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ARSENIC SURVEY OF YELLOWKNIFE BAY

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ARSENIC SURVEY OF YELLOWKNIFE BAY

SUMMARY

The concentration of dissolved arsenic in the water supplies of Con Mines, Giant Yellowknife Mines and the Town of Yellowknife has increased to alarming levels. For this reason, engineers from this office conducted a survey of the water in the bay to determine whether or not an arsenic-low water current exists that may be tapped as a source of domestic water.

This study revealed the presence of water currents containing low levels of dissolved arsenic. However, these arsenic concentrations are well above the recommended limit of 0.01 mg/l*. For this reason, a pipeline should be constructed to convey Yellowknife River water to Giant Yellowknife Mines Ltd. and the Town of Yellowknife. Water for drinking and culinary purposes for Con Mine Ltd. should be hauled from the Yellowknife Public Supply.

RECOMMENDATIONS

1. Adopt 0.01 mg/l arsenic as the recommended or acceptable limit of arsenic concentration in domestic water supplies.

2. Construct an underwater pipeline to supply Giant Yellowknife Mines Ltd. and the Town of Yellowknife with Yellowknife River water. The potable water supply to Con Mine Ltd. will be in portable containers delivered by truck.

3. Continue the study to determine methods of reducing both air and water pollution.

INTRODUCTION

The potable water supplies for the Town of Yellowknife, Giant Yellowknife Mines Ltd., Con Mines Ltd., and Indian Village are obtained from Yellowknife Bay. Analyses of water samples from these water supplies show the presence of excessive concentrations of dissolved arsenic.[1]

The physiological effects of arsenic have been discussed in a previous report.[2] This report shows that arsenic is carcinogenic and thus must not be allowed to exceed safe limits with respect to its concentration in domestic water supplies. This office suggests the permissable level of arsenic concentration in the water supplies be set at 0.01 ppm.[3]

* - mg/l - ppm

In order to determine if there was an arsenic-low water current in the bay, this department, with the co-operation of the Medical Services Directorate, Mackenzie District, instituted weekly sampling in Yellowknife Bay. The samples were taken from 11 locations within the bay. Samples were also taken at the Work Camp, Giant Yellowknife Mines Ltd., Con Mines Ltd., and the Town of Yellowknife. This sampling program is continuing during the summer.

During the latter part of April, two engineers from this office set up a sampling grid on and took water samples from Yellowknife Bay. The sampling grid extended from the mouth of the Yellowknife River to south of the Con Mine Ltd. water intake.

The field work was done by Messrs. R.N. Dawson and J.W. Slupsky.

This report was prepared by Messrs. J.W. Grainge and J.W. Slupsky.

WEEKLY SAMPLING

A weekly sampling program of Yellowknife Bay was organized by this office in January, 1967. This program consisted of taking water samples from the bay at the locations shown in Figure 1. Two samples were taken at each location, 4/5 and 1/5 depth. Water samples were also taken from the water intakes of Giant Yellowknife Mines Ltd., Con Mines Ltd., Town of Yellowknife, and the Work Camp.

The samples were analysed for arsenic concentration and the results are presented in Table 1.

The sampling was carried out by the Public Health Inspector, M.F. Gillis, Medical Services Directorate.

Depth samples were obtained using a standard B.O.D. sampler which was adapted for this purpose. However, during the latter part of April, it was noted that the sampler leaks around the cap. Thus all of the results for the Bay in Table 1, except April 26, should be used for their qualitation value only. The April 26 results were obtained using the April survey sampler.

APRIL SURVEY

During the period April 10 to 23 two engineers from this office set up a sampling grid on Yellowknife Bay extending from the mouth of the Yellowknife River to below the Con Mine

Ltd. water supply intake, as shown in Figure 2. This sampling grid consisted of 20 lines, numbered from north to south, one-quarter mile apart with a maximum of five sample point locations on each line. The grid was laid out, see Table 2, so that it could be re-established with an error limit of 20 feet for any one point. The number of samples taken at each location was varied according to the water depth, see Table 3, as follows:

Water Depth	Number of Samples	Sample Depth
greater than 12 feet	4	Top, 1/3, 2/3, bottom
4 to 12 feet	3	Top, middle, bottom
less than 4 feet	1	middle

The sampler, shown in Figure 3, was field fabricated. A test showed a water leak into it amounting to 10 ml in a 500 ml volume or 2%. This leak is the result of loosely placing the stopper on the sampler for easy removal underwater.

