Pu Plant Laboratory Drain System

The laboratory drain system consisted of two seperate drain systems. The uranium laboratory room drain system was located in Room 140 and exited the building through the east wall and terminated in the 10,000 gallon collection tanks. This system consisted of approximately fifty two feet of two inch durcon pipe under the floor of Room 140. The Plutonium laboratory rooms drain system serviced most of the laboratory area and exited through the buildings north wall and terminated in the 10,000 gallon collection tanks. This system consisted of approximately 335 feet of two inch durcon pipe.

Since the uranium drainage system was contaminated to approximately 500 dpm/100 cm^2 smearable and was concentrated in one room we decided that it would be easier to remove this small system (Figure #1). This was accomplished by using a concrete saw to cut around the up risers, breaking out the concrete, and digging up the pipe. We performed a release survey on all concrete that was removed. All dirt was drummed as it was removed. All joints were inspected for leakage and surveyed for detectable contamination. After the pipe was removed each hole was surveyed with an Eberline PRM-5 with PG-2 gamma probe and soil samples were taken. Since no contamination problems were detected the dirt was then returned to the hole.

Our initial plan was to clean and survey the Pu drain system (figure #2 and #2A). To accomplish this, we saw the need to acquire some special detectors and to prove that this system was leak proof. We initially removed a portion of this system outside of the building between the building and the 10,000 gallon tanks and installed a sight glass riser on the pipe at the lower level outside of the building (Figure #3). We proceeded to fill the entire system under the building with water to the floor level and marked the water level in the sight glass riser.

The results of out initial leak test indicated a leak rate of approximately 0.5 gallons of water per minute in this remaining system. In an attempt to locate this leak we decided to remove the line from under rooms 141, 142, 143, 140, and 132 since we already had access under the floor in room 140. We also decided to cut a hole in the northwest corner of room 129 and to seperate the drain line there for our next leak test (figure #4).

Our second leak test consisted of the remaining drain system in the laboratory area only. We installed two standpipes, one in the northwest corner of room 129, and the other in room 132 northwest corner (Figure #4). After filling this portion of the drain system with water, we still indicated a leak rate of approximately 0.5 gallons per minute. Because of the results of this leak test we continued to remove Pu drain line until we found a wet area in room 135. This wet dirt was drummed seperately and labeled as possibly contaminted dirt (Figure #5.) As we continued to remove dirt at this location we found an elbow at approximately 6 feet below floor level with the back of the elbow broken out. Since there was only approximately 35 feet of this drain system left in the laboratory area, we decided to complete removal of this system from the laboratory area (Figure #6). Our third leak test consisted of the drain line from the northwest corner of room 129 to the north wall of the Pu bulding (Figure #7). After this portion of the system was filled with water and left 24 hours it indicated no leakage from this part of the system. This is a straight run of approximately 82 feet of two inch durcon pipe that runs through the exhaust ventilation tunnel and under the production hall thru room 127 (Figure #7). Initial smearable results indicated approximatley 1000 dpm/100 cm^2 smearable in this pipe. We used a rotating steel brush with a water flush to clean this pipe to less than 20 dpm/100 cm^2 smearable.

We built a cylindercial gas proporational alpha detector to pull through this line for our direct survey. Our initial survey indicated approximately 50% of our readings were still above 100 dpm/100 cm^2 and a maximium of 408 dpm/100 cm^2 (Figures #8A, B,C,). After recleaning the pipe with a brush hone our results were all less than 100 dpm/100 cm^2 direct and less than 20 dpm/100 cm^2 smearable (Figures #9A,B,C,D,E,F,G).

W.A. Rogers

W. A. Rogers

Pu-Plant Fab. Drain Survey

	DIRECT
TOTAL DPM	4986
# READINGS	533
AVG. DPM/100 cm²	9.35
MAX. READING	81
MDA DPM/100 cm²	13.66

Average smear was 1 DPM/100 cm²

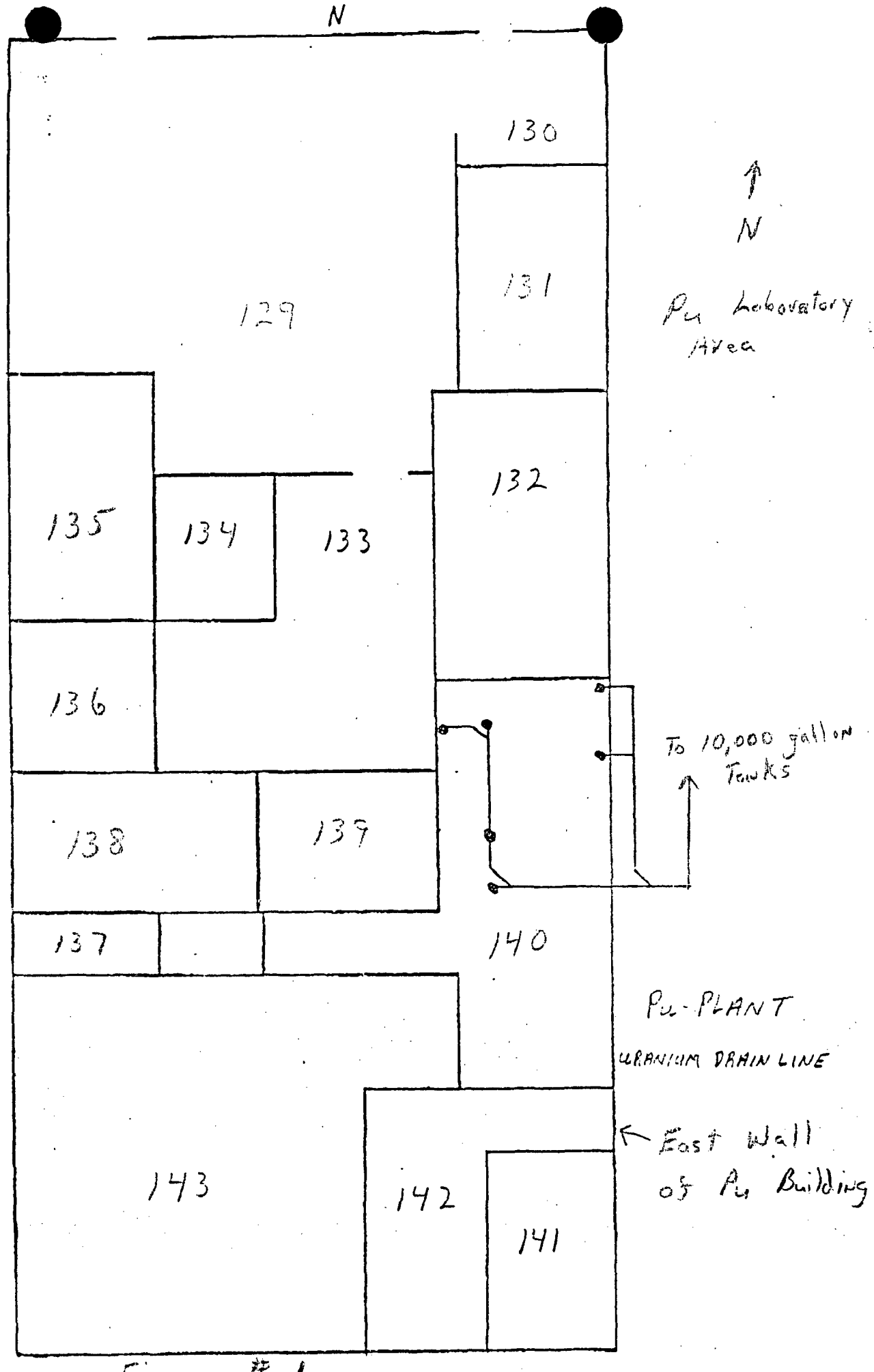

N
130
131
129
132
135
134
133
136
138
139
137
140
143
142
141
↑
N
Pu Laboratory Area
To 10,000 gallon Tanks
Pu-PLANT
URANIUM DRAIN LINE
East Wall of Pu Building

