REPORT ON THE

TOWN OF YELLOWKNIFE

WATER SUPPLY LINE

for

DEPARTMENT OF INDIAN AFFAIRS

AND NORTHERN DEVELOPMENT

Technical Report

April 1968

REID, CROWTHER & PARTNERS LIMITED
Consulting Engineers

TOWN OF YELLOWKNIFE

WATER SUPPLY LINE

CONTENTS

List of Exhibits

Reid, Crowther & Partners Limited

CONSULTING ENGINEERS 10350-124TH STREET, EDMONTON, ALBERTA • TELEPHONE 482-4411, AREA CODE 403

PLEASE REFER TO FILE No.

April 29, 1968

LETTER OF TRANSMITTAL

Mr. K. W. Stairs,
Chief, Engineering Division,
Department of Indian Affairs & Northern
Development,

Ottawa, Ontario

Dear Sir:

Re: Town of Yellowknife
Proposed Water Supply Line

We take pleasure in submitting our report on the proposed water supply line and associated works for Yellowknife, N.W.T.

We have been unable to assess at this time what treatment is required, if any, for the proposed source of water in the Yellowknife River. This is due to the lack of records as to the colour and turbidity qualities for the river during the spring runoff period. We propose to carry out a testing program to provide this data during this spring and once analysis of this data is complete, we will report on this aspect of the proposed system.

Estimated costs have been prepared, however, it should be noted that the cost of this project could vary over a wide range due to higher than normal risk involved and contractor interest in the project.

We thank you for this opportunity in participating in the development of the north and are prepared to meet with you and review this report should you feel this is required.

Yours truly,

J. R. Tweddle

J. R. Tweddle, P. Eng.

JRT:lz

TOWN OF YELLOWKNIFE

WATER SUPPLY LINE

I. INTRODUCTION

This report outlines the results of our review of various alternatives open to provide water with lower concentrations of arsenic than are now being experienced, to the Town of Yellowknife, Giant Mine and the Con-Rycon Mine complex.

The Town of Yellowknife and the adjacent mines currently draw their water supplies from three separate intakes on Yellowknife Bay.

It has been reported that the arsenic content of the water in the distribution systems at the Town of Yellowknife and the Giant and Con-Rycon Mine has occasionally been in excess of the U.S. Public Health Service recommended limit of 0.05 parts per million. Exhibit No. 3 shows arsenic test results obtained by the Department of National Health and Welfare taken over a period from November 1966 to February 1968.

There are two sources of the arsenic pollution namely through the mill stacks and from the mill tailings ponds.

The pollution from mill stacks has been fairly well checked at this time with recoveries of arsenic in the order of 99 percent and 90 percent reported at Giant Mine and the Con-Rycon Mine respectively.

The mill tailings comprise a more difficult problem. Four methods by which the Town's potable water supply may be protected from the arsenic

1. INTRODUCTION (continued)

pollution have been studied in varying detail. The first is to remove the arsenic from the mill tailings. Although some progress by Giant Mines has been reported recently in reducing the amount of soluable arsenic in the tailings, it is not deemed practical to remove all the arsenic from the tailings.

The second method is to transport the tailings to a remote location which would not interfere with the Yellowknife water supply. This is the method currently used by Con Mine as their tailings are drained in a southerly direction and enter Great Slave Lake south of Yellowknife Bay. This approach is not practical to control the Giant Mine tailings as there are no lakes within reasonable distance which do not drain into Yellowknife Bay or endanger other unpolluted areas.

The use of either of the first two methods does not remove the possibility of a large amount of arsenic being introduced into Yellowknife Bay, should dykes fail on the tailings storage pond adjacent to Yellowknife Bay.

A third approach is to provide treatment of the Yellowknife Bay water to reduce arsenic levels to the recommended limits during the periods of higher concentrations. This method would give some measure of assurance, should stored tailings be accidently discharged into the Bay.

1. INTRODUCTION (continued)

We have had some laboratory work carried out during the period from June 1967 to this time, with a view to determining a method of lowering arsenic concentrations which could be applied to a water treatment plant. The following samples of raw water from the Town intake were analyzed for arsenic content:

1. Sample No. 1 - arsenic content - 0.122 ppm
2. Sample No. 2 - no trace
3. Sample No. 3 - arsenic content - 0.020 ppm

Lime and ferric sulphate treatment was applied to the first raw water sample achieving a 25 percent reduction in arsenic content from 0.122 ppm to 0.09 ppm. The third sample was reduced by the same process from 0.020 to 0.016 ppm for a 20 percent reduction.

Removal of the arsenic by the use of a Manganese Zeolite Filter was also attempted, but without success.

