DILLON
Consulting Engineers • Planners
Environmental Scientists

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File -	✓

Our File: 93-1232-01

September 15, 1993

0640
Clyde River
Baffin District

Northwest Territories Water Board
P.O. Box 1500
Yellowknife, N.W.T.
X1A 2R3

Attention: Dave Nickerson

Dear Mr. Nickerson;

On behalf of the Department of Municipal and Community Affairs, we are submitting one (1) copy of each of the following reports:

- Sanitary Site Clean-Up - Broughton Island, N.W.T.
- Sanitary Site Clean-Up - Clyde River, N.W.T.

Please have these reports reviewed and comments forwarded to Mr. Rick Armstrong of M.A.C.A. in Iqaluit. Review comments would be appreciated within six (6) weeks.

Thank you for your co-operation in this matter.

Yours truly,

M.M. DILLON LIMITED

V. Wattis, for
Gary Strong, P.Eng.
Project Manager

GS:vw
Encls.

cc: Mr. Rick Armstrong, MACA

DILLON
Consulting Engineers • Planners
Environmental Scientists

FAXED

ORIG. TO FOLLOW IN MAIL

Our File: 93-1232-01

September 07, 1993

Municipal & Community Affairs
Government of Northwest Territories
Box 1000
Iqaluit, N.W.T.
X0A 0H0

Attention: Rick Armstrong
Project Officer

Broughton Island and Clyde River
Sanitary Site Clean-Up

Dear Mr. Armstrong;

The laboratory analysis for the water samples collected during the above mentioned project has been completed. Attached are the revised Tables #1 from the respective reports illustrating the results. Based on these results, the draft report will be revised and the following statements will be incorporated into the report.

Broughton Island Sanitary Site Clean-Up

Water samples were taken between the dates of June 18 to 20, 1993 near the sanitary disposal area of Broughton Island. Samples were analyzed for routine water indicators and heavy metals. Based on the Guidelines for Canadian Drinking Water Quality, 1989 and the Guidelines for Municipal Type Wastewater Discharge in the NWT, 1981, turbidity, colour and iron levels were found to be elevated above guidelines in only one of the two samples taken.

The turbidity, colour and iron concentrations identified in the water samples obtained "downstream" of the landfill site, at the shoreline, indicate a variation in colour, turbidity and iron, (with one sample meeting all guidelines for parameters tested). The one sample with elevated colour and iron only, is indicative of general land run-off effects on shoreline water quality. The plan to remove all previously deposited wastes from the shore area will minimize potential long term effects of wastes on the adjoining surface waters and the Community's fishing area.

The Community's water supply source is not located downstream of the discharge locations identified and sampled during this investigation and, therefore, will not be affected.

...continued

Clyde River Sanitary Site Clean-Up

Water samples were taken between the dates of June 16 to 18, 1993 near the sanitary disposal area of Clyde River. Samples were analyzed for routine water indicators and heavy metals. Based on the Guidelines for Canadian Drinking Water Quality, 1989 and the Guidelines for Municipal Type Wastewater Discharge in the NWT, 1981, turbidity, colour and iron levels were found to be elevated above the guidelines.

Turbidity, colour and iron concentrations identified in the water samples obtained "downstream" of the landfill areas, indicate levels elevated above typical lake water quality. This is, however, likely indicative of surface run-off sediments as opposed to waste material leachate effects. The iron concentration in the surface run-off water decreases with increased distance from the landfill area. The elevated iron levels in the run-off water are likely the result of metal oxidation and dissolution, and the decrease in concentration indicates sedimentation particulate iron. The presence of iron is not of concern.

Also, the Community's water supply source is not located downstream of the landfill run-off locations identified and sampled during this investigation and, therefore, will not be affected.

Bases on these analyses and on the clean-up plan outlined in the report, no long-term impacts are anticipated on the Community's fishing area or water supply.

We trust this information will be sufficient to permit the completion of the review of the draft report. I will contact you in mid September to arrange a review meeting in Iqaluit.

Yours truly,

M.M. DILLON LIMITED

Gary Strong, P.Eng.
Project Manager

GS:vw

Encls.