Figure # 1

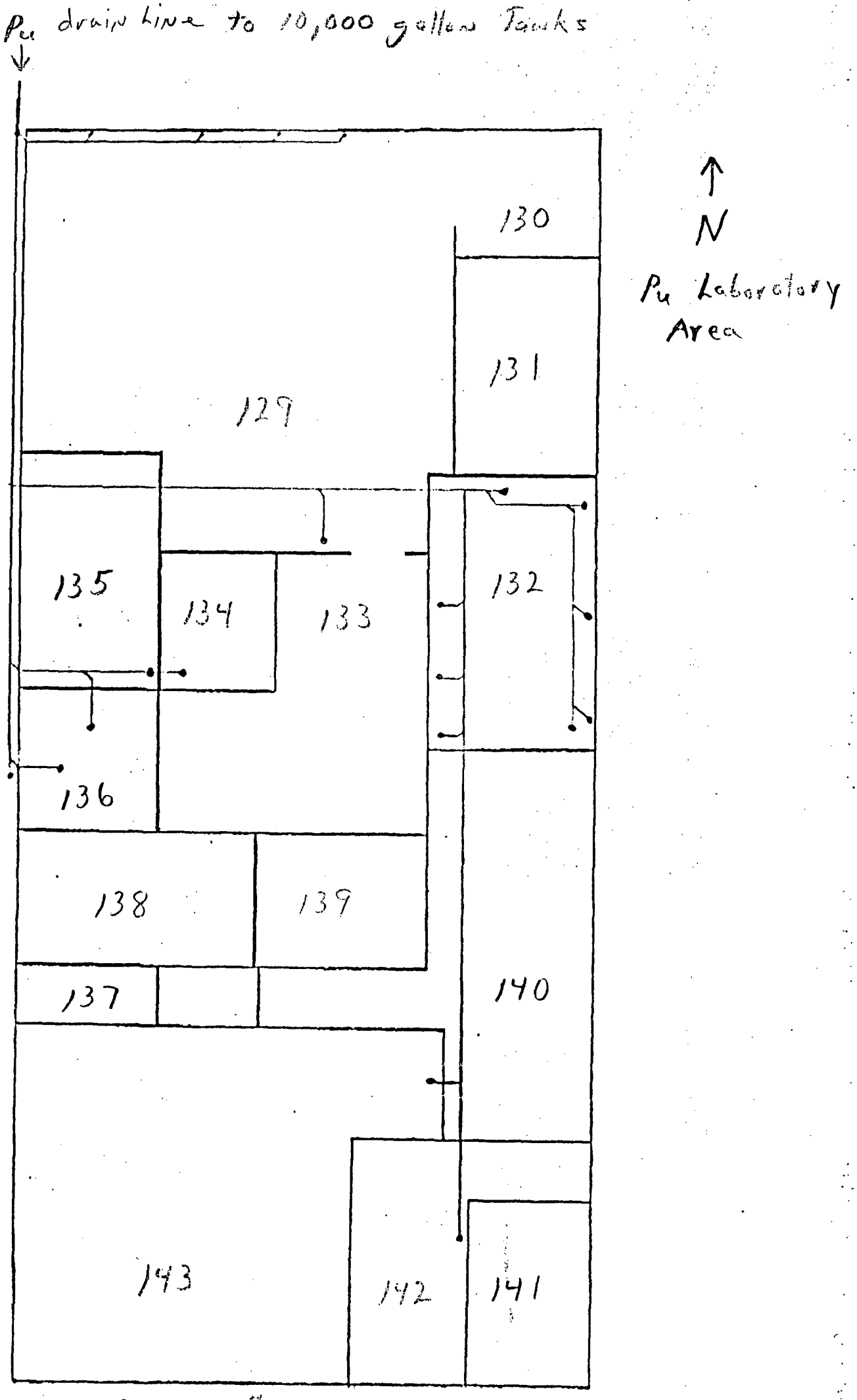
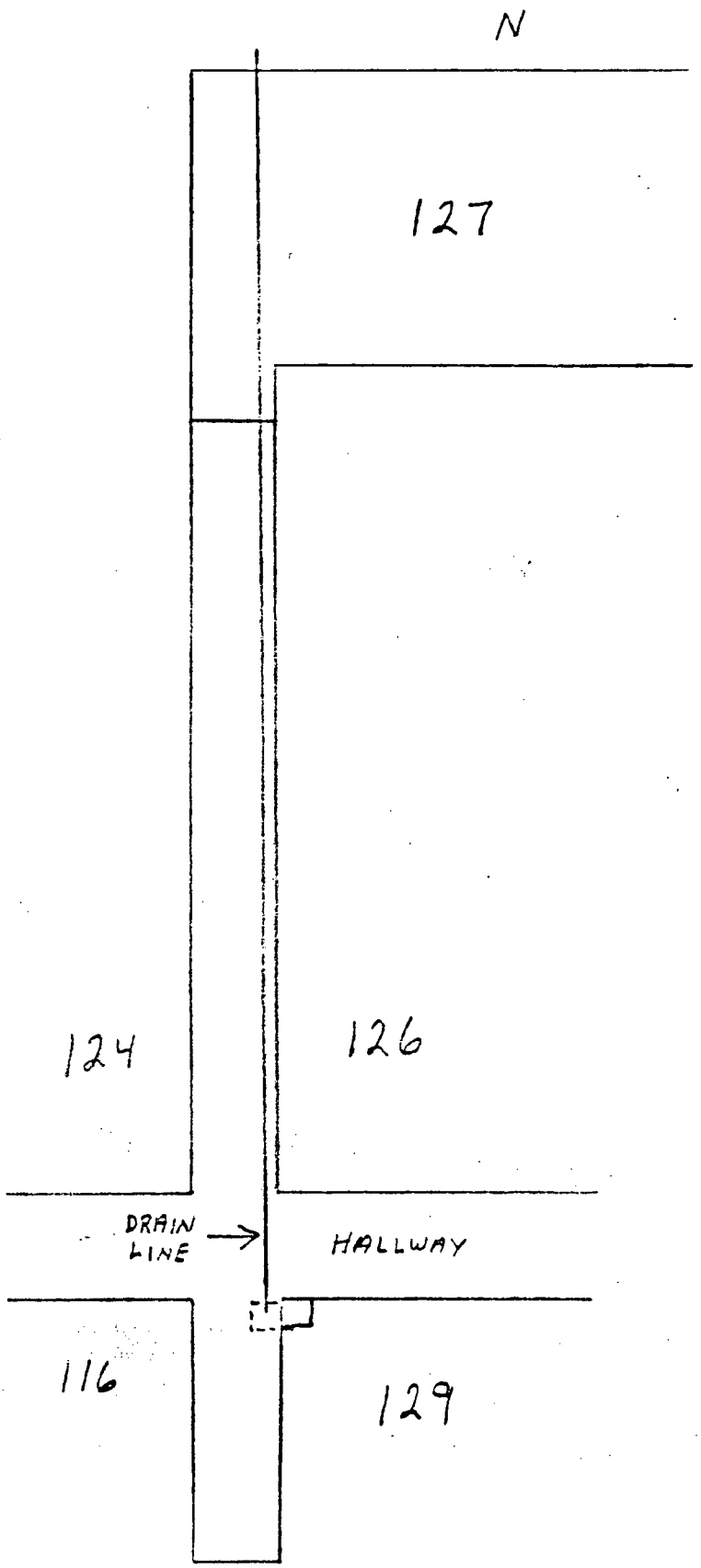

