.46	0.17	0.27
June	12.60	0.93	0.12	0.19
July	9.34	1.68	0.15	0.08
August	10.30	0.95	0.25	0.17
September	11.82	1.48	0.23	0.21
October	7.75	1.70	0.22	0.25
November	9.33	0.89	0.37	0.17
December	8.93	1.07	0.32	0.39
Average	9.94	1.28	0.24	0.24
High	13.44	3.30	0.48	0.39
Low	7.67	0.46	0.12	0.08

Bottom Sediment Samples (pCi/g)

<u>Location</u>	<u>Date</u>	<u>Beta Concentration</u>	<u>Alpha Concentration</u>
1-DD-U	3-29-67	8.20	0.18
	6-29-67	8.90	0.20
	9-22-67	6.90	0.18
	11-24-67	6.10	0.34
	Average	7.53	0.23
ALRR Outfall	3-29-67	8.00	0.20
	6-29-67	9.00	0.25
	9-22-67	7.10	0.09
	11-24-67	10.00	0.54
	Average	8.53	0.27
3-On-U	3-29-67	7.50	0.20
	6-29-67	8.20	0.11
	9-22-67	7.10	0.29
	11-24-67	11.00	0.40
	Average	8.45	0.25
4-On-D	3-29-67	8.10	0.27
	6-29-67	10.00	0.29
	9-22-67	7.40	ND*
	11-24-67	7.30	0.27
	Average	8.20	0.21
5-Sq-U	3-29-67	12.00	0.75
	6-29-67	18.80	0.78
	9-22-67	9.30	0.65
	11-24-67	12.00	0.90
	Average	13.03	0.77
6-Sq-D	3-29-67	10.00	0.75
	6-29-67	17.00	1.00
	9-22-67	15.60	0.90
	11-24-67	15.00	1.00
	Average	14.40	0.91

* Not detectable

Bottom Sediment Samples (pCi/g)

<u>Location</u>	<u>Date</u>	<u>Beta Concentration</u>	<u>Alpha Concentration</u>
7-Sk-U	3-29-67	8.10	0.80
	6-29-67	17.40	2.40
	9-22-67	8.10	2.71
	11-24-67	4.90	2.00
	Average	9.63	1.98
9-CC	3-29-67	11.00	0.71
	6-29-67	12.00	0.52
	9-22-67	6.70	0.11
	11-24-67	12.00	0.39
	Average	10.43	0.43
10-DM	3-29-67	13.00	0.61
	6-29-67	17.00	0.41
	9-22-67	12.50	1.32
	11-24-67	15.00	1.00
	Average	14.38	0.84
11-Sk-S	3-29-67	11.00	0.51
	6-29-67	18.00	2.20
	9-22-67	13.60	0.52
	11-24-67	8.10	0.14
	Average	12.68	0.84
Todd Pond	3-29-67	No Sample (pond dry & dredged)	
	6-29-67	15.00	1.80
	9-22-67	13.10	0.60
	11-24-67	14.00	0.87
	Average	14.03	1.09
Izaak Walton League Pond	3-29-67	10.00	0.30
	6-29-67	21.00	2.10
	9-22-67	10.40	0.38
	11-24-67	15.00	0.33
	Average	14.10	0.78

Bottom Sediment Samples (pCi/g)

<u>Location</u>	<u>Date</u>	<u>Beta Concentration</u>	<u>Alpha Concentration</u>
Kelley Pond	3-29-67	19.00	0.50
	6-29-67	17.00	0.40
	9-22-67	18.40	0.78
	11-24-67	15.00	0.90
	Average	17.35	0.65
Average for 51 Samples		11.70	0.76
High		21.00	2.71
Low		4.90	0.09
Detection Limits	0.25 pCi/g β 0.10 pCi/g α		

Precipitation Samples (pCi/l)