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BROUGHTON ISLAND

TABLE #1 - Water Sample Results

Location	640-04	640-04	640-04	640-05	640-05	J	K	GCDWQ
Lab #	900740	920866	42112	890797	900741	930574	930575	
Sample Date	06/16/90	06/14/92	06/05/85	06/10/89	06/16/90	06/12/93	06/17/93	
pH	7.23	6.92	8.49	6.70	7.84	5.69	6.68	6.5-8.5
Conductivity (umho/cm)	1,850.0	2,400.0		3,8000.0	5,5000.0	25.1	424	
Dissolved Oxygen								
Turbidity (NTU)		37.50	22.00			1.0	4.5	1
Colour		225.0				<5	150	≤15
Suspended Solids	341.0	60.0	64.0	34.0	113.0	3	217	
TDS Residue		1,328.0	400.0	19,900.0		<10	<10	≤500
Calcium					307.00	<1	4.7	
Magnesium					105.00	0.39	6.59	≤0.05
Total Hardness ($CaCO_3$)					5,090.00	<3	38.9	
Total Alkalinity ($CaCO_3$)					98.10	<0.3	11.0	
Sodium					8,400.00	4.3	59.0	≤200
Potassium					343.00	0.2	3.5	
Chloride					16,500.00	5.2	92	≤250
Sulphate					2,090.00	3	20	≤500
Fluoride								
BOD 5	480.0				2.0			
COD								
Carbon IC								
Carbon TDC			74.0					
Ammonia Nitrogen						<0.002	0.094	
Nitrate + Nitrate	0.040	0.040			0.040	<0.008	0.065	45
Ttl Kjeldahl Nitrogen								
Phosphorus O-P (as)						0.000	0.002	
Phosphorus Tot. (P)	29.00	4.230		0.100	0.024	0.004	0.028	
Silica								
Total Cyanide								0.2
Avail. Cyanide								

DILLON

Location	640-04	640-04	640-04	640-05	640-05	J	K	GCDWQ
Total Resid. Cl								
Sulphide								
Oil & Grease			5.0					
Phenols								
Arsenic (ug/l)			1.00			<0.3	<0.3	2.5
Cadmium (ug/l)			0.46	0.20		<0.1	<0.1	5
Copper (ug/l)			14.70	13.00		<1	1	≤1,000
Iron (ug/l)			154.00	604.00		22	1460	300
Lead (ug/l)			15.80	4.00		<0.7	4.3	10
Mercury (ug/l)			0.180			<0.02	<0.02	1
Nickel (ug/l)			10.00	1.00		<1	<1	45,000
Zinc (ug/l)			95.00	37.00		6	49	5,000
Chromium (ug/l)			3.35	1.00		1	1	5
Cobalt (ug/l)						<1	<1	

* Note - Values are expressed in mg/l unless noted

Locations:

640-04 - Run off from sewage disposal area prior to discharge to ocean.

640-05 - Run off from dump area - 15 - 20 m downstream of D.I.A.N.D. test program.

J & K - Locations as shown on Photo Plate #1.

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CLYDE RIVER

TABLE #1 - Water Sample Results

Location	CR-02	CR-02	CR-04	CR-04	#1	#2	GCDWQ
Lab #	Lab	920863	900737	920867	930572	930573	
Sample Date	08/14/90	08/13/93	08/14/90	08/13/92	06/15/93	06/15/93	
pH	7.13	7.60			6.71	6.81	6.5-8.5
Conductivity (umho/cm)	1780.0	1720.0			444	374	
Dissolved Oxygen							
Turbidity (NTU)		260.0			75	22	1
Colour		500.0			100	65	≤15
Suspended Solids	45.0	280.0			168	159	
TDS Residue		624.0			210	41	≤500
Calcium		12.00			6.3	9.5	
Magnesium		4.60			2.61	3.33	≤0.05
Total Hardness ($CACO_3$)		49.00			26.5	37.4	
Total Alkalinity ($CACO_3$)		674.00			132	93.5	
Sodium		101.00			26.7	24	≤200
Potassium		37.20			10.5	7.6	
Chloride		61.80			26	23	≤250
Sulphate		68.0			29	36	≤500
Fluoride							
BOD 5	500.0						
COD							
Carbon IC							
Carbon TOC							
Ammonia Nitrogen					27.8	19.5	
Nitrate + Nitrate	0.060	0.040			<0.008	<0.008	45
Ttl Kjeldahl Nitrogen							
Phosphorus O-P					2.94	1.93	
Phosphorus Tot.	17.000	20.400			3.21	2.11	
Silica					3.21	3.66	
Total Cyanide							0.2
Available Cyanide							