Pu drain line to 10,000 gallon Tanks
130
131
129
135
134
133
132
136
138
139
140
137
143
142
141
N
Pu Laboratory Area

Figure #2



Pu DRAIN LINE

Figure # 2A

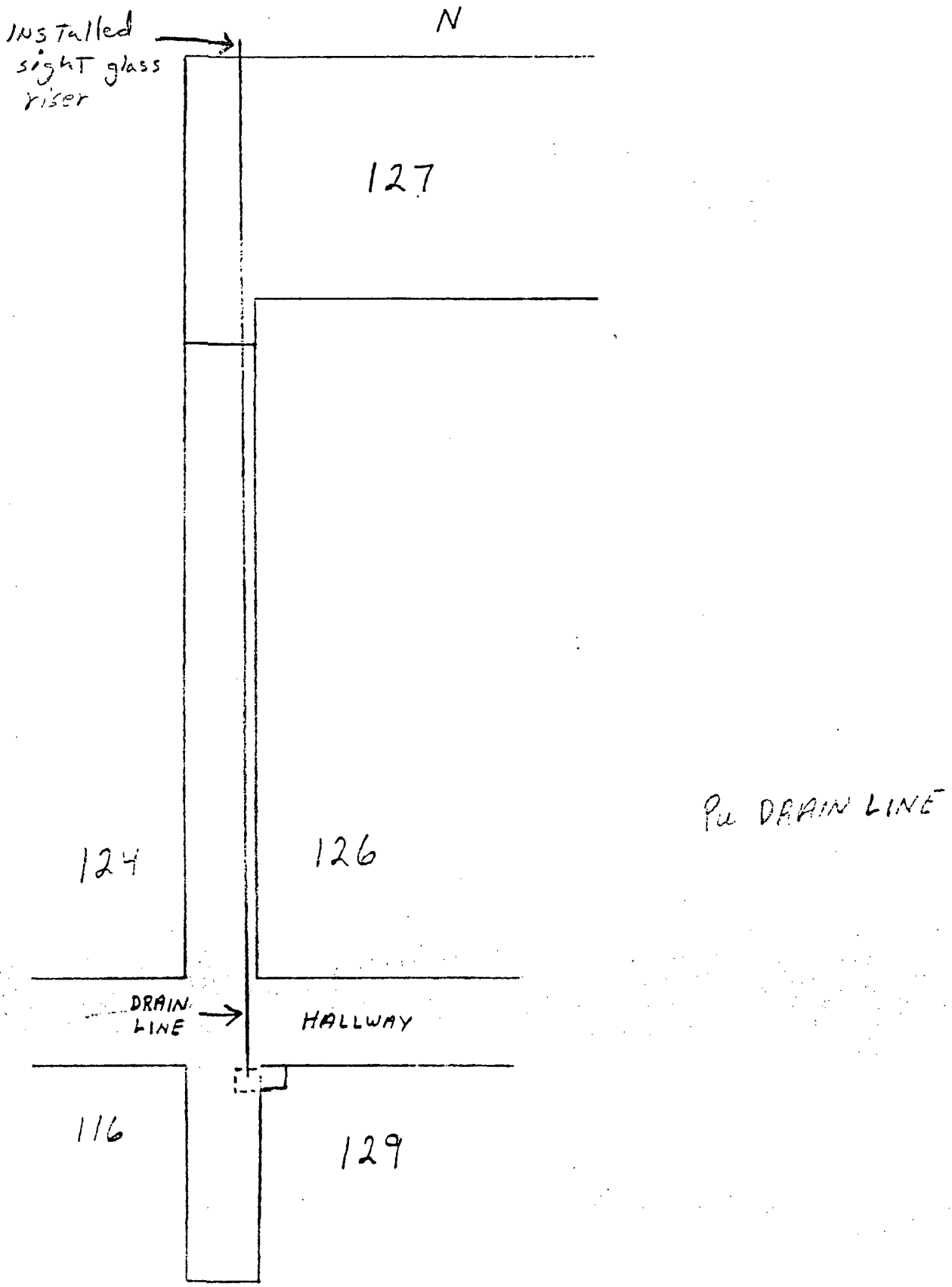

Installed sight glass riser
N
127
124
126
DRAIN LINE
HALLWAY
116
129
Pw DRAIN LINE