<u>Date</u>	<u>Beta Activity</u>		<u>Alpha Activity</u>	
	<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
January	64.33	22.00	1.71	0.94
February	130.00	120.00	1.54	2.60
March	100.66	62.00	1.67	7.96
April	37.86	22.62	2.30	2.30
May	41.70	112.94	1.92	3.49
June	14.80	3.77	2.17	0.56
July	23.05	7.70	0.37	0.18
August	13.20	5.19	1.26	0.57
September	12.30	8.57	1.06	0.50
October	8.87	6.90	0.56	1.06
November	13.45	37.45	0.34	0.75
December	17.80	18.70	4.09	2.64
Average	39.84	35.65	1.58	1.96
Individual High	173.00	500.00	8.50	20.50
Individual Low	2.80	0.14	0.18	0.18
Detection Limits	1.00 pCi/g β			
	0.39 pCi/l α			

Well Water Samples (pCi/l)

<u>Location</u>	<u>Date</u>	<u>Beta Activity</u>		<u>Alpha Activity</u>	
		<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
City of Ames	1-30-67	5.00	0.41	0.36	ND*
	2-27-67	3.50	ND*	0.90	1.10
	3-31-67	7.30	ND	1.80	0.54
	4-24-67	5.70	0.81	0.90	ND
	5-27-67	2.20	0.68	0.36	0.36
	6-26-67	4.50	0.68	2.20	ND
	7-31-67	6.20	1.50	0.36	ND
	8-28-67	2.70	ND	0.36	0.36
	9-25-67	7.80	ND	0.72	0.18
	10-30-67	2.70	1.90	0.90	0.54
	11-30-67	13.50	1.60	1.30	0.18
	12-27-67	5.50	0.41	1.30	0.36
Average		5.50	0.67	0.96	0.30
High		13.50	1.90	2.20	1.10
Low		2.20	0.41	0.36	0.18

Detection Limits 1.00 pCi/l β
0.39 pCi/l α

* Not detectable

Well Water Samples (pCi/l)

<u>Location</u>	<u>Date</u>	<u>Beta Activity</u>		<u>Alpha Activity</u>	
		<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
Iowa State University	1-30-67	6.60	ND*	0.54	0.36
	2-27-67	7.00	1.40	1.10	0.90
	3-31-67	6.50	1.40	1.10	ND
	4-24-67	3.50	ND	1.10	ND
	5-27-67	6.60	0.68	0.36	ND
	6-26-67	5.00	0.41	2.30	1.80
	7-31-67	7.60	1.10	1.10	ND
	8-28-67	4.30	0.41	0.72	ND
	9-25-67	6.20	0.54	0.72	ND
	10-30-67	5.40	0.27	0.72	ND
	11-30-67	7.40	0.14	0.72	ND
	12-27-67	7.20	2.00	0.72	0.36
Average		6.11	0.76	0.93	0.29
High		7.60	2.00	2.30	1.80
Low		3.50	0.14	0.36	0.36

Detection Limits 1.00 pCi/l β
0.39 pCi/l α

* Not detectable

Well Water Samples (pCi/l)

<u>Location</u>	<u>Date</u>	<u>Beta Activity</u>		<u>Alpha Activity</u>	
		<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
Arland Martin Acreage	1-30-67	5.80	ND*	0.36	ND
	2-27-67	8.40	0.54	0.18	0.18
	3-31-67	7.70	ND	1.40	ND
	4-24-67	6.20	0.14	ND	0.18
	5-27-67	8.40	0.81	0.36	ND
	6-26-67	7.20	1.50	0.54	ND
	7-31-67	10.30	0.54	0.18	ND
	8-28-67	7.20	ND	0.90	ND
	9-25-67	8.90	ND	1.10	0.18
	10-30-67	10.50	0.68	0.90	0.36
	11-30-67	7.70	ND	0.54	0.36
	12-27-67	9.20	1.50	1.10	ND
Average		8.13	0.48	0.63	0.11
High		10.50	1.50	1.40	0.36
Low		5.80	0.14	0.18	0.18
Average for 36 Samples		6.59	0.61	0.84	0.23
High for 36 Samples		13.50	2.00	2.30	1.80
Low for 36 Samples		2.20	0.14	0.18	0.18

* Not detectable

Pond Water Samples (pCi/l)