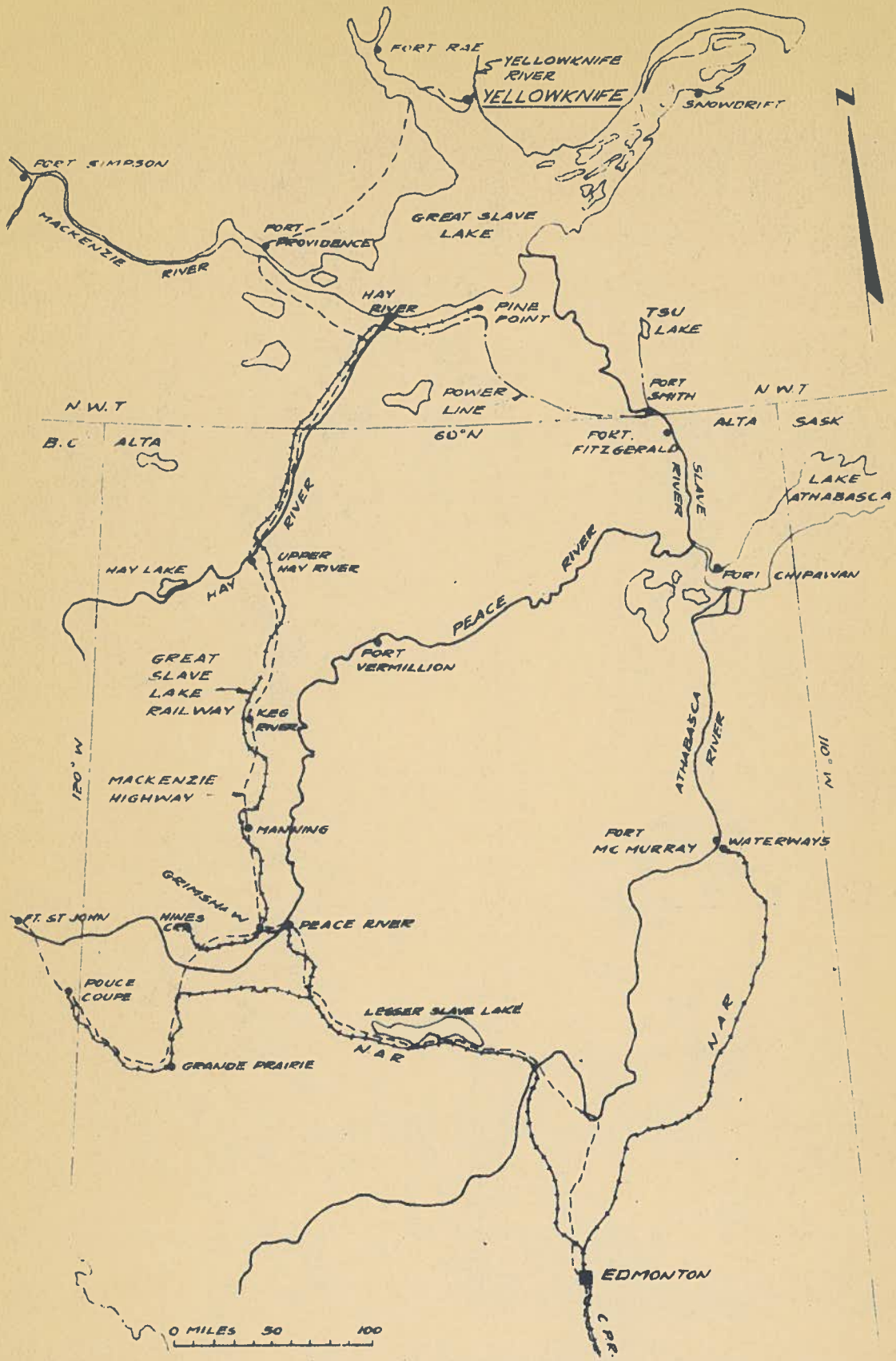
Although this small amount of laboratory work carried out has met with only slight success, we feel that the pursuit of this aspect, should time and funds be available, might ultimately provide the best solution. However, the potential success of research is difficult to assess at this time.

The fourth alterntaive is to obtain the Town's potable water supply from a new source. Examination was carried out of a number of potential

1. INTRODUCTION (continued)

sources of water, hopefully arsenic free, within Yellowknife Bay both upstream and downstream from the present Town intake. An extensive program of sampling in Yellowknife Bay was carried out in April and October of 1967. The result of these surveys which are compiled in Exhibit No. 3 indicated a fairly constant distribution of arsenic throughout the Bay. Therefore a potential source of water in the Yellowknife River was reviewed and it was proposed by the Department of National Health and Welfare to construct a new potable water intake at the mouth of the Yellowknife River and to supply the Town of Yellowknife and the adjacent mines with water from this intake through a submarine pipeline on the bottom of Yellowknife Bay.