Figure # 3

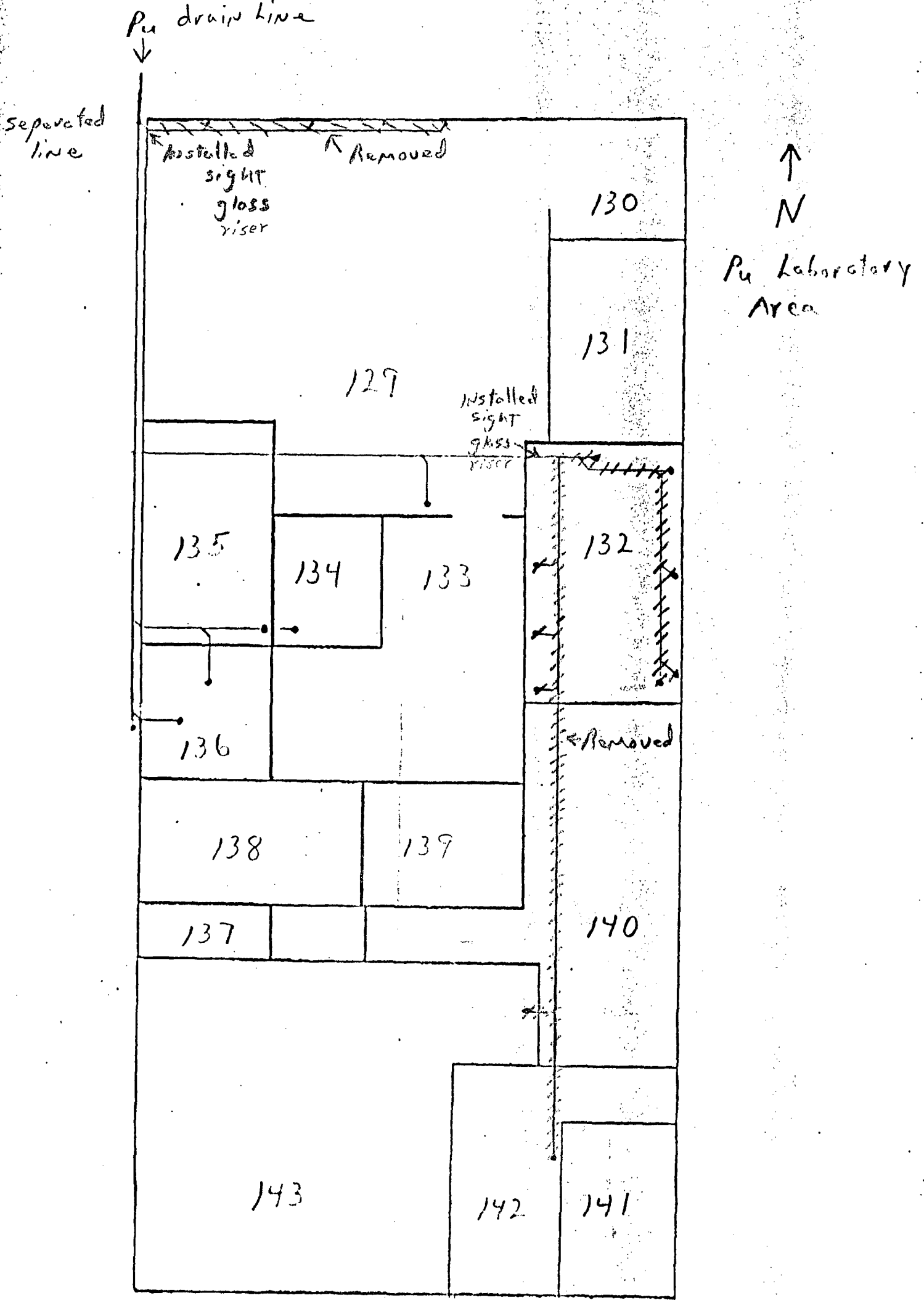

Pu drain line
separated line
Installed sight glass riser
Removed
130
131
127
Installed sight glass riser
135
134
133
132
136
Removed
138
139
137
140
143
142
141
N
Pu Laboratory Area

Figure # 4

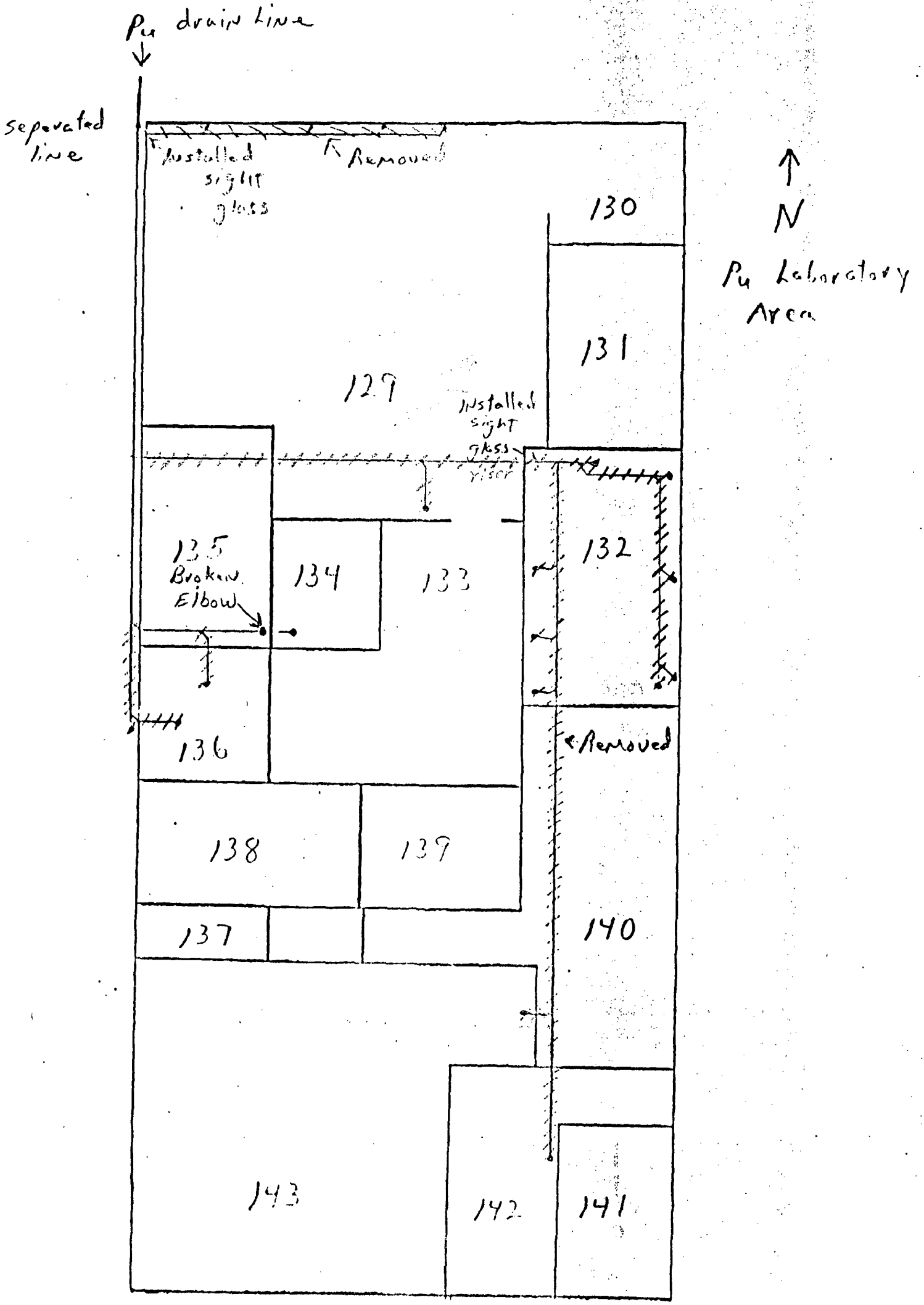

Pu drain line
separated line
Installed sight glass
Removed
130
131
129
Installed sight glass
visor
135
Broken Elbow
134
133
132
136
Removed
138
139
137
140
143
142
141
N
Pu Laboratory Area