<u>Location</u>	<u>Date</u>	<u>Beta Activity</u>		<u>Alpha Activity</u>	
		<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
Izaak Walton League Pond					
	1-30-67	28.40	2.30	ND*	ND
	2-28-67	20.00	3.10	1.10	0.18
	3-31-67	7.30	1.90	1.60	2.20
	4-24-67	18.60	0.27	0.90	0.36
	5-27-67	23.20	1.60	0.18	0.72
	6-26-67	19.00	0.81	0.72	0.54
	7-31-67	22.30	1.20	ND	0.72
	8-28-67	21.90	0.54	ND	0.36
	9-25-67	24.80	1.80	1.40	ND
	10-30-67	18.70	0.95	1.10	0.36
	11-30-67	21.50	0.95	1.30	ND
	12-27-67	12.80	2.20	0.18	0.90
Average		19.88	1.47	0.71	0.53
High		28.40	3.10	1.60	2.20
Low		7.30	0.27	0.18	0.18
Detection	1.00 pCi/l β				
	0.39 pCi/l α				

* Not detectable

Pond Water Samples (pCi/l)

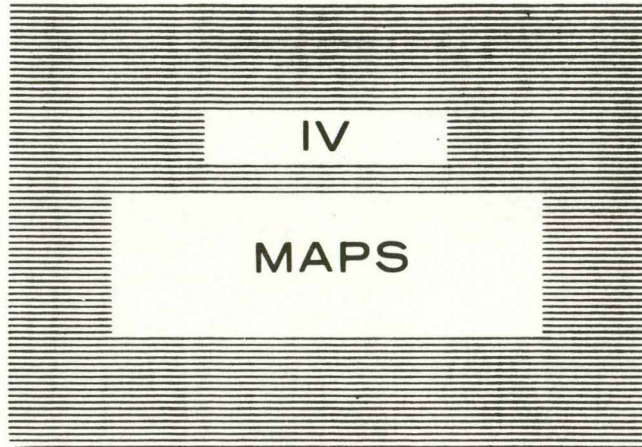
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		<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
Geo. Todd Pond	1-30-67	No Sample	-----	-----	-----
	2-28-67	No Sample	-----	-----	-----
	3-31-67	No Sample	-----	-----	-----
	4-24-67	No Sample	-----	-----	-----
	5-27-67	No Sample	-----	-----	-----
	6-26-67	4.60	0.80	0.90	0.36
	7-31-67	8.00	1.40	0.90	ND*
	8-28-67	9.60	0.14	0.36	0.54
	9-25-67	6.50	1.90	0.90	0.36
	10-30-67	8.10	1.80	0.54	0.18
	11-30-67	15.00	1.20	2.20	0.18
	12-27-67	11.20	0.27	0.54	0.54
Average		9.00	1.07	0.91	0.31
High		15.00	1.90	2.20	0.54
Low		4.60	0.14	0.36	0.18
Detection Limits		1.00 pCi/l β			
		0.39 pCi/l α			

* Not detectable

Pond Water Samples (pCi/l)