DILLON

Location	CR-02	CR-02	CR-04	CR-04	#1	#2	GCDWQ
Total Resid. Cl							
Sulphide							
Oil & Grease							
Phenols							
Arsenic (ug/l)				0.50	<0.3	0.3	25
Cadmium (ug/l)			0.20	0.20	<0.1	<0.1	5
Copper (ug/l)			2.00	2.00	24	32	≤1,000
Iron (ug/l)			46.00	53.00	8,280	2,160	300
Lead (ug/l)			1.00	1.00	3.0	<0.7	10.0
Mercury (ug/l)					.10	<0.02	1.0
Nickel (ug/l)			1.00	1.00	7	2	45,000
Zinc (ug/l)			1.00	1.00	102	88	5,000
Chromium (ug/l)			1.00	2.00	<1	<1	5
Cobalt (ug/l)					1	<1	

* Note: Values are expressed in mg/l unless noted

Locations:

CR-02 - Sewage run-off at landfill site.

CR-04 - 25 m downstream of landfill site.

#1 & #2 - Locations as shown on Photo Plate #1.

Clyde River
Baffin District

GNWT
MUNICIPAL & COMMUNITY AFFAIRS

SANITARY SITE CLEAN UP
CLYDE RIVER, N.W.T.

DRAFT

M.M. DILLON LIMITED
CONSULTING ENGINEERS,
PLANNERS, AND ENVIRONMENTAL
SCIENTISTS

93-1232-01-01
July 1993

TABLE OF CONTENTS

1.0 INTRODUCTION

The Community of Clyde River is currently completing work on a new sewage lagoon and solid waste facility. The solid waste facility started receiving waste in 1992. The lagoon is scheduled for completion in 1993 and will receive sewage waste by the fall of 1993.

There is a requirement to develop and implement a closure concept for the old waste disposal area. The closure concept must meet the requirements of the regulating agencies of the Northwest Territories. To develop and document the closure concept, the Department of Municipal and Community Affairs retained M.M. Dillon Limited in May 1993. This report documents the following:

- The findings of the site investigation conducted in June 1993.
- The requirements of the regulating agencies for the closure of the waste disposal area.
- The development of the closure concept subject to regulatory approval.
- The development of a workplan for the Hamlet to complete the remedial works in implementing the closure concept.

The workplan is presented at a level of detail to permit the local forces to complete the work with minimal external assistance. The closure concept acceptance by regulating agencies is not included in the scope of work for this assignment.

2.0 SITE INVESTIGATION

2.1 General

On the 16th to 18th of June 1993, M.M. Dillon Limited travelled to Clyde River and conducted a site investigation. The objectives of the investigation were to:

- Identify borrow sources for use as cover and capping material.
- Identify the historic operational practices used at the waste disposal area.
- Identify the manpower and equipment requirements for the closure concept.
- Receive comments from the Hamlet regarding their concerns with the site.

The following sections discuss the results of the site investigation. Photo Plates are included to enhance the discussion:

- **Photo Plate 1** is a high level air photograph showing the community area, the potential gravel sources (A,B,C), and the old and new landfill areas (D,E).
- **Photo Plate 2** is a low level air photograph showing the landfill area, the cemetery, borrow source, working face of the landfill, and water sample locations.
- **Photo Plates 3** and **4** are ground level photographs of the working face of the landfill.

2.2 Geotechnical Investigation

In May 1993, HBT AGRA was retained by M.M. Dillon Limited to conduct an airphoto and research study to identify potential borrow sources for capping material. The borrow source is required to have the following key characteristics:

- Borrow source is to be located near the waste site and preferably near the existing road system. The development of haul roads is expensive and to be avoided if possible.

- Material is to provide a cap of low permeability to minimize the development of leachate. Material with a reasonable fine content will be suitable for this application.

- Borrow source should not be a potential granular source for the community because granular sources in communities can be scarce or expensive to develop. Also, granular sources for road construction are typically low in fines content and would, therefore, be unsuitable for capping material.

HBT Agra completed a literative search of previous granular source studies and an air photo interpretation to identify potential sources. The result of this study is the identification of three (3) granular sources. A fourth (4th) source was identified during the site visit. The source location and results of material sampling is described below:

- Borrow source A is located 2.1 kms northeast of the Community on the south side of the runway. (See **Photo Plate 1,** source marked '**A**'). A material sample was taken form this source and the results of the grain size analysis indicates a sandy gravel with approximately 10% fines.