Figure A 5

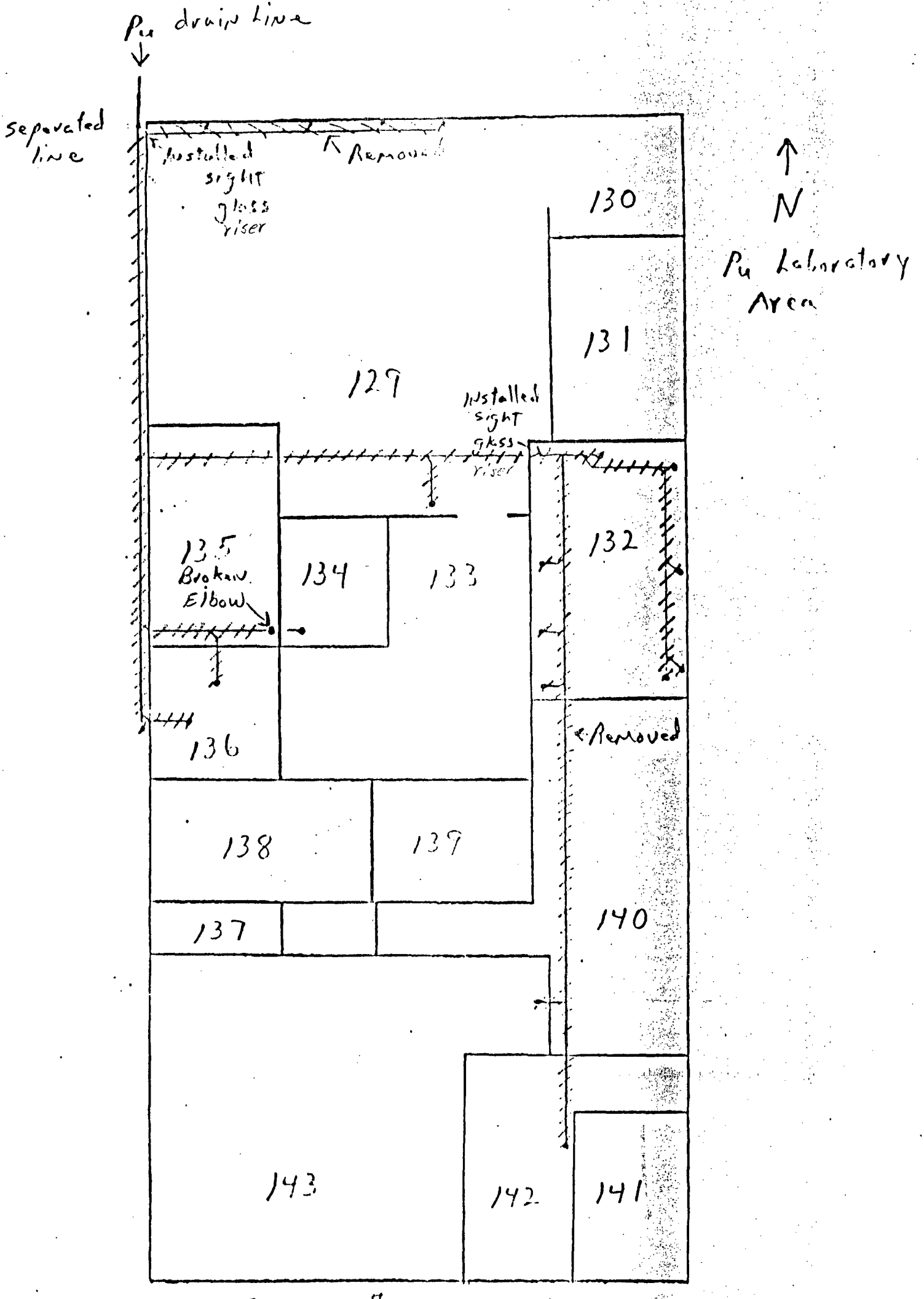

Pu drain line
separated line
Installed sight glass riser
Removed
130
131
127
Installed sight glass riser
N
Pu Laboratory Area
135
Broken Elbow
134
133
132
136
Removed
138
137
137
140
143
142
141

Figure # 6

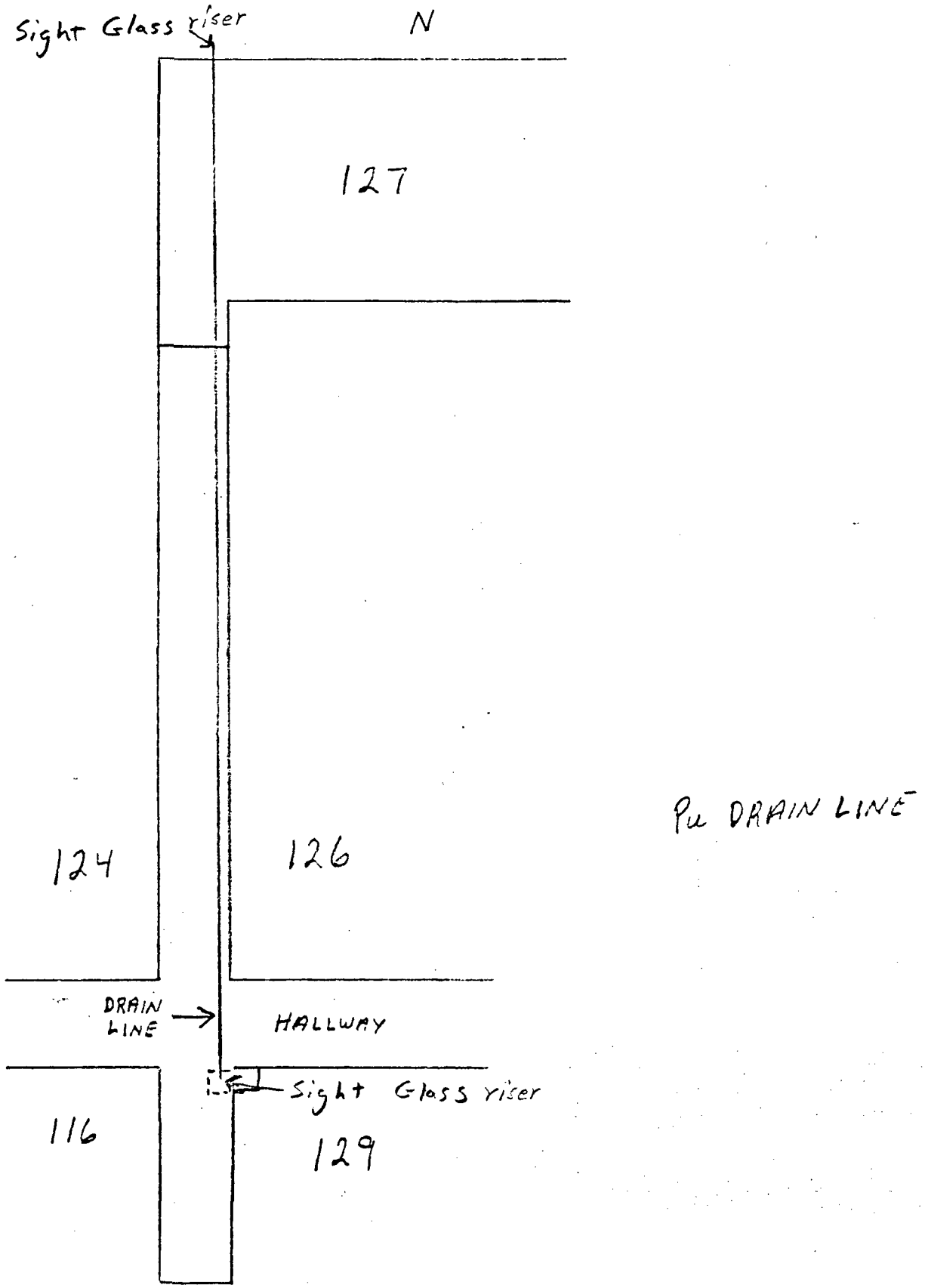
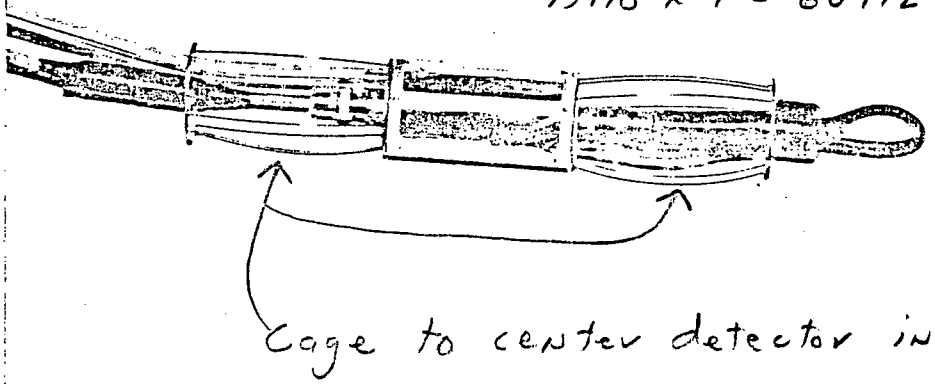

Sight Glass riser
N
127
124
126
DRAIN LINE
HALLWAY
Sight Glass riser
116
129
Pw DRAIN LINE