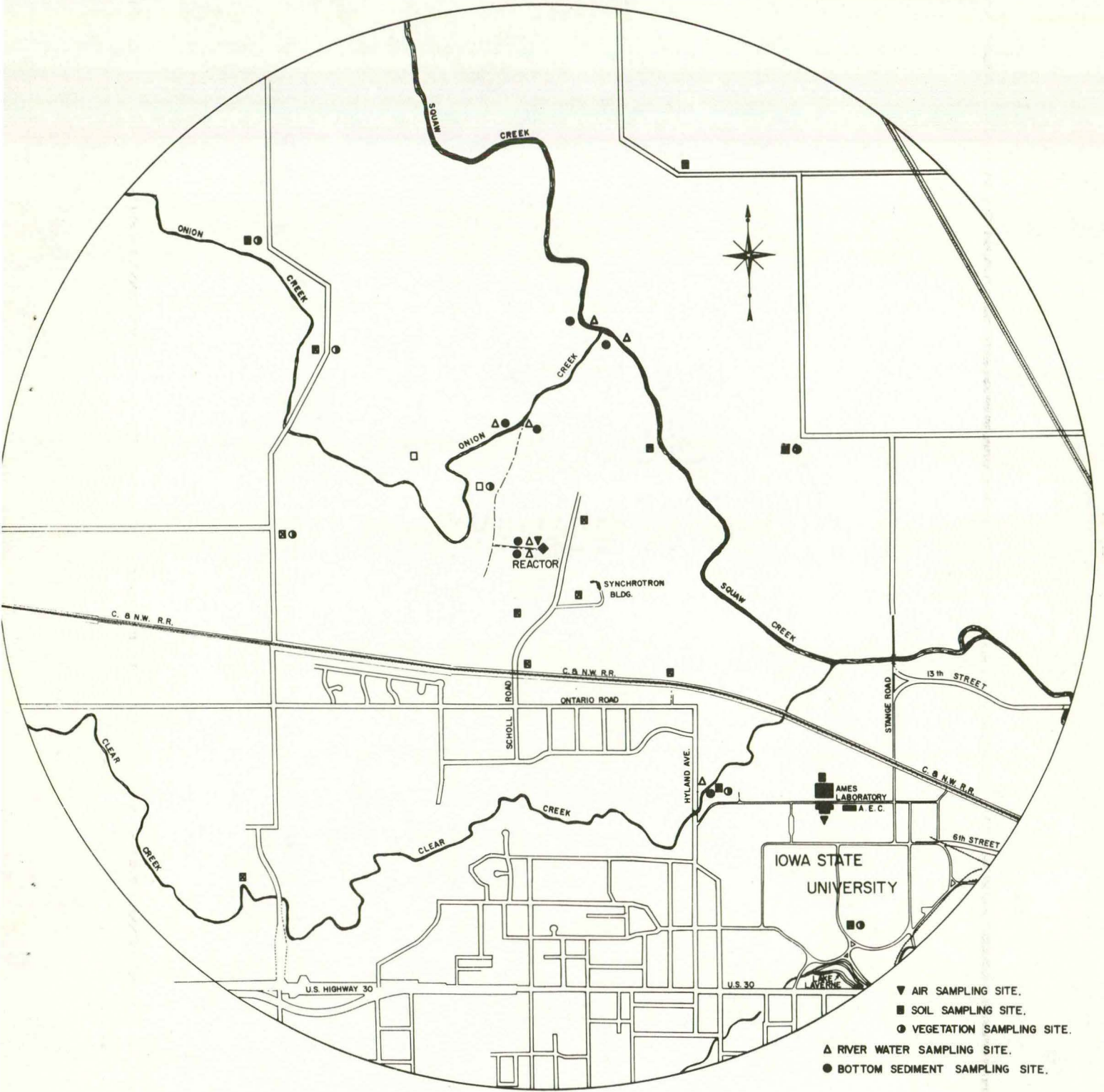
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		<u>Soluble</u>	<u>Insoluble</u>	<u>Soluble</u>	<u>Insoluble</u>
Kelley Pond	1-30-67	23.60	2.80	0.36	ND*
	2-28-67	10.30	1.40	0.36	0.36
	3-31-67	10.00	0.81	1.30	1.10
	4-24-67	6.90	0.41	ND	ND
	5-27-67	11.00	1.90	0.54	0.54
	6-26-67	7.40	1.40	ND	0.36
	7-21-67	10.70	1.10	0.72	ND
	8-28-67	7.40	ND	ND	0.90
	9-25-67	8.60	0.54	0.36	0.18
	10-30-67	9.70	ND	ND	0.36
	11-30-67	15.80	ND	0.90	0.18
	12-27-67	19.00	1.20	0.90	0.54
	Average		11.70	0.96	0.45
High		23.60	2.80	1.30	1.10
Low		6.90	0.41	0.36	0.18
Average for 31 Samples		14.25	0.99	0.65	0.42
High for 31 Samples		28.40	3.10	2.20	2.20
Low for 31 Samples		4.60	0.14	0.18	0.18
Detection Limits		1.00 pCi/l β			
		0.39 pCi/l α			