- Borrow source B is located 2.8 kms northeast of the Community north of the runway. This source is marked '**B**' on **Photo Plate 1.** A sample from this source was taken and found to contain high organic content. This material is not suitable for capping material and, therefore, a grain size analysis was not completed.

- Borrow source C is located 0.7 kms north of the Community and is shown as '**C**' on **Photo Plate 1**. This source was inaccessible at the time of the site visit due to heavy snow cover. In discussion with the Hamlet foreman, we understand this source is inaccessible for most of the year and is, therefore, inappropriate for use in this project.

- The fourth granular source is located at the old landfill site and has been used in the past for capping material. This source is marked '**G**' in **Photo Plate 2**. Grain size analysis results for this source is included in the Appendix. This material is a silty sand with 22% fines.

HBT Agra's literative and photo report is included in the Appendix.

The source at the landfill site (marked '**G**' in **Photo Plate 2**) is the best material of the four for use as a material cap and is located closest to the work area. The material is, therefore, recommended for use and is to be placed and compacted as follows:

LEGEND

A	POTENTIAL GRANULAR SOURCE LOCATIONS
B	POTENTIAL GRANULAR SOURCE
C	POTENTIAL GRANULAR SOURCE
D	LANDFILL AREA TO BE CLOSED
E	NEW SOLID WASTE AND SEWAGE LAGOON AREA

PHOTO PLATE #1

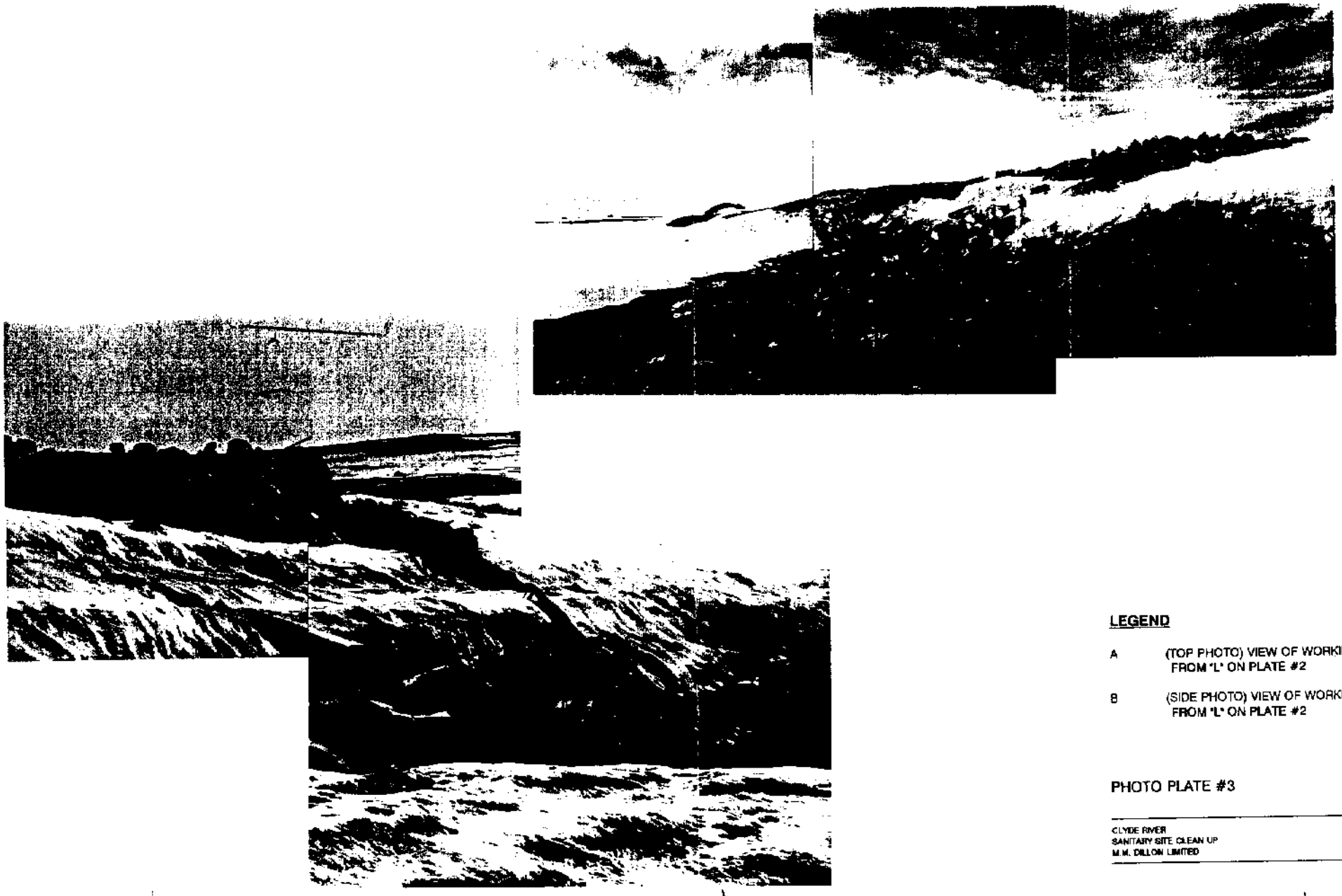
CLYDE RIVER
SANITARY SITE CLEAN UP
M.M. DILLON LIMITED

LEGEND

F	CEMETERY SITE
G	CURRENT GRANULAR SOURCE FOR LANDFILL COVER
H	WORKING FACE OF LANDFILL
I	SMALL BARREL DUMP
J	WATER SAMPLE POINT #1
K	WATER SAMPLE POINT #2
L	VIEW FOR PHOTO PLATE 3
M	VIEW FOR PHOTO PLATE 3A AND 4

PHOTO PLATE #2

CLYDE RIVER
SANITARY SITE CLEAN UP
M.M. DILLON LIMITED



LEGEND

A (TOP PHOTO) VIEW OF WORKING FACE FROM 'L' ON PLATE #2

B (SIDE PHOTO) VIEW OF WORKING FACE FROM 'L' ON PLATE #2

PHOTO PLATE #3

CLYDE RIVER
SANITARY SITE CLEAN UP
M.M. DILLON LIMITED

LEGEND

OVERVIEW OF WORKING FACE OF LANDFILL

PHOTO PLATE #4

CLYDE RIVER
SANITARY SITE CLEAN UP
M.M. DILLON LIMITED

APPENDIX #1

HBT AGRA AIR PHOTO REPORT

HBT AGRA Limited
Engineering & Environmental Services

135 Enterprise Road
P.O. Box 2245
Yellowknife, N.W.T.
X1A 2P7
Tel (403) 920-4140
Fax (403) 920-4402

June 11, 1993

File No. YX00342

M.M. Dillon Limited
Suite 201, 5102 51 Street
Yellowknife, N.W.T.
X1A 1S7

Attention: Mr. G. Strong, P.Eng.

Dear Sir:

Re: Clyde River and Broughton Island
Sanitary Site Clean-Up

HBT AGRA Limited (HBT) was requested by M.M. Dillon Limited (Dillon) to provide geotechnical information regarding the decommissioning of sanitary sites in Clyde River and Broughton Island, N.W.T. This letter provides a preliminary assessment based on a review of available information in HBT's, and Government libraries, and from telephone interviews with government and community personnel.

It is understood that of specific interest to Dillon are sources of soils that would be suitable for construction of berms and for capping purposes. Such soils would include clays, silts, and dirty sands and gravels. Relevant information for each community is presented in following sections.

Clyde River

The following reports were reviewed with respect to the availability of suitable soils in the decommissioning of the sanitary site:

- Geotechnical Investigation - Nursing Station/Health Centre - Clyde River, N.W.T. prepared by HBT AGRA Limited, 1993.
- Geotechnical Investigation - Proposed Community Hall and Arena - Clyde River, N.W.T. prepared by Hardy BBT Limited, 1991.

- Pile Foundation Design for Kuluak School, Clyde River, N.W.T. prepared by Hoggan Engineering and Testing Ltd., 1983.

- Evaluation of Granular Material Deposits Near Clyde River, N.W.T. prepared by Terrain Analysis and Mapping Services Ltd., 1981.

- Air Photo Interpretation - Borrow Sources of the Clyde River Area prepared by Thurber Consultants Ltd., 1980.

Relevant information from these sources is given below.

Clyde River is part of the Davis Highlands physiographic region. The Clyde River hamlet is predominantly underlain by deposits of colluvial, marine, and glacial origin. These deposits are perenially frozen, except for the upper 1 m approximately that experiences seasonal thawing. Excess ice in the permafrost soils is likely. The surficial deposits are underlain by granite and granite gneiss bedrock.