The balance of this report has been divided into sections dealing with the various aspects of this proposed water supply system.



			DEPT. OF INDIAN AFFAIRS & NORTHERN DEVELOPMENT.	SCALE AS SHOWN
			KEY PLAN	DATE APRIL, 1968
				DES ____ DWN A.C.
				CKD ____ APP ____
			REID, CROWTHER & PARTNERS LIMITED CONSULTING ENGINEERS	DWG NO. 2529-4-101
DATE	REVISIONS	APP	VANCOUVER CALGARY EDMONTON REGINA WINNIPEG TORONTO	

EXHIBIT 1

II. INTAKE SITE

An intake site has been selected in the Yellowknife River north of the existing minimum security camp. The river channel location at this point is stable and has adequate depth to construct a submerged intake which would not be subject to the ice problems generally associated with intakes which extend to the surface of the water.

Tests have indicated that water in the river in the vicinity has arsenic contents well below the accepted levels.

Flow records taken at the Bluefish River Dam indicate that there should be adequate flows of water in the Yellowknife River to supply the potable water requirements of the Town and the mines throughout the year.

The site selected would tend to be less affected than sites further down the mouth of the river should effluent from the Giant Mine tailings pond be accidently discharged into the Bay, or by the backing up of water in Yellowknife Bay which is occasionally experienced when the wind is from the south.

The existence of mud flats in the vicinity of the river mouth below the proposed intake site could indicate that the river carries considerable turbidity at times.

We have been unable to locate any existing records for the Yellowknife

II. SITE INTAKE (continued)

River as to the colour and turbidity qualities of the water in the river. Therefore, sampling of the river water will have to be conducted during the spring runoff and early summer to determine these qualities.

Should significant colour or turbidity be encountered, treatment for their removal will be required. This aspect will have to be given further study once results of the water sampling program are available.

IV PIPELINE

A sounding program was carried out during February and March, 1968, to determine as far as possible the profile and characteristics of the bottom of Yellowknife Bay along routes selected from aerial photographs. Proposed routes are shown on Exhibit No. 2.

The soundings indicated that the bottom of Yellowknife Bay in areas sounded is, with a few exceptions, gently undulating. The depth of water encountered was from 2 feet to 65 feet. Profiles of the routes are also shown on Exhibit No. 2.

The limited lake bottom information obtained from manual soundings indicated that the bottom composition varied from mud and silt in the shallow areas in the vicinity of the Yellowknife River mouth to exposed rock or boulders in the vicinity of Latham Island. One near vertical sided hole was found on the first trial line for the submarine alternate connection to Con Mine. A second trial submarine connection to Con Mine was sounded and found acceptable.

The profile of the rock bottom area off Latham Island varies considerably in elevation within short distances, however, we believe that these gaps can be bridged by the use of heavy walled welded steel pipe. It is assumed this area represents a fault in the bedrock extending across the lake

IV. PIPELINE (continued)

from the end of Latham Island.

Various types of pipes were considered for the installation. At present we would favour the use of welded steel pipe due to its known performance record and its ability to provide some bridging. The fact that steel pipe retains its strength and can be jointed in severe cold weather would indicate its superiority for a winter installation over plastic pipes considered. Additionally, plastic pipes generally require the provision of anchors.

Some dredging will be required through the mud flats area in the vicinity of the mouth of the Yellowknife River as no distinct channels of adequate depth to protect the pipeline were found.

The possibility of constructing an overland line from the Yellowknife River to the existing Town system was briefly reviewed.

Both a buried line and an insulated surface line were considered. These alternatives were both estimated to cost more than the proposed underwater pipeline due to increased overall length and the rugged terrain over which the lines would have to be constructed. In view of the high estimated cost of the overland routes and the risk of freezing should flow in the line be stopped due to pump breakdown, we would not recommend this approach.

IV. PIPELINE (continued)

An alternative overland route to Con Mine was studied from the existing Town distribution system at 54 Avenue and 52 Street, southerly along the westerly side of Rat Lake. This overland route is estimated to cost approximately $120,000. and the submarine route is estimated to cost $125,000. As the overland route appears slightly cheaper and would be potentially useful in the future, we would recommend that the overland route to Con Mine should be constructed.

V. OPERATION OF PIPELINE

Two basic methods of operating the proposed pipeline have been reviewed, that is, firstly, as a suction line and secondly, as a pressure line.

If a suction line is constructed a 24 inch diameter pipeline will be required to handle the demand when the Town population reaches 10,000. The advantage of a suction line is that no pumping station would be required at the Yellowknife River. However, there are several disadvantages. The proposed pipeline is to be constructed through the water which it is desired to exclude from the water distribution system. Should leaks occur in the suction line, the pipeline would fail in its purpose. Additionally, leaks in a suction line would be extremely difficult to locate. A suction line will be difficult to start up and maintain due to the tendency for air to collect at the summits of the pipeline laid on the undulating bottom.