The samples were taken over a period of 4 days as follows:

April 20 - lines 20, 18, 16, 14, 12 (sample points 3 to 5 incl.), 10 (sample points 3 to 5 incl.), 8 and 6.

April 21 - lines 19, 17, 15, 13 (sample points 3 to 5 incl.), 12 (sample point 1), 11, 10 (sample points 1 and 2), 9 and 7.

April 22 - lines 5, 4, 2 and the Yellowknife River.

April 23 - samples 13 - 1 and 13 - 2.

Yellowknife River samples were taken just below and on the north side of the bridge. The sample point locations were as follows:

YR-1 - 30 ft. from west abutment (18 in. ice, 18 ft. water)
YR-2 - 70 ft. from west abutment (1 ft. ice, 14 ft. water)
YR-3 - 110 ft. from west abutment (1 ft. ice, 9 ft. water)

The samples were analysed for arsenic concentration and the results are presented in Table 4.

DISCUSSION

A report by Mr. J.W. Grainge dated December 23, 1963 showed that arsenic exhibits carcinogenic properties. His literature survey shows that in one case exposure to a drinking water equivalent of 3.1 mg/l arsenic over a

period of three weeks has caused cancer. One case of cancer was recorded as a result of exposure to a drinking water equivalent of 0.2 mg/l arsenic with the consumption of 700 grams of arsenic trioxide. As a result of this, we in this office concur with the adoption of the U.S. Public Health Drinking Water Standard, that the concentration of arsenic in drinking water should not exceed 0.01 mg/l. This will provide, to the best of our knowledge, an adequate safeguard with regards to this element. This level of arsenic concentration should be maintained at the allowable limit until such time when sufficient information is available to warrant a change.

The arsenic concentrations in the water supplies to the Town of Yellowknife, Giant Yellowknife Mines Ltd. and Con Mines Ltd. have varied from year to year as well as during the year. The most important part of these fluctuations is that the arsenic concentrations in these supplies are consistently very high during the months of May, June and July. An examination of this data shows that there is a trend towards these arsenic concentrations increasing in subsequent years.

Table 1 shows that during the period Feb. 13 to April 26, the arsenic concentration in the water in Yellowknife Bay at the various sample points varied, on the average, by a factor of 7 (average of max/min. for the points). These results also show that the arsenic concentration of the Yellowknife River water (analysis of Work Camp intake water) did not exceed 0.01 mg/l. The arsenic concentration of a few water samples from Yellowknife Bay, in the vicinity of the Indian Village, were on a few occasions below 0.01 mg/l.

An examination of Table 4 shows the arsenic concentration in the Yellowknife River is 0.011 mg/l or less and the arsenic concentration in the Bay varies from 0.020 to 0.294 mg/l, average arsenic concentration is 0.120 mg/l. Two analysis, namely 2.200 and 1.781 mg/l arsenic from samples 7-2-B and 8-2-B respectively are exceptionally high. This is due to contamination of these samples with bottom mud. The presence of arsenic in the Yellowknife River water may be attributed to the water passing over rock containing arsenic and/or arsenic fallout as a result of air pollution. The variation in arsenic concentration of the water in the Bay is due to incomplete mixing of Giant Tailings Pond effluent with incoming river water, flow channels and lack of vertical mixing. Evidence of these is shown by the following samples:

(a) Incomplete mixing - analysis of all samples on lines 2, 4 and 5.

(b) Flow Channels - analyses of samples from sample points 6-3, 6-5, 7-4, 7-5, 9-2, 9-3, 9-4, 10-2, 10-3, 11-3, 12-3, 12-4, 12-5, 13-3, 13-4, 14-4, 14-5, 15-3, 15-5, 17-2, 18-3, 18-4, 19-3, 19-4, and 20-1.

(c) Lack of vertical mixing - analysis of samples from sample points 16-5, 17-1, 17-4, 17-5, 18-3, 18-4, 19-1, 19-2.

At the present time Giant Yellowknife Mines Ltd. have converted part of their mill circuit for arsenic removal. This is the result of an applied research project carried out by Giant Yellowknife Mines Ltd. during early 1967.

Based on a bench-scale study, 2200 lb/day of quick lime (CaO) will reduce the amount of arsenic in solution leaving the mill from 237 lb/day to 36 lb/day (85% reduction). At $0.05/lb for quick lime delivered at the mine, this operation will cost $110 per day. This would reduce the average levels of arsenic in the drinking water by 0.07 to 0.02 mg/l.