* Not detectable

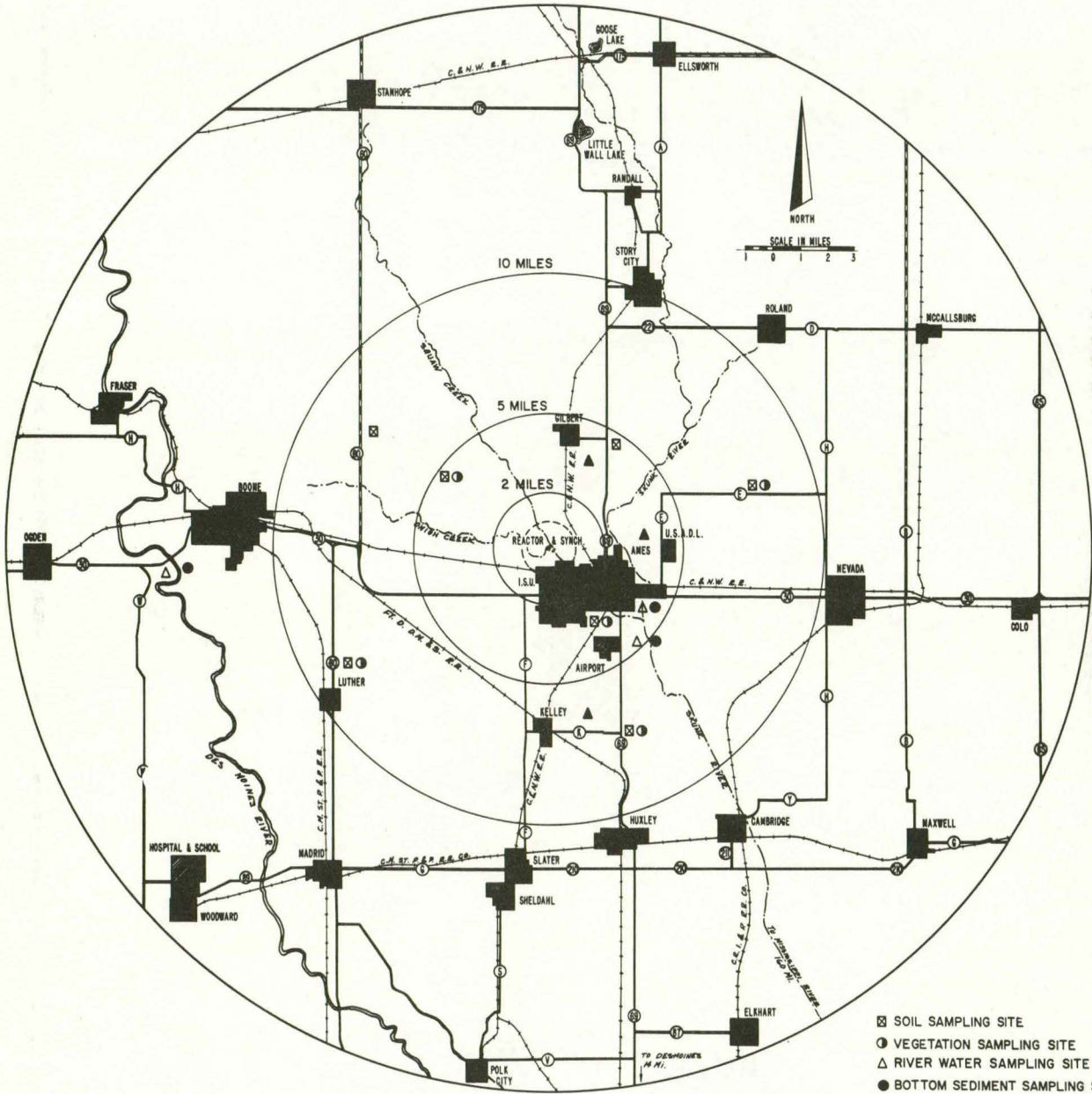


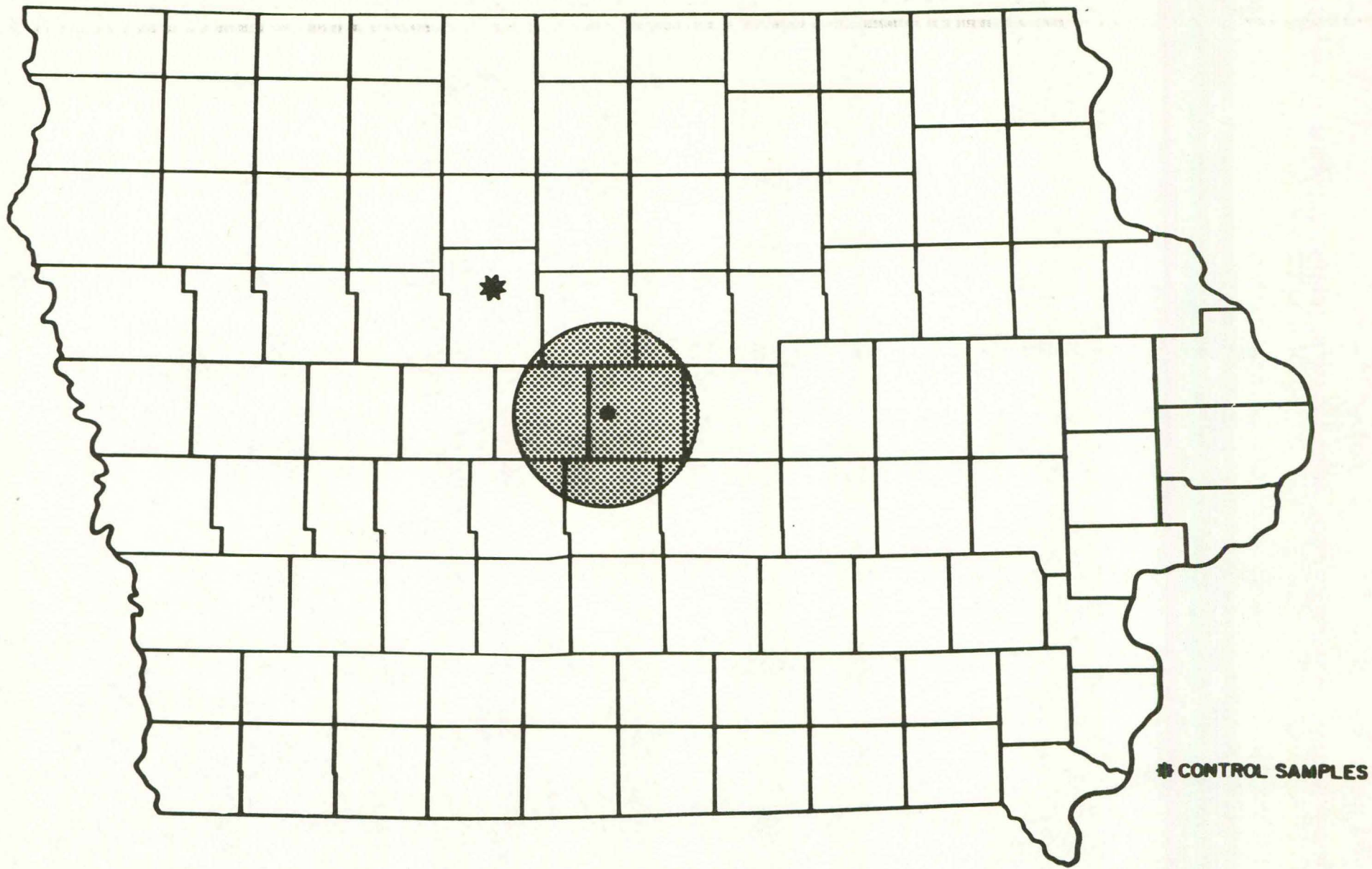
IV

MAPS



MAP 1





MAP 3

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City of Ames - Water Department - Sewage Treatment Department

City of Fort Dodge - Water Department

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