The second alternative is to operate the pipeline as a pressure line which, of course, would require a pump station constructed at the Yellowknife River intake. A 16 inch diameter pipeline would be required to handle the estimated demand when the Town reaches a population of 10,000 persons. In addition to the smaller pipe size required a pressure line has the advantage that should leaks occur in the line, water will flow out of the pipeline and thus still maintain its purpose of excluding the undesirable water from the

V. OPERATION OF PIPELINE (continued)

system. We would also anticipate that leaks in a pressure line would be somewhat easier to locate than with a suction line. We would, therefore, recommend that a pressure pipeline be utilized and that a pump station be constructed in connection with the Yellowknife River intake.

The area on the east side of the river adjacent to the proposed intake appears satisfactory for a pump station and treatment plant, if it is found to be necessary. Some soil testing will be required at this location when design of the intake and pumphouse is carried out. It would not appear desirable to carry out any detailed design for these items until results of water tests are known this summer.

Arrangements will have to be made with Con-Hydro to construct an electrical substation and obtain power from the Con Hydro Transmission Line which crosses the river about 1,400 feet south of the proposed intake.

Control of the pumps at the Yellowknife River intake will take some special consideration, the pumps being so far from the source of demand.

VI. RENOVATIONS TO EXISTING TOWN PUMPHOUSE

It is proposed that the existing pumphouse operate in a similar manner as to current operation. The fire pump and suction would be retained to provide for the intermittent fire flows. Additionally, the existing low lift pumps will be retained to provide for emergency use should difficulties develop with the new intake line or pumping station. The proposed new supply line would, therefore, bypass the existing low lift pumps and feed into the existing 10,000 gallon makeup storage tank. An automatically controlled valve will be required to adjust flow through the supply line to meet the demand of the Town and the Con Mine.

With the addition of the Con Mine demand on the Town system, the existing high lift pumps will not provide for any standby capacity. It is, therefore, proposed to change to two 40 H.P. Ingersl Rand pumps and headers for two larger pumps and headers while the balance of the renovations are being carried out.

New piping arrangements will be required in the existing intake well and pipe tunnel, as well as for the floridation equipment.

As the existing pumphouse is crowded and the renovations will have to be done while the system is operating special consideration will have to be given to the scheduling of construction for this portion of the project.

VII. ESTIMATED COSTS

Estimating the cost of the proposed Yellowknife pipeline has presented a considerable problem, as there is little comparable experience in constructing a pipeline of this nature on which to base costs.

A 10 inch diameter pipeline was constructed at Hay River during the winter of 1965-66. This pipeline was laid in a well graded bottom with no rock protrusions in depths up to 50 feet. Some 3,000 feet of ditching close to shore was included in this work. Four tenders were received for this project, varying considerably from a low of $12.00 per lineal foot, second low of $17.00 per lineal foot to a high of $28.00 per lineal foot.

The increased cost for the Yellowknife pipeline would be approximately $7.00 per lineal foot for the supply of the pipe. The Yellowknife pipeline, in addition to being larger in diameter and twice as heavy requiring heavier equipment, represents a more difficult job as the bottom is rougher, connections and valves will have to be provided resulting in increased underwater work. Based on the experience at Hay River and considering increased cost trends since 1966, the larger and heavier pipeline, and the somewhat more difficult nature of the job at Yellowknife, one can expect a cost range from approximately $25.00 per lineal foot to approximately $50.00 per lineal foot for supply and installation of the pipeline.

VII. ESTIMATED COSTS (continued)

providing the lower tenders on the Hay River project were interested in constructing another project.

We have also interviewed various parties who have been associated with the laying of submarine pipelines. We have received indications of costs which vary over a very large range, that is, as low as $32.00 per lineal foot to $150.00 per lineal foot for supplying and laying the submarine line. The latter figure was received from a reputable contractor experienced in this field for laying the pipeline during the summer.

As the cost of the pipeline may be strongly influenced by contractor interest, and there is a fairly high risk factor involved on this type of project, we have used an estimating figure of $40.00 per lineal foot for supplying and laying the 16 inch diameter pipeline. On this basis, the estimated cost of the main 16 inch pipeline is $1,220,000. The 24 inch diameter suction line was estimated to cost in the order of $1,700,000.

The estimated cost to construct the Yellowknife River intake and pumphouse is $225,000.

The renovations and provision of additional pumping capacity in the existing Town of Yellowknife pumphouse is estimated at $75,000.

Should it be found necessary to provide treatment of the water, an additional amount in the range of $500,000. will be required for provision

VII. ESTIMATED COSTS (continued)

of the treatment plant. We have included this figure as a guide only, as the requirements for a treatment plant, if any, will have to be determined once results of the testing program are known.