The most economical route for a pipeline to supply Yellowknife River water to Giant Yellowknife Mines Ltd., Con Mines Ltd. and the Town of Yellowknife is an underwater pipeline. This would supply the Town of Yellowknife at peak demand with 700 USgpm of water (three times average consumption). The estimated cost of this pipeline would be $330,000. See appendix. Giant Yellowknife Mines Ltd. could construct a branch line from this main line to their water works to supply domestic water only. In the case of Con Mines Ltd., the resident population is small, so that it should be serviced by a truck hauling portable water containers of river water that would be used for drinking and culinary purposes only.

CONCLUSIONS

1. During recent years the arsenic concentration in Yellowknife Bay water has increased to levels which render the water unsuitable for human consumption.

2. The concentration of dissolved arsenic in drinking water should be less than 0.01 mg/l because of the carcinogenic nature of ingested arsenic.

3. During winter there are no locations within Yellowknife Bay where the arsenic concentration is less than 0.01 mg/l. which is reasonably accessible to the intakes of the water supplies. In fact, the arsenic concentration in the water samples taken from the three water supply intakes is generally less than the arsenic concentrations at most points in the bay, except those across the bay from Con Mine Ltd.

4. The source of most of the arsenic in the water in Yellowknife Bay is the Giant Yellowknife Mines Ltd. tailings pond effluent.

5. A secondary but very significant source of arsenic is contained in run-off water. This is the result of stack emissions which settle on the ground in the vicinity of Con Mine Ltd. and Giant Yellowknife Mines Ltd. Baker Creek is the principal stream which affects the pollution in Yellowknife Bay.

6. Diverting the Giant Yellowknife Mines Ltd. tailings pond effluent to Baker Creek will reduce the arsenic concentration in the water at the mouth of the Yellowknife River to that of the river which is generally less than 0.01 ppm.

7. It is possible to improve the treatment of stack wastes and tailings to reduce the arsenic concentration in the bay to less than 0.05 ppm. However, it is not economically feasible to reduce the concentration of arsenic in the water in the bay to less than 0.01 mg/l.

8. The most economical method of supplying Yellowknife River water is to use an underwater pipeline.

An alternative route for the pipeline would be overland, past the townsite of Giant Yellowknife Mines Ltd.

9. A tap could be made to this pipeline to supply domestic water to Giant Yellowknife Mines Ltd.

10. The pipeline should be large enough to accommodate the highest instantaneous domestic demand anticipated. However, fire demands could be met by injecting Yellowknife Bay water into the system. This use of bay water (water containing more than 0.01 ppm arsenic) is acceptable as a minimal amount of it would be injested and, in these cases, would not be physiologically significant.

11. It would be feasible to supply the small number of people living at Con Mine Ltd. with acceptable water in portable containers.

J.W. Grainge

J.W. Grainge, P. Eng.
Regional Engineer

BIBLIOGRAPHY

1. Dawson, R.N. "Arsenic Concentrations in Water Supplies, Yellowknife, N.W.T." December 9, 1966.

2. Grainge, J.W. "Water Pollution, Yellowknife Bay, N.W.T." December 23, 1963.

3. Drinking Water Standards - 1962, Public Health Service Publication No. 956.

APPENDIX

Comparison of estimated costs of two pipelines to supply Yellowknife River water to the Town of Yellowknife, Giant Yellowknife Mines Ltd. and Con Mine Ltd. - by haulage.

Basis:
1. The water works remain at their present location.
2. The system is designed to supply a peak flow of 700 USgpm (3 times average use in Yellowknife).
3. Fire water requirements will be met by using Yellowknife Bay water.
4. Pipe insulation is 1" thick Polyurethane + 28 ml Polyethylene cover.

66 ft?

	Routes	
	Overland	Underwater
Estimated distance	5 1/2 mi	4 1/2 mi
Estimated pipeline pressure drop	90 psi.	16 ft water
Design pipe size	10"	16"
Estimated costs -		
Pipe	$145,200 ($5/ft)	$190,000 ($8/ft)
Insulation	$111,800 ($3.82/ft)	
Freight -		
Pipe ($3.78/100#)	$ 44,400	$ 56,200
Insulation ($6.33/100#)	$ 882	
Labor -		
Installation and welding	$ 46,464	$ 76,032
Insulation	$ 882	
Pipe bed preparation	$ 20,000	
Pumphouse installation	$ 17,000	
TOTAL CAPITAL COST	$386,628	$322,232

The overland route has the following estimated daily operating costs.

Pumping - Electricity	$26.64
Heating	$19.16
1 man 8 hr/day at $2.50/hr	$20.00
TOTAL	$65.80

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N.B. The heating cost in that heat/required in the water to prevent it freezing while travelling the 5 1/2 miles. This cost, although occurring only during the heating season is shown as being spread throughout the whole year.