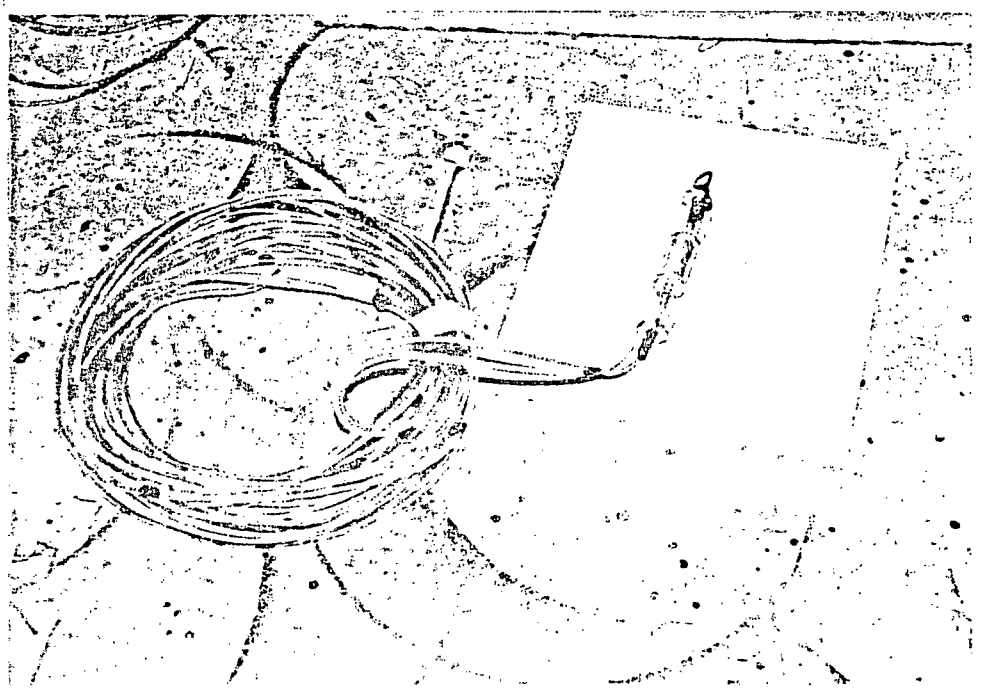
Figure # 7

2 inch Pipe Detector

Gas Proportional Detector
round cylinder with four windows
Each window = 6.6 cm X 2.3 cm = 15.18 cm^2
15.18 X 4 = 60.72 cm^2



Cage to center detector in pipe



Inside surface area of pipe = $2\pi rh$

$2 \times 3.1416 \times \frac{5.1\ cm}{2} \times 6.6\ cm = 105.75\ cm^2$

Calibrated detector to see 360° surface of pipe $105.75\ cm^2 \approx 100\ cm^2$

COUNTER TEST - CHI SQUARED (χ^2)

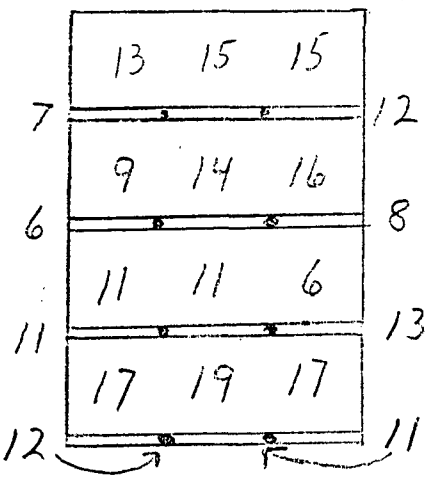
COUNTER #	DATE		VOLTAGE SETTING	STANDARD SOURCE NO
Ludlum 2500	8-17-88	W.A. Rogers	1750	1840

2" Pipe Detector	COUNT TIME - ONE MINUTE	HV-6.9	VALUE 100 dpm 4π

Bkg 0.3 cpm

COUNT NUMBER*	NET COUNT (n)	AVERAGE COUNT* ($\bar{n}$)	$(n-\bar{n})$	$(n-\bar{n})^2$
1	13	12	1	1
2	15		3	9
3	15		3	9
4	7		-5	25
5	12		0	0
6	9		-3	9
7	14		2	4
8	16		4	16
9	6		-6	36
10	8		-4	16
11	11		-1	1
12	11		-1	1
13	6		-6	36
14	11		-1	1
15	13		1	1
16	17		5	25
17	19		7	49
18	17		5	25
19	12		0	0
20	11		-1	1
21				
TOTAL OF 20 COUNTS (Σn)*	243		TOTAL ($\Sigma (n-\bar{n})^2$) *	265

Detector Source Position



CHI LIMIT
95% C.L.
.4453 - 1.6464

$\bar{X} + \sigma = 19$

$\bar{X} = 12$

$\bar{X} - \sigma = 5$

* DISCARD ONE UNUSUALLY HIGH OR LOW COUNT IN CALCULATING $\bar{n}$.

$\bar{X} = \frac{\Sigma X}{N} = \frac{(243)}{20} = 12.15$

TOTAL (1) ΣX = 243

TOTAL (2) $\Sigma (x - \bar{x})^2$ = 265

$CHI^2 = \frac{\Sigma (x - \bar{x})^2}{\Sigma X} = \frac{(265)}{(243)} = 1.0905$

$\text{COUNTER EFFICIENCY} = \frac{\text{AVERAGE COUNT CPM}}{\text{SOURCE VALUE (dpm)}} = \frac{(12.15)}{(100)} = 0.1215$

$2\sigma = 1.96 \sqrt{\bar{x}} = 1.96 \times 3.4857 = 6.832 = \pm 7$

cpm - bkg. X 9 = dpm/100 cm^2

Figure # 8A

2" Pipe Detector 1st count North end Date: 8-31-88 Initial Survey

Ludlum 2500 26465 H. P. W. G. Rogers

10 Min Bkg. = 0,9 cpm Source #1840 - 100 dpm 4π

Source Response = 16, 23, 7, 10, 9

Reading taken approx. every 2" detector face = 2 5/8" long

reading#	cpm-bkg	dpm/100cm^2	reading#	cpm-bkg	dpm/100cm^2	reading#	cpm-bkg	dpm/100cm^2
1	1	9	32	2	18	63	4	36
2	4	36	33	15	135	64	3	27
3	7	63	34	15	135	65	1	9
4	6	54	35	29	261	66	3	27
5	7	63	36	15	135	67	7	63
6	10	90	37	7	63	68	9	81
7	4	36	38	8	72	69	5	45
8	5	45	39	5	45	70	12	108
9	7	63	40	4	36	71	5	45
10	5	45	41	6	54	72	3	27
11	3	27	42	41	369	73	4	36
12	7	63	43	8	72	74	27	243
13	6	54	44	5	45	75	14	126
14	5	45	45	8	72	76	14	126
15	8	72	46	8	72	77	17	153
16	7	63	47	6	54	78	3	27
17	3	27	48	5	45	79	9	81
18	2	18	49	14	126	80	16	144
19	0	0	50	3	27	81	5	45
20	6	54	51	1	9	82	13	117
21	7	63	52	3	27	83	12	108
22	7	63	53	10	90	84	14	126
23	5	45	54	7	63	85	39	351
24	9	81	55	7	63	86	8	72
25	10	90	56	7	63	87	23	207
26	7	63	57	4	36	88	18	162
27	12	108	58	10	90	89	46	414
28	10	90	59	10	90	90	4	36
29	17	153	60	10	90	91	16	144
30	9	81	61	6	54	92	20	180
31	4	36	62	1	9	93	17	153