The cost of a treatment plant could vary over a very large range, depending on the water quality. The total cost of the new supply system to Town is, therefore, estimated at $1,520,000. excluding the cost of a treatment plant. Should a treatment plant be required, an additional minimum of $500,000. will be required.

The submarine connections from the 16 inch supply to Giant Mine and to the Con-Rycon Mine are estimated to cost $180,000. and $125,000. respectively. The recommended overland route from the Town distribution system to Con Mine is estimated at $120,000. The above figures do not include any allowance for renovations of mine intake or distribution systems.

The total cost of the proposed Town water supply system and the connections to the mines is estimated at $1,820,000. to $2,320,000. depending on whether treatment of the river is required.

Cost of operation of the system is estimated at approximately $25,000. per year, providing treatment of the river water is not required.

VIII. RECOMMENDATIONS (continued)

on the bottom of Yellowknife Bay from the proposed intake site on the Yellowknife River to the existing Town of Yellowknife intake be constructed.

3. That the pipeline be operated as a pressure line.

4. That water samples be taken periodically through the spring and early summer to determine colour and turbidity qualities with a view to determining if treatment of the water of the Yellowknife River will be required.

5. That an overland connection from the Town of Yellowknife distribution system to the Con-Rycon Mine be utilized in preference to a submarine line.

6. That a submarine connection from the proposed line to the Townsite to Giant Mine be constructed.

RAT LAKE

EXIST WATERGROUND

PROP OVERLAND PIPE LINE TO CON. MINE

EXIST. CON MINE WATER INTAKE

EXIST. TOWN OF YELLOWKNIFE WATER INTAKE

ALTERNATE PIPE LINE TO CON MINE

MAGNER I.

JOLLIFFE I.

LATHAM I.

YELLOWKNIFE BAY
GREAT SLAVE LAKE

S.W. CORNER OF DOCK AT EXIST. GIANT MINE PUMPHOUSE

GIANT MINE CONNECTION

PROP. PIPE LINE TO TOWN OF YELLOWKNIFE

GIANT TAILINGS POND

POND DRAINAGE

PROPOSED INTAKE & PUMPHOUSE

YELLOWKNIFE RIVER

EXIST. CON. MINE WATER INTAKE

EXIST. TOWN OF YELLOWKNIFE WATER INTAKE

S.W. CORNER OF DOCK AT EXIST. GIANT MINE PUMPHOUSE

LAKE BOTTOM PROFILE TO GIANT MINE

LAKE BOTTOM PROFILE TO TOWN OF YELLOWKNIFE

DETAIL SYMBOL
DETAIL NUMBER
REFERENCE DWG No.

APPD

NO	DATE	REVISION	BY	APPD

Reid, Crowther & Partners Limited
CONSULTING ENGINEERS
VANCOUVER CALGARY EDMONTON REGINA WINNIPEG TORONTO