TABLE 1. RESULTS OF ARSENIC CONCENTRATIONS, WEEKLY SAMPLES

YELLOWKNIFE BAY. FEB. 13 TO APRIL 26, 1967

ARSENIC CONCENTRATIONS - mg/l

SAMPLING BY M.F. GILLIS, PUBLIC HEALTH INSPECTOR, MEDICAL SERVICES DIRECTORATE

Sample Date -	Feb.13	Feb.16	Feb.22	Feb.28	Mar.6	Mar.13	Mar.20	Apr.3	Apr.10		Apr.26*
Sample Point											
A-1		0.006	0.060	0.018	0.011	0.012	0.017	0.023	0.027	0.023	
A-2		0.006	0.130	0.032	0.015	0.175	0.018	0.025	0.029	0.036	0.006
B-1	0.004	0.006	0.050	0.010	0.011	0.025	0.018	0.023	0.028	0.023	
B-2	0.004	0.018	0.010	0.030	0.026	0.031	0.028	0.036	0.033	0.036	
C-1	0.008	0.006	0.060	0.011	0.023	0.032	0.035	0.029	0.029	0.034	
C-2	0.007	0.020	0.025	0.044	0.028	0.058	0.019	0.057	0.044	0.028	0.006
D-1	0.033	0.040	0.040	0.050	0.058	0.080	0.054	0.070	0.082	0.078	0.026
D-2	0.025	0.030	0.029	0.068	0.120	0.166	0.066	0.108	0.118	0.114	0.080
E-1	0.027	0.031	0.040	0.060	0.056	0.066	0.056	0.086	0.084	0.080	0.026
E-2	0.035	0.038	0.044	0.076	0.070	0.142	0.087	0.128	0.114	0.090	
F-1	0.022	0.032	0.074	0.062	0.060	0.046	0.056	0.068	0.088	0.084	0.056
F-2	0.015	0.099	0.045	0.075	0.084	0.146	0.100	0.114	0.106	0.150	0.122
G-1	0.046	0.585	0.044	0.074	0.064	0.090	0.100	0.115	0.120	0.118	0.070
G-2	0.025	0.056	0.052	0.072	0.076	0.144	0.110	0.118	0.118	0.146	0.104
H-1	0.028	0.064	0.050	0.085	0.106	0.139	0.070	0.112	0.116	0.092	
H-2	0.018	0.017	0.078	0.075	0.130	0.160	0.095	0.122	0.114	0.110	
I-1	0.104	0.161	0.142	0.093	0.112	0.180	0.091	0.128	0.154		
I-2	0.029	0.064	0.080	0.110	0.134	0.120	0.092	0.118	0.086		
J-1	0.100	0.087	0.135	0.160	0.170	0.175	0.101	0.136	0.152	0.136	
J-2	0.060	0.064	0.072	0.120	0.155	0.144	0.097	0.124	0.106	0.140	
K	0.107	0.056	0.060	0.038	0.058	0.050	0.058	0.056	0.074	0.098	
Work Camp		0.004	0.006	0.010	0.009	0.005	<0.001	<0.001	0.006	0.001	N.D.**
Con Tap	0.034	0.040	0.038	0.062	0.114	0.036	0.124	0.144	0.136		0.122
Giant Tap	0.050	0.050	0.150	0.162	0.220	0.180	0.120	0.166	0.158	0.154	0.128
Town Tap	0.050	0.008	0.043	0.086	0.030	0.034	0.026	0.023		0.120	0.016
Indian Village				0.042		0.032	0.170	0.120		0.140	0.120

* - Used April Survey Samples.