On the south side of the community is Patricia Bay. The beach materials tend to be rocky, and as such will be likely unsuitable for use in this project.

Geotechnical drilling in the community encountered predominantly silty sands and silts. The soils are likely ice-rich and should be expected to contain some cobble and boulder sized materials. The depth of these soils at the sites drilled typically exceeded 10 m.

The airstrip, located northeast of the community is understood to be constructed of deltaic sands and gravels.

Several granular borrow sources were identified in the reports reviewed. Although these reports are somewhat dated, they appear to confirm that sufficient granular resources are available near the community. Two of the more promising deposits exist on the west and east sides of the airstrip. The west side deposit is located on the north side of the road, just outside the airport boundary. This deposit is immediately north of a depleted sandy gravel borrow source; see Deposit A - Figure 1. The deposit is reported to contain poorly graded sands with some boulders. The fine content was estimated to be 50 to 60 percent.

The deposit on the east side of the airstrip (Deposit B - Figure 1) consists of poorly graded sands, of glaciomarine origin. The fine content is reported to be quite low, but the volume of material is high and localized finer materials are likely to be present.

A third potential deposit is located north of the community (Deposit C - Figure 1). It is likely to be predominantly poorly graded sands and gravels, but localized zones of finer materials may be present.

Finally, fine alluvial sediments may exist along the river channel. This may provide potential borrow materials. Access may be gained to the river delta area from locations along the road between the community and airport.

Discussions with MACA personnel indicate that availability of granular materials has not been a problem in Clyde River in the past. No specific information regarding fine grained deposits was available. It was inferred from these discussions that because there were sufficient quantities of higher grade materials, there would be no need to exploit the lower quality deposits, which would be of use in the decommissioning of the sanitary sites.

Broughton Island

The following reports were reviewed with respect to the availability of suitable soils in the decommissioning of the sanitary site:

- Geotechnical Investigation - Proposed RCMP Building - Broughton Island, N.W.T. prepared by HBT AGRA Limited, 1993.
- Compaction Control- Broughton Island Radar Site - Clyde River, N.W.T. prepared by Hardy BBT Limited, 1989.
- Geotechnical Investigation - Proposed School Building - Broughton Island, N.W.T., prepared by Hardy BBT Limited, 1988.
- Geotechnical Investigation - Proposed School Building - Broughton Island, N.W.T., prepared by Hardy BBT Limited, 1987.
- Geotechnical Investigations for Land Development Projects - Broughton Island, Baffin Region prepared by FMS Lavalin Geocon, 1986.
- Evaluation of Granular Material Deposits Near Broughton Island, N.W.T. prepared by Terrain Analysis and Mapping Services Ltd., 1981.

Relevant information from these sources is provide below.

Broughton Island is part of the Davis Highlands physiographic region. The terrain consists primarily of glacially derived deposits over bedrock. These deposits are perenially frozen, except for the upper 1 m approximately that experiences seasonal thawing. The bedrock consists of granite and granite gneiss bedrock.

The surficial soils generally comprise poorly graded, fine-grained till or glaciomarine (beach) deposits and sandy and gravelly glaciomarine deposits. Low lying areas may contain fairly recent deposits of fine grained soils and organics. Alluvial processes and solifluction are common. Excess ice is likely present in most surficial deposits.

A number of deposits have been identified that may contain finer grained soils. One potential deposit is located adjacent to the existing lagoon (Deposit A - Figure 2). This material is expected to consist of poorly graded sand, underlain by a silty sand with a fine content up to about 20 percent.

A second potential site is located on the road to the lagoon (Deposit B - Figure 2). It reportedly consists of poorly graded medium grained sand and silt, with a fine content of 30 to 40 percent.

The third potential deposit is located on the north side of the hamlet (Deposit C - Figure 2). This deposit consists of a silty sand over poorly graded sand. The fine content may be in the order of 40 percent. The depth of this material may be in the order of 1 to 3 m.

The Hamlet Foreman in Broughton Island (Les Kuniliusie) was contacted to provide additional information. Unfortunately, he was unable to discuss, on the telephone, the availability of finer grained soils.

Closure

It is recommended that during the site inspections at each community, potential sources be investigated. The local DPW and Hamlet personnel should be able to provide specific information and confirm the sources discussed in this report. Samples from potential sources should be collected and submitted to HBT for laboratory testing. Testing that may be undertaken include grain size analyses, hydrometer tests, natural water content, and Atterberg Limits.

We trust this information is sufficient for your present needs. If you have any questions, please contact our office.

Yours truly,
HBT AGRA Limited

J.M. Oswell, P.Eng.
Project Engineer

attachments

YX00342.RPT

FIGURE 1

YX00342

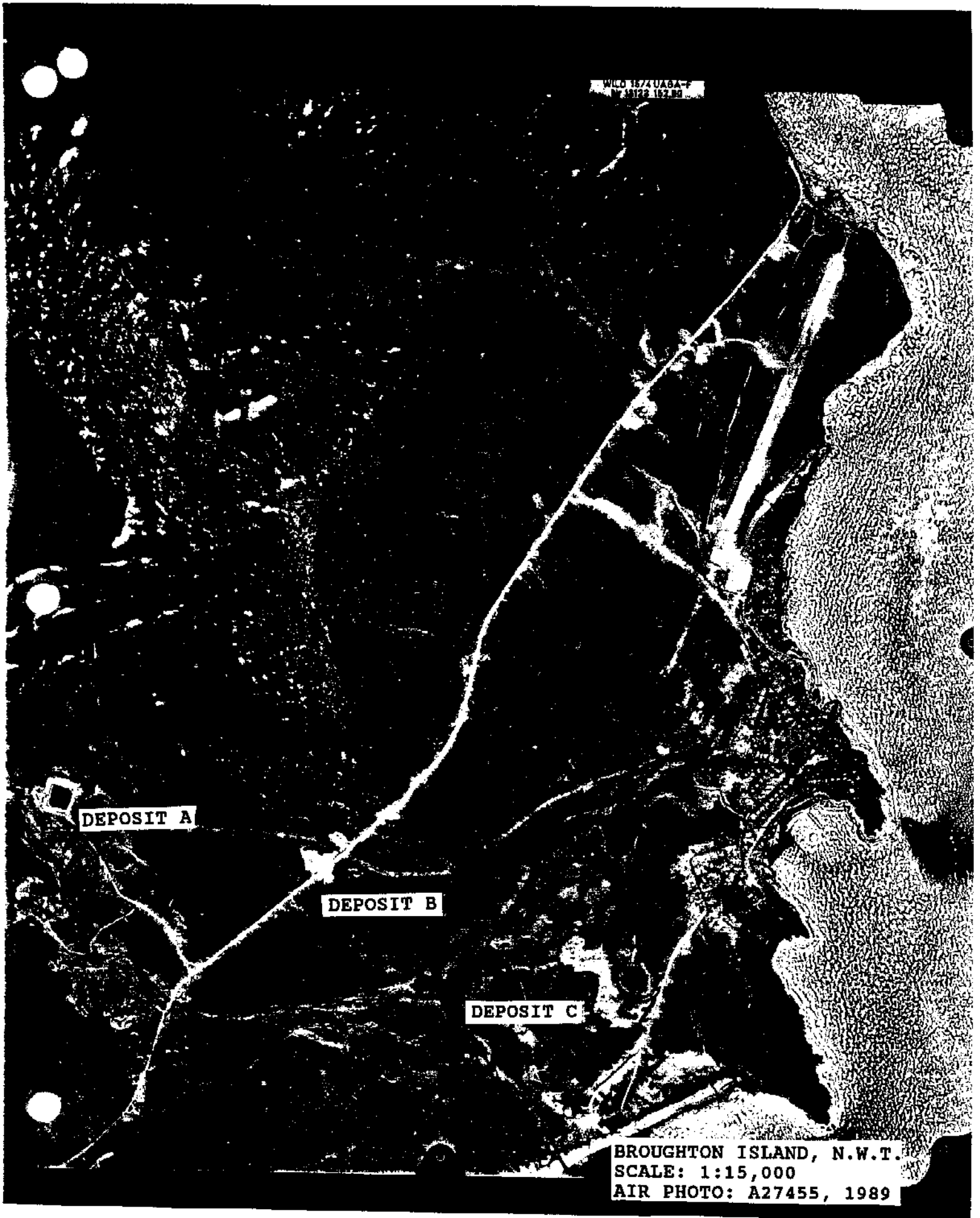