F... # 8B

2" Pipe Detector Page 2 Date: 8-31-88 Initial Survey

Ludlum 2500 26465 H. P. W.O. Rogers

10 Min Bkg. = 0.9 cpm Source #1840 - 100 dpm 4π

Source Response = 16, 23, 7, 10, 9

Reading taken approx. every 2" detector face = 2 5/8" long

reading#	cpm-bkg	dpm/100cm^2	reading#	cpm-bkg	dpm/100cm^2	reading#	cpm-bkg	dpm/100cm^2
94	21	189	107	32	288	120	32	288
95	33	297	108	27	243	121	21	189
96	11	99	109	40	360	122	17	153
97	27	243	110	21	189	123	12	108
98	32	288	111	51	459	124	14	126
99	10	90	112	26	234	125	17	153
100	13	117	113	8	72	126	9	91
101	21	189	114	15	135	127	17	153
102	18	162	115	19	171	128	15	135
103	14	126	116	23	207	129	37	333
104	16	144	117	17	153	130	11	99
105	15	135	118	21	189			
106	14	126	119	39	351			

Form #8C

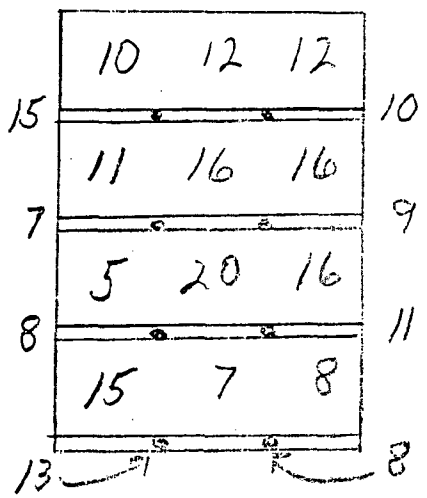
COUNTER TEST - CHI SQUARED (χ^2)

COUNTER #	DATE		VOLTAGE SETTING	STANDARD SOURCE NO
Ludlum 2500	10-24-88	W.A. Rosen	1750	1840

2" Pipe Detector	COUNT TIME - ONE MINUTE	HV-6.9	VALUE 100 dpm 4π

Background - 0.3 cpm

COUNT NUMBER*	NET COUNT (n)	AVERAGE COUNT* ($\bar{n}$)	$(n-\bar{n})$	$(n-\bar{n})^2$
1	10	11	-1	1
2	12		1	1
3	12		1	1
4	15		4	16
5	10		-1	1
6	11		-0	0
7	16		5	25
8	16		5	25
9	7		-4	16
10	9		-2	4
11	5		-6	36
12	20		9	81
13	16		5	25
14	8		-3	9
15	11		0	0
16	15		4	16
17	7		-4	16
18	8		-3	9
19	13		2	4
20	8		-3	9
21				
TOTAL OF 20 COUNTS (Σn)*	229		TOTAL ($\Sigma (n-\bar{n})^2$) =	295



χ^2 LIMIT
95% C.L.
.4453 - 1.6464

$\bar{X} + \sigma = 18$

$\bar{X} = 11$

$\bar{X} - \sigma = 4$

* DISCARD ONE UNUSUALLY HIGH OR LOW COUNT IN CALCULATING $\bar{n}$.

$\bar{X} = \frac{\Sigma X}{N} = \frac{(229)}{20} = 11.45$

TOTAL (1) ΣX = 229

TOTAL (2) $\Sigma (x - \bar{x})^2$ = 295

$\chi^2 = \frac{\Sigma (x - \bar{x})^2}{\Sigma X} = \frac{(295)}{(229)} = 1.2882$

COUNTER EFFICIENCY = $\frac{\text{AVERAGE COUNT CPM}}{\text{SOURCE VALUE (dpm)}} = \frac{(11.45)}{(100)} = .1145$

$2\sigma = 1.96 \sqrt{\bar{x}} = 1.96 \times 3.3838 = 6.63 = \pm 7$

Figure # 9A

2" Pipe Detector 1st count North end Date: 10-24-88 Final Survey

Ludlum 2500 26465 H. P. W.O. Rogers

10 Min Bkg. = 0.3 cpm Source #1840 - 100 dpm 4π

Source Response = 10, 12, 12, 11, 16

Reading taken approx. every 2" detector face = 2 5/8"

reading#	cpm-bkg	dpm/100cm^2	reading#	cpm-bkg	dpm/100cm^2	reading#	cpm-bkg	dpm/100cm^2
1	2	18	31	3	27	61	0	0
2	5	45	32	1	9	62	0	0
3	4	36	33	0	0	63	1	9
4	5	45	34	1	9	64	1	9
5	4	36	35	1	9	65	1	9
6	4	36	36	0	0	66	1	9
7	1	9	37	1	9	67	0	0
8	9	81	38	0	0	68	0	0
9	3	27	39	1	9	69	0	0
10	2	18	40	0	0	70	1	9
11	2	18	41	2	18	71	0	0
12	2	18	42	1	9	72	0	0
13	1	9	43	0	0	73	0	0
14	2	18	44	0	0	74	1	9
15	4	36	45	0	0	75	3	27
16	5	45	46	0	0	76	2	18
17	3	27	47	0	0	77	0	0
18	1	9	48	0	0	78	0	0
19	4	36	49	1	9	79	2	18
20	4	36	50	0	0	80	0	0
21	0	0	51	1	9	81	0	0
22	2	18	52	1	9	82	0	0
23	5	45	53	1	9	83	0	0
24	2	18	54	1	9	84	6	54
25	4	36	55	0	0	85	0	0
26	2	18	56	1	9	86	1	9
27	1	9	57	0	0	87	0	0
28	2	18	58	1	9	88	1	9
29	6	54	59	0	0	89	0	0
30	3	27	60	1	9	90	1	9

Form #9B

2" Pipe Detector Page 2 Date: 10-24-88

Ludlum 2500 26465 H. P. W. A. Rogers

10 Min Bkg. = 0.3 cpm Source #1840 - 100 dpm 4π

Source Response = 10, 12, 12, 11, 16

Reading taken approx. every 2" detector face = 2 5/8"

reading#	cpm-bkg	dpm/100cm^2	reading#	cpm-bkg	dpm/100cm^2	reading#	cpm-bkg	dpm/100cm^2
91	2	18	121	1	9	151	2	18
92	2	18	122	1	9	152	1	9
93	0	0	123	0	0	153	1	9
94	0	0	124	1	9	154	0	0
95	1	9	125	0	0	155	0	0
96	1	9	126	1	9	156	1	9
97	0	0	127	0	0	157	0	0
98	1	9	128	2	18	158	0	0
99	0	0	129	1	9	159	1	9
100	0	0	130	0	0	160	1	9
101	0	0	131	0	0	161	0	0
102	1	9	132	0	0	162	2	18
103	2	18	133	1	9	163	1	9
104	0	0	134	0	0	164	1	9
105	2	18	135	2	18	165	1	9
106	1	9	136	0	0	166	2	18
107	0	0	137	1	9	167	1	9
108	0	0	138	0	0	168	0	0
109	0	0	139	2	18	169	2	18
110	1	9	140	4	36	170	0	0
111	1	9	141	3	27	171	1	9
112	0	0	142	2	18	172	2	18
113	0	0	143	3	27	173	3	27
114	1	9	144	0	0	174	0	0
115	0	0	145	1	9	175	2	18
116	1	9	146	0	0	176	1	9
117	1	9	147	0	0	177	1	9
118	0	0	148	0	0	178	0	0
119	1	9	149	0	0	179	0	0
120	1	9	150	0	0	180	1	9