** - None Detected.

TABLE 2. LOCATION OF SAMPLE POINTS, APRIL SURVEY, YELLOWKNIFE BAY

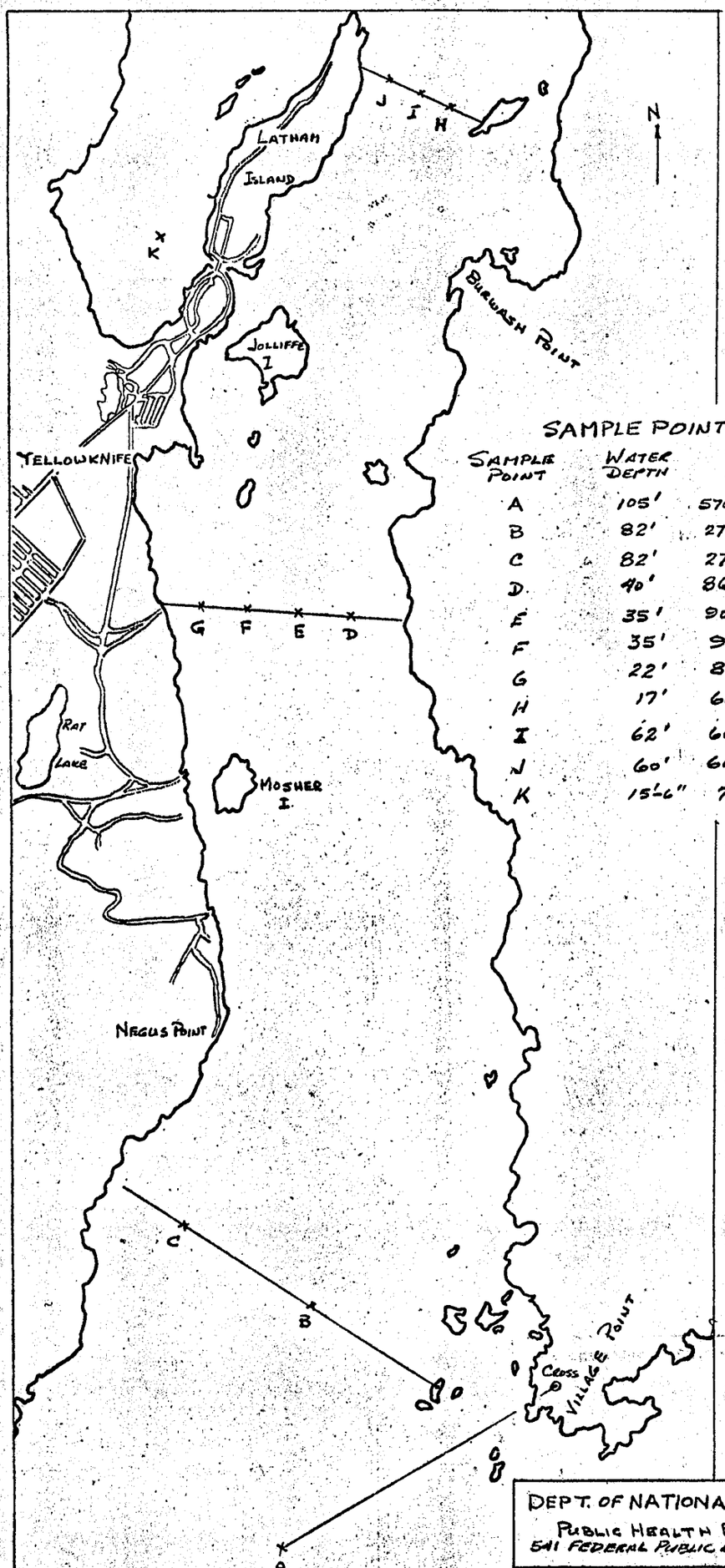
Grid Line	Sample Point (Distance from West Shore) - See Fig. No. 2																			
	1				2				3				4				5			
	Dist. in 100 Ft.	Ice Ft.	Ice & Water Ft.	Water Ft.	Dist. in 100 Ft.	Ice Ft.	Ice & Water Ft.	Water Ft.	Dist. in 100 Ft.	Ice Ft.	Ice & Water Ft.	Water Ft.	Dist. in 100 Ft.	Ice Ft.	Ice & Water Ft.	Water Ft.	Dist. in 100 Ft.	Ice Ft.	Ice & Water Ft.	Water Ft.
1	8.5				8.5				8.5											
2	10	3	4	1	10	3	5	2	10	3	4	1	10	3	10	7				
3	10.5				10.5				10.5				10.5							
4	10	4	29	25	10	4	20	16	10	4	7	3	10	4	13	9	10	4	10	6
5	12.1	4	25	21	12.1	4	12	8	12.1	4	5	1	12.1	4	29	25	12.1	4	15	11
6	1				16.4	3	34	31	16.4	3	31	28	16.4	3	33	30	5	3	35	32
7	1	3	14	11	15.8	3	45	42	15.8	3	34	31	15.8	3	39	36	15.8	3	26	23
8	1	3	15	12	15.8	3	42	39	15.8	3	19	16	15.8	3	33	30	15.8	3	15	12
9	1	3	18	15	10.5	3	36	33	9	3	51	48	9	3	25	22	9	Mud		
10	8.5	3	28	25	8.5	3	15	12	9	3	61	58	11	3	16	13	10	3	4	1
11	8.5	3	22	19	8.5	3	18	15	13.2	3	60	57	13.2	3	24	21	13.2	3	6	3
12	7.9	3	10	7	1	Near Runway			10	3	41	38	10	3	54	51	10	3	47	44
13	2.0	3	9	6	4	3	8	5	7.4	3	51	48	7.4	3	60	57	7.4	3	4	1
14	1	2	2	0	6.3	3	11	8	7.4	3	21	18	7.4	3	35	32	7.4	3	66	63
15	7.9	3	5	2	6.9	3	27	24	6.9	3	35	32	6.9	3	39	36	6.9	3	41	38
16	1	3	5	2	9.0	3	24	21	9	3	30	27	9	3	48	45	9	3	36	33
17	1	3	20	17	8.5	3	24	21	8.5	3	18	15	8.5	3	17	14	8.5	3	13	10
18	1	3	17	14	8.5	Water on Ice			8.5	3	34	31	8.5	3	30	27	8.5	3	35	32
19	1	3	26	23	11.1	3	25	22	11.1	3	37	34	11.1	3	54	51	11.1	3	19	16
20	1	3	42	39	11.1	3	31	28	11.1	3	74	71	11.1	3	57	54	11.1	3	11	8

TABLE 2 ARSENIC CONCENTRATION IN SAMPLES - APRIL SURVEY

Note: Results Reported as Follows: Sample Depth - Ft.
Analysis mg/l - As.

SAMPLING BY: R.N. DAWSON, ENGINEER AND J.W. SLUPSKY, ENGINEER, PUBLIC HEALTH ENG. DIV.

Grid Line	SAMPLE (Locations - See Table No. 2 and Fig. No. 2)																									
	1					2					3					4					5				
	Top	1/3	1/2	2/3	Bottom	Top	1/3	1/2	2/3	Bottom	Top	1/3	1/2	2/3	Bottom	Top	1/3	1/2	2/3	Bottom	Top	1/3	1/2	2/3	Bottom
Y.R.		6 .003		12 .011			6 .006		10 .014			2 .003		6 .003											
1																									
2			5 .157		1			1 .169		2			5 .174		1	1 .183		4 .157		7 .169					
3																									
4	1 .122	8 .157		16 .154	25 .202	1 .151	5 .137		15 .144	17 .170	1 .197				3	1 .177		4 .234		9 .231	1 .149		3 .143		6 .134
5	1 .223	7 .257		16 .235	21 .211	1 .196		4 .206		9 .260			5 .174		1	1 .231	8 .206		16 .122	25 .183	1 .186		5 .194		11 .174
6						1 .211	10 .231		20 .262	31 .294	1 .137	9 .166			18 .083	28 .115	1 .117	10 .123		20 .100	30 .077	1 .143	11 .114		27 .086	37 .129
7	1 .060		5 .160		11 .137	1 .174	14 .137		26 .120	42 .220	1 .143	10 .163			20 .106	31 .169	1 .137	12 .183		24 .094	36 .114	1 .146	8 .157		16 .043	23 .094
8	1 .129		6 .166		12 .217	1 .146	13 .151		26 .114	39 1.29	1 .106	5 .129			10 .143	16 .186	1 .172	10 .129		20 .103	30 .100	1 .160		6 .126		12 .143
9	1 .126	5 .060		10 .120	15 .071	1 .142	11 .166		20 .109	32 .031	1 .143	15 .089			22 .063	48 .200	1 .140	7 .163		14 .060	22 .049	Mud				
10	1 .126	8 .054		18 .143	25 .083	1 .061		6 .146		12 .163	1 .120	13 .069			38 .114	58 .169	1 .140	4 .140		8 .106	12 .094					1 .131
11	1 .057	5 .034		10 .049	15 .062	1 .128	5 .097		10 .111	15 .057	1 .149	12 .074			38 .146	57 .186	1 .136	7 .131		14 .103	21 .160			1.5 .143		3
12	1 .105		3 .128		7 .131	Road Runway					1 .117	13 .149			26 .050	39 .105	1 .120	17 .053		34 .160	51 .120	1 .123	15 .074		30 .071	44 .103
13	1 .154				3 .129	1 .126		3 .129		5 .137	1 .146	16 .086			32 .080	48 .149	1 .140	9 .066		38 .069	57 .134			.5 .131		1
14	No Water					1 .140		4 .131		8 .131	1 .129	6 .140			12 .131	18 .089	1 .131	11 .034		22 .069	32 .086	1 .163	21 .046		42 .103	63 .103
15			1 .143		2	1 .157	8 .137		16 .100	24 .094	1 .131	11 .137			22 .071	32 .083	1 .140	12 .126		24 .040	36 .174	1 .117	13 .074		26 .043	38 .083
16					2 .134	1 .146	7 .126		14 .094	21 .094	1 .117	9 .134			18 .069	27 .046	1 .114	15 .080		30 .046	45 .066	1 .054	11 .086		22 .049	33 .034
17	1 .149	8 .154		12 .100	17 .080	1 .149	7 .103		14 .089	21 .126	1 .126	5 .140			10 .146	15 .030	1 .137	5 .143		10 .086	14 .048	1 .137		5 .121		10 .069
18	1 .131	5 .134		10 .131	16 .143	Water on Ice					1 .146	10 .106			20 .029	31 .031	1 .129	8 .123		18 .026	27 .031	1 .143	11 .056		22 .026	32 .040
19	1 .083	8 .137		16 .043	23 .031	1 .146	7 .140		18 .109	22 .020	1 .151	11 .057			22 .026	34 .026	1 .143	17 .020		24 .031	51 .026	1 .123	5 .143		10 .069	16 .031
20	1 .163	13 .074		26 .029	39 .083	1 .149	9 .129		12 .049	22 .031	1 .169	24 .023			48 .023	71 .114	1 .163	18 .026		36 .026	54 .026	1 .174		4 .163		8 .094



SAMPLE POINT DATA

Sample Point	Water Depth	Location
A	105'	5700' from Cross
B	82'	2700' from Lobstick I. Marker
C	82'	2700' from B
D	40'	865' from East Shore
E	35'	900' from D
F	35'	900' from E
G	22'	800' from F
H	17'	600' from I
I	62'	600' from J
J	60'	600' from Latham I.
K	15'-6"	740' from Latham I.

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FIGURE 1
LOCATION OF WEEKLY SAMPLING SAMPLE POINTS, YELLOWKNIFE BAY

SCALE: 1" = ½ MILE. | DWG BY J.W. Slupesky

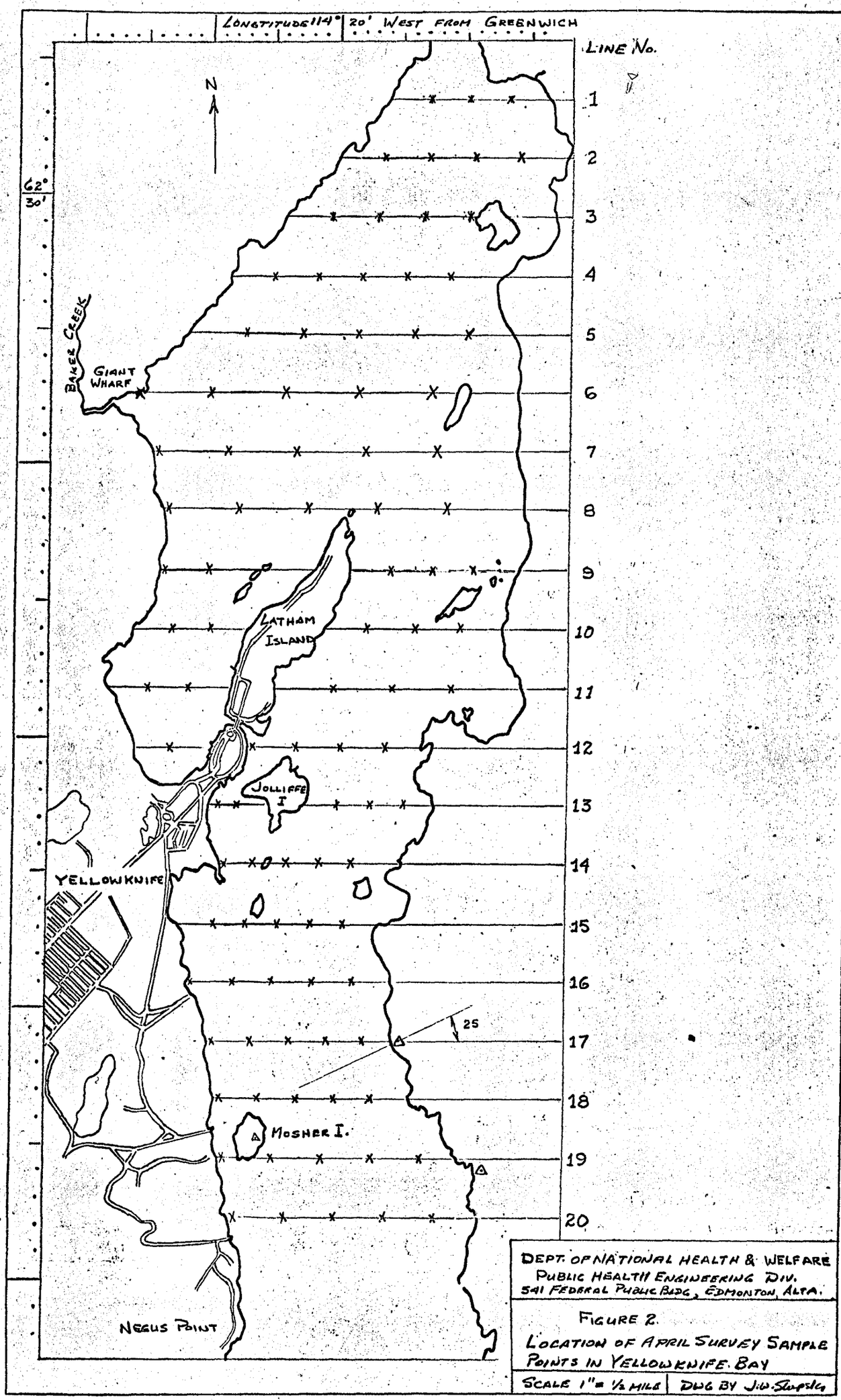

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FIGURE 2.
LOCATION OF APRIL SURVEY SAMPLE POINTS IN YELLOWKNIFE BAY

SCALE 1" = ½ MILE | DWG BY J.W. STUPICH

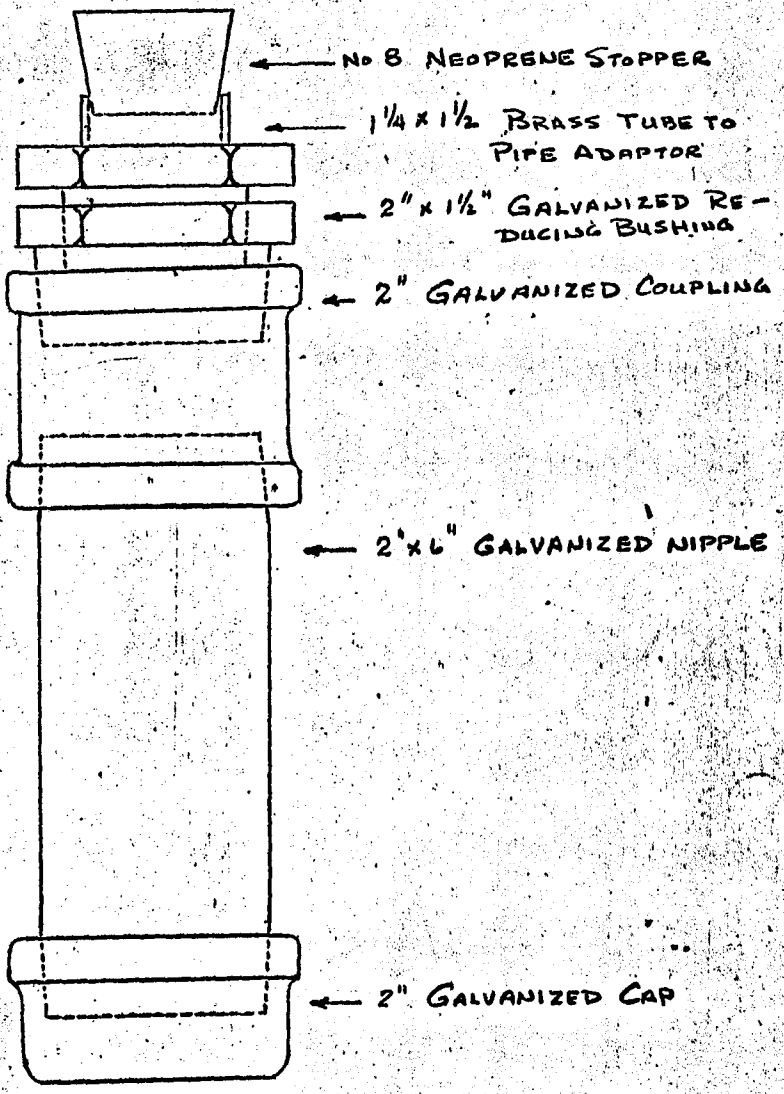

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FIGURE 3.
FIELD FABRICATED SAMPLER
(APRIL SURVEY)

SCALE: 1/2 SCALE | DWG BY: J.W. Slupecky