DEPT. INDIAN AFFAIRS & NORTHERN DEVELOPMENT

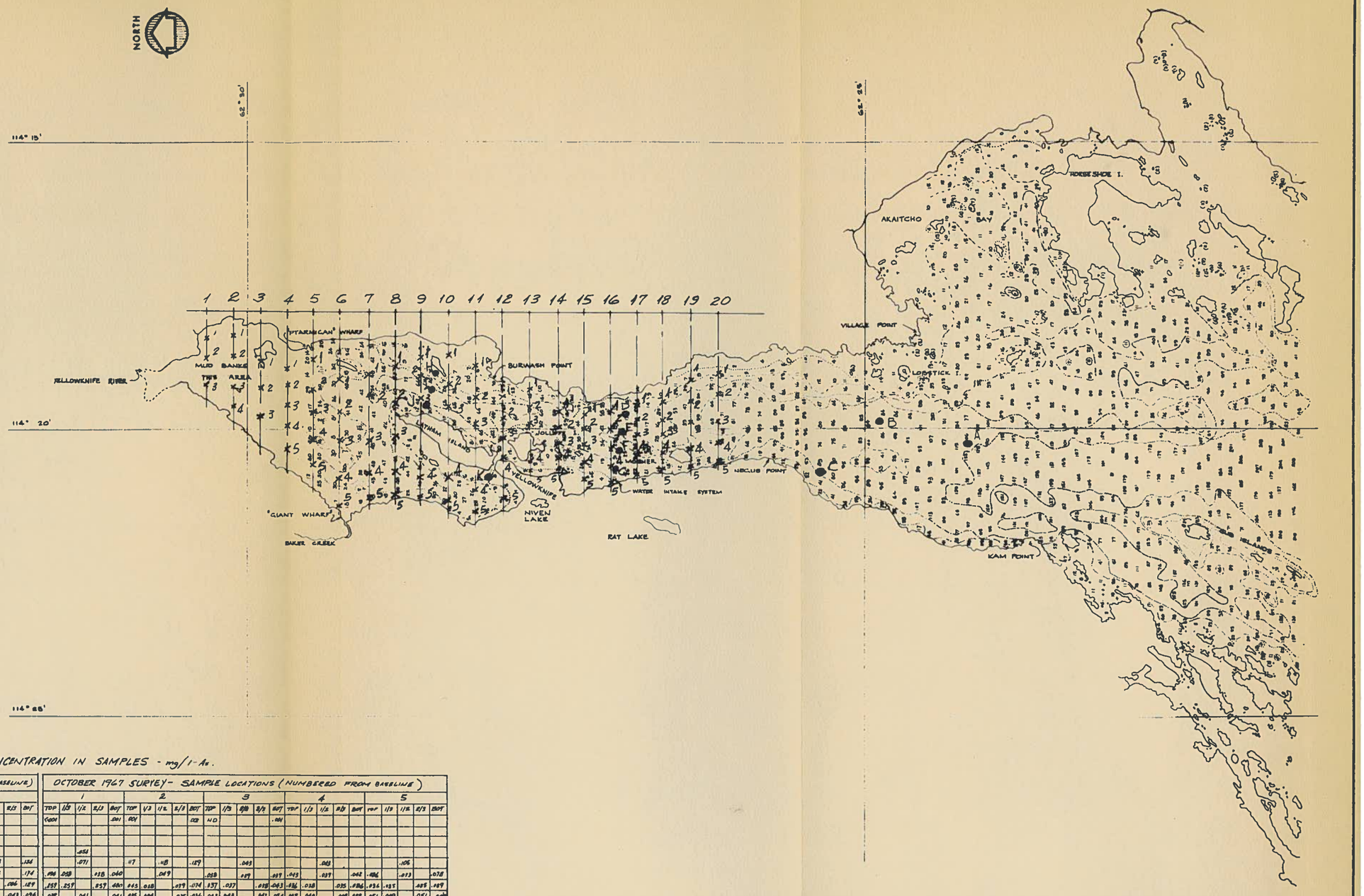
WATER SUPPLY LINE
PLAN & PROFILE

DES.	DWN P.C.C.	CKD
DATE	APRIL, 1968	
SCALE	H-1"=1000' V-1"=10'	
PROJECT NO	2529	
DRAWING NO	2529-4-103	

TABLE I ARSENIC CONCENTRATION mg/l-As.

DATE	SAMPLE LOCATIONS (SEE PLAN) A	B	C	D	E	F	G	H	I	J	K	L	CON TAP	GIANT TAP	TOWN TAP	HOOKY VILLAGE
NOV. 14 1966													.040	.015	.040	.010
NOV 21 1966													.050	.068	.050	.046
NOV. 28 1966													.020	.040	.040	.036
DEC. 5 1966													.030	.043	.040	
DEC. 12 1966													.036	.040	.036	.036
DEC. 19 1966													.036	.036	.046	.016
JAN. 18 1967													.020	.030	.028	.028
JAN. 26 1967													.030	.038	.030	.046
JAN. 30 1967													.020	.038	.036	.038
FEB 13 1967	*	.004 .004	.008 .001	.023 .026	.023 .035	.038 .013	.046 .095	.060 .018	.106 .089	.180 .060	.187		.036	.020	.030	
FEB 16 1967	.006 .006	.006	.026	.040	.031	.032	.065	.046	.141	.087	.046	.006	.040	.030	.008	
FEB 22 1967	.040 .030	.050 .010	.060 .035	.040 .027	.040 .026	.076 .045	.066 .028	.050 .078	.062 .080	.028 .078	.040	.006	.035	.120	.043	
FEB. 28 1967	.018 .038	.010 .023	.014 .026	.050 .028	.040 .076	.062 .079	.076 .012	.064 .078	.098 .078	.093 .110	.140 .120	.028	.010	.026	.112	.026	.042
MAR. 6 1967	.011 .015	.011 .026	.023 .028	.028 .020	.026 .070	.040 .028	.024 .012	.106 .110	.112 .134	.170 .156		.028	.009	.116	.220	.010	
MAR. 13 1967	.022 .178	.026 .021	.032 .038	.020 .166	.046 .148	.041 .126	.090 .144	.137 .160	.180 .160	.178 .144	.150	.006	.026	.180	.026	.022
MAR. 20 1967	.017 .008	.018 .028	.035 .019	.024 .026	.026 .087	.056 .108	.100 .110	.070 .095	.091 .058	.101 .097	.198	< .001	.126	.120	.126	.178
APRIL 3 1967	.028 .026	.028 .026	.029 .027	.028 .028	.026 .128	.086 .116	.112 .118	.088 .122	.126 .118	.126 .128	.096	< .001	.128	.120	.028	.178
APRIL 10 1967	.027 .029	.028 .033	.026 .064	.028 .118	.024 .112	.030 .096	.120 .118	.116 .114	.056 .086	.158 .106	.071	.026	.126	.168	.120	.160
APRIL 18 1967 (AFTERNOON)	.020 .026	.023 .026	.028 .026	.118 .114	.080 .090	.026 .130	.118 .166	.098 .110		.136 .160	.078	.001		.154		
APRIL 26 1967	.006		.006	.024 .80	.026	.026 .122	.070 .104						NONE			
APRIL 26 PM (NOON)	READINGS FROM GIANT SUMP 1800 : 1.950 ; 1.800 ; @ 1.900															
MAY 1 1967 (AFTERN)													.030	.098	.112	.022	.080
MAY 25 1967													< .001	.155	.322	.044	
MAY 31 1967													< .001	.198	.101	.126	
JUNE 5 1967	CON PT. 1 @ 1.200 ; CON. PT. B @ 1.000, SAILING POND .010, YELLOW KNIFE .024 ; BAKER C. .139 , MOUTH BAKER C. .140, MINE INTAKE 2.000.												< .001	.126	.58	.030	
JUNE 13 1967													.002	.160	.140	.110	
JUNE 20 1967	YELLOW TAILINGS TO BAKER CK. (1) 75.000 (2) 78.000. LATHAM 15 READING .160												.014	.078	.182	.066	.068
JULY 7 1967	BRIDGE LATHAM 15 .082 , MOUTH BAKER CK 1.650, EFFLUENT TAILING POND GIANT @ 1.800												.002	.023	.170	.010	
JULY 14 1967	BRIDGE LATHAM 15. .126 , YELLOWKNIFE R. BRIDGE .006, MOUTH BAKER CK. @ .648 , TAILINGS POND GIANT @ 1.000.												.002	.036	.125	.018	.010
JULY 20 1967		.016	.018	.022 .020	.019 .020	.046 .020	.046 .020					.018	.048	.068	.094	.030	.016
JULY 26 1967	BRIDGE LATHAM 15. .068, YELLOWKNIFE R. BRIDGE .008, MOUTH BAKER CK @ 1.250 ; GIANT TAILINGS POND @ 1.800.																
JAN 8 1968													.026	.012	.020	.002	
JAN 12 1968													.018	.041	.010		
JAN 23 1968													.026	.012	.880		
FEB 21 1968													.002	.011	.010		

NOTE WHERE TWO READINGS ARE SHOWN PER STATION - UPPER READING IS AT 4/5 DEPTH & LOWER READING AT 1/5 DEPTH



114° 25'

TABLE II ARSENIC CONCENTRATION IN SAMPLES - mg/l-As.

GRID LINE NE.	APRIL · 1967 SURVEY - SAMPLE LOCATIONS (NUMBERED FROM BASELINE) 1 TOP	1/8	1/4	3/8	BOT	2 TOP	1/3	1/2	2/3	BOT	3 TOP	1/3	1/2	2/3	BOT	4 TOP	1/3	1/2	2/3	BOT	5 TOP	1/3	1/2	2/3	BOT
Y.R.		.009		.011			.006		.011	—		.003	.008												
1																									
2			.157					.169				.174					.183		.167			.149			
3																									
4	.172	.157		.156	.223	.151	.137			.160	.172	.197				.177		.196		.179			.143		.126
5	.229	.257		.206	.211	.196		.200			.160		.174			.221	.208		.123	.168	.186		.196		.176
6						.188	.230			.208	.194	.187	.162		.089	.114	.117	.189		.198	.177	.143	.114		.096	.189
7	.089		.169		.137	.174	.187			.220	.220	.183	.163		.196	.169	.157	.193		.096	.116	.146	.157		.043	.096
8	.159		.146		.117	.146	.151			.184	.118	.106	.120		.143	.186	.172	.189		.143	.130	.140		.126		.143
9	.126	.067		.120	.071	.144	.166			.107	.134	.143	.097		.086	.200	.160	.163		.066	.089	MUD				
10	.126	.056		.143	.063	.069		.146		.143	.120	.069			.116	.169	.160	.140		.104	.084					.131
11	.167	.096		.049	.069	.128	.097			.111	.057	.149	.174		.166	.166	.126	.131		.109	.169			.143		
12	.106		.128		.131	NEAR	BUMPAY			.117	.149		.086		.142	.120	.063		.109	.120	.129	.134		.071	.103
13	.154		.129		.126	.139				.137	.146	.086		.089	.149	.160	.066		.069	.134			.191		
14	NO WATER					.140		.131		.131	.139	.160		.111	.189	.187	.126		.149	.096	.163	.146		.103	.103
15			.143		.196	.167	.147			.100	.194	.151	.173		.171	.183	.160	.146		.160	.176	.177	.176		.043	.083
16						.146	.126			.096	.094	.117	.086		.089	.149	.146	.080		.086	.144	.096	.086		.099	.196
17	.149	.156		.100	.080	.149	.193			.085	.166	.128	.140		.146	.198	.137	.145		.096	.148	.137		.121		.069
18	.178	.196		.151	.165	WATER	ON	CB		.146	.106		.089	.121	.129	.123			.026	.131	.165	.166		.086	.040
19	.099	.157		.163	.091	.166				.089	.151	.057		.126	.163	.130			.091	.126	.183	.149		.069	.051
20	.143	.176		.089	.283	.149	.123			.089	.191	.149	.123		.033	.114	.163	.126		.066	.146	.136		.115		.094

GRID LINE	OCTOBER 1967 SURVEY - SAMPLE LOCATIONS (NUMBERED FROM BASELINE) 1 TOP	1/8	1/4	3/8	BOT	2 TOP	1/3	1/2	2/3	BOT	3 TOP	1/8	3/8	1/2	5/8	3/4	7/8	BOT	4 TOP	1/3	1/2	2/3	BOT	5 TOP	1/3	1/2	2/3	BOT
Y.R.	.004				.001	.001				.002	ND							.001										
1																												
2																												
3				.021																								
4			.071			.17		.18		.129				.043						.083			.106					
5	.198	.058			.018	.060					.049				.058		.09	.097	.043		.037		.042	.086		.073		.078
6	.258			.257		.257	.680	.063	.018		.039	.024	.357	.037		.018	.043	.086	.038		.035	.086	.034	.035		.025	.089	
7	.238		.041		.041	.035	.095				.035	.036	.043	.043			.041	.056	.057	.060		.049	.028	.051	.049		.051	.049
8	.020	.035		.042	.040	.036	.036				.045	.045	.033	.031			.032	.020	.027	.028		.045	.043	.026	.043		.043	.030
9	.038		.037		.043	.035	.034				.035	.029	.010	.021			.030	.029	.026		.027		.016			.020		
10	.044	.027		.045	.029					.036			.021	.031			.032	.036	.125	.029		.031	.022			.029		
11	.045		.037		.032	.035				.039		.048	.035	.033			.031	.025	.023	.027		.048	.028			.029		
12			.741			.029	.033			.027	.029	.026	.026				.026	.031	.028	.037		.017	.028	.020	.029		.027	.028
13	.028		.027		.027	.046		.031		.049	.031	.029					.018	.033	.032	.021		.026	.032	.036		.031		.021
14	.030		.031		.026	.028				.026	.025	.023					.026	.021	.026	.032		.023	.028	.028	.028		.030	.026
15	.021		.048		.042	.031	.021			.026	.016	.018	.022				.049	.013	.028	.027		.030	.020	.020	.029		.028	.028
16	.006		.013		.012	.018	.018			.011	.017	.017	.031	.027			.037	.028	.011	.018		.018	.017	.016		.021		.020
17	.013			.013	.007	.013		.011		.014	.019	.010					.020	.019	.021	.021		.023	.020	.020		.025		.028
18	.016			.006	.010	.010	.006			.026	.007	.010	.011				.005	.006	.012	.011		.011	.010	.017		.019		.018
19	.021			.005	.006	.010	.010			.011	.010	.009	.014				.008	.006	.009	.011		.011	.007	.006	.008		.006	.008
20	.026			.007	.008	.002	.006			.007	.010	.005	.005				.005	.006	.005	.008		.008	.008	.005	.006		.008	.008

LEGEND

190 SOUNDINGS
(8) HEIGHT ABOVE WATERLINE OF ROCKS OR ISLANDS.
m MUD
r ROCK
SOUNDINGS ARE BASED ON LOW WATER DATUM : 6.98' BELOW B.M. "KANGON"

5000 SCALE OF FEET 5000

SAMPLE LOCATION TABLE I SHOWN.. ●C
SAMPLE LOCATION TABLE II SHOWN.. ↑4

DETAIL SYMBOL — DETAIL NUMBER / REFERENCE DWG. No.

NO	DATE	REVISION	BY	APPD

APPD .....

Reid, Crowther & Partners Limited
CONSULTING ENGINEERS
VANCOUVER CALGARY EDMONTON REGINA WINNIPEG TORONTO

DEPT. OF INDIAN AFFAIRS & NORTHERN DEVELOPMENT

WATER SUPPLY LINE

PLAN & TABLES FOR ARSENIC COUNT

DES ..... DWN ..A.C CKD.....	DATE APRIL, 1968	SCALE 1" = 2640'	PROJECT NO 2529	DRAWING NO 2529-4-102

EXHIBIT 3