Figure # 9 c

2" Pipe Detector Page 3 Date: 10-24-88

Ludlum 2500 26465 H. P. W. G. Argue

10 Min Bkg. = 0.3 cpm Source #1840 - 100 dpm 4π

Source Response = 10, 12, 12, 11, 16

Reading taken approx. every 2" detector face = 2 5/8"

reading#	cpm-bkg	dpm/100cm^2	reading#	cpm-bkg	dpm/100cm^2	reading#	cpm-bkg	dpm/100cm^2
181	0	0	211	1	9	241	1	9
182	1	9	212	1	9	242	7	63
183	1	9	213	3	27	243	0	0
184	0	0	214	1	9	244	1	9
185	0	0	215	0	0	245	0	0
186	0	0	216	1	9	246	0	0
187	1	9	217	2	18	247	0	0
188	1	9	218	1	9	248	0	0
189	2	18	219	2	18	249	1	9
190	0	0	220	0	0	250	1	9
191	1	9	221	0	0	251	1	9
192	1	9	222	2	18	252	2	18
193	0	0	223	2	18	253	1	9
194	0	0	224	2	18	254	1	9
195	2	18	225	1	9	255	1	9
196	2	18	226	0	0	256	0	0
197	0	0	227	1	9	257	0	0
198	1	9	228	0	0	258	0	0
199	0	0	229	2	18	259	1	9
200	1	9	230	1	9	260	0	0
201	2	18	231	0	0	261	1	9
202	0	0	232	0	0	262	0	0
203	1	9	233	1	9	263	1	9
204	1	9	234	0	0	264	0	0
205	1	9	235	0	0	265	3	27
206	1	9	236	2	18	266	4	36
207	1	9	237	0	0	267	0	0
208	2	18	238	0	0	268	0	0
209	2	18	239	1	9	269	0	0
210	0	0	240	0	0	270	0	0

Figure # 9 D

2" Pipe Detector Page 4 Date: 10-24-88

Ludlum 2500 26465 H. P. W.G. Rogers

10 Min Bkg. = 0.3 cpm Source #1840 - 100 dpm 4π

Source Response = 10,12,12,11,16

Reading taken approx. every 2" detector face = 2 5/8"

reading#	cpm - bkg	dpm/100cm^2	reading#	cpm-bkg	dpm/100cm^2	reading#	cpm-bkg	dpm/100cm^2
271	0	0	301	2	18	331	0	0
272	0	0	302	0	0	332	2	18
273	0	0	303	0	0	333	0	0
274	0	0	304	0	0	334	2	18
275	0	0	305	1	9	335	0	0
276	0	0	306	0	0	336	1	9
277	0	0	307	0	0	337	1	9
278	2	18	308	1	9	338	0	0
279	1	9	309	0	0	339	0	0
280	0	0	310	1	9	340	0	0
281	3	27	311	0	0	341	0	0
282	0	0	312	2	18	342	0	0
283	1	9	313	1	9	343	2	18
284	0	0	314	0	0	344	0	0
285	0	0	315	0	0	345	1	9
286	2	18	316	0	0	346	0	0
287	1	9	317	0	0	347	0	0
288	1	9	318	1	9	348	0	0
289	2	18	319	1	9	349	1	9
290	2	18	320	0	0	350	4	36
291	0	0	321	0	0	351	0	0
292	0	0	322	1	9	352	1	9
293	0	0	323	0	0	353	2	18
294	0	0	324	1	9	354	0	0
295	0	0	325	0	0	355	0	0
296	3	27	326	0	0	356	0	0
297	0	0	327	2	18	357	2	18
298	2	18	328	0	0	358	1	9
299	2	18	329	0	0	359	2	18
300	1	9	330	1	9	360	1	9

Figure # 9E

2" Pipe Detector Page 5 Date: 10-24-88

Ludlum 2500 26465 H. P. W.C. Rogers

10 Min Bkg. = 0.3 cpm Source #1840 - 100 dpm 4π

Source Response = 10, 12, 12, 11, 16

Reading taken approx. every 2" detector face = 2 5/8"

reading#	cpm - bkg	dpm/100cm^2	reading#	cpm-bkg	dpm/100cm^2	reading#	cpm-bkg	dpm/100cm^2
361	0	0	391	0	0	421	3	27
362	1	9	392	2	18	422	3	27
363	2	18	393	0	0	423	1	9
364	0	0	394	2	18	424	4	36
365	1	9	395	1	9	425	4	36
366	0	0	396	2	18	426	4	36
367	0	0	397	2	18	427	0	0
368	0	0	398	4	36	428	0	0
369	2	18	399	4	36	429	2	18
370	1	9	400	0	0	430	2	18
371	0	0	401	2	18	431	0	0
372	2	18	402	1	9	432	3	27
373	0	0	403	0	0	433	3	27
374	1	9	404	3	27	434	3	27
375	1	9	405	1	9	435	1	9
376	1	9	406	1	9	436	0	0
377	2	18	407	0	0	437	1	9
378	1	9	408	2	18	438	0	0
379	2	18	409	0	0	439	1	9
380	0	0	410	0	0	440	4	36
381	2	18	411	2	18	441	2	18
382	0	0	412	0	0	442	0	0
383	4	36	413	1	9	443	1	9
384	2	18	414	0	0	444	1	9
385	1	9	415	2	18	445	4	36
386	0	0	416	2	18	446	4	36
387	2	18	417	2	18	447	0	0
388	0	0	418	4	36	448	3	27
389	1	9	419	3	27	449	3	27
390	1	9	420	1	9	450	2	18

Figure # 9 F

2" Pipe Detector Page 6 Date: 10-24-88

Ludlum 2500 26465 H. P. W.G. Rogers

10 Min Bkg. = 0.3 cpm Source #1840 - 100 dpm 4π

Source Response = 10, 12, 12, 11, 16

Reading taken approx. every 2" detector face = 2 5/8"

reading#	cpm-bkg	dpm/100cm^2	reading#	cpm-bkg	dpm/100cm^2	reading#	cpm-bkg	dpm/100cm^2
451	0	0	481	1	9	511	3	27
452	0	0	482	0	0	512	1	9
453	0	0	483	0	0	513	2	18
454	0	0	484	0	0	514	2	18
455	0	0	485	0	0	515	0	0
456	1	9	486	0	0	516	1	9
457	1	9	487	1	9	517	1	9
458	0	0	488	0	0	518	2	18
459	1	9	489	2	18	519	1	9
460	0	0	490	1	9	520	0	0
461	1	9	491	1	9	521	1	9
462	1	9	492	1	9	522	1	9
463	2	18	493	0	0	523	0	0
464	1	9	494	1	9	524	1	9
465	1	9	495	2	18	525	1	9
466	2	18	496	0	0	526	2	18
467	1	9	497	0	0	527	3	27
468	2	18	498	0	0	528	2	18
469	1	9	499	2	18	529	0	0
470	0	0	500	2	18	530	0	0
471	0	0	501	2	18	531	1	9
472	0	0	502	1	9	532	2	18
473	1	9	503	0	0	533	0	0
474	2	18	504	1	9	Background = 0.5		
475	0	0	505	1	9	Source Check		
476	1	9	506	1	9		11	
477	0	0	507	1	9		10	
478	0	0	508	1	9		16	
479	0	0	509	3	27		10	
480	1	9	510	0	0		13	
						After completion of		
Smearable results = 1 dpm/100 cm^2						Survey		

Figure # 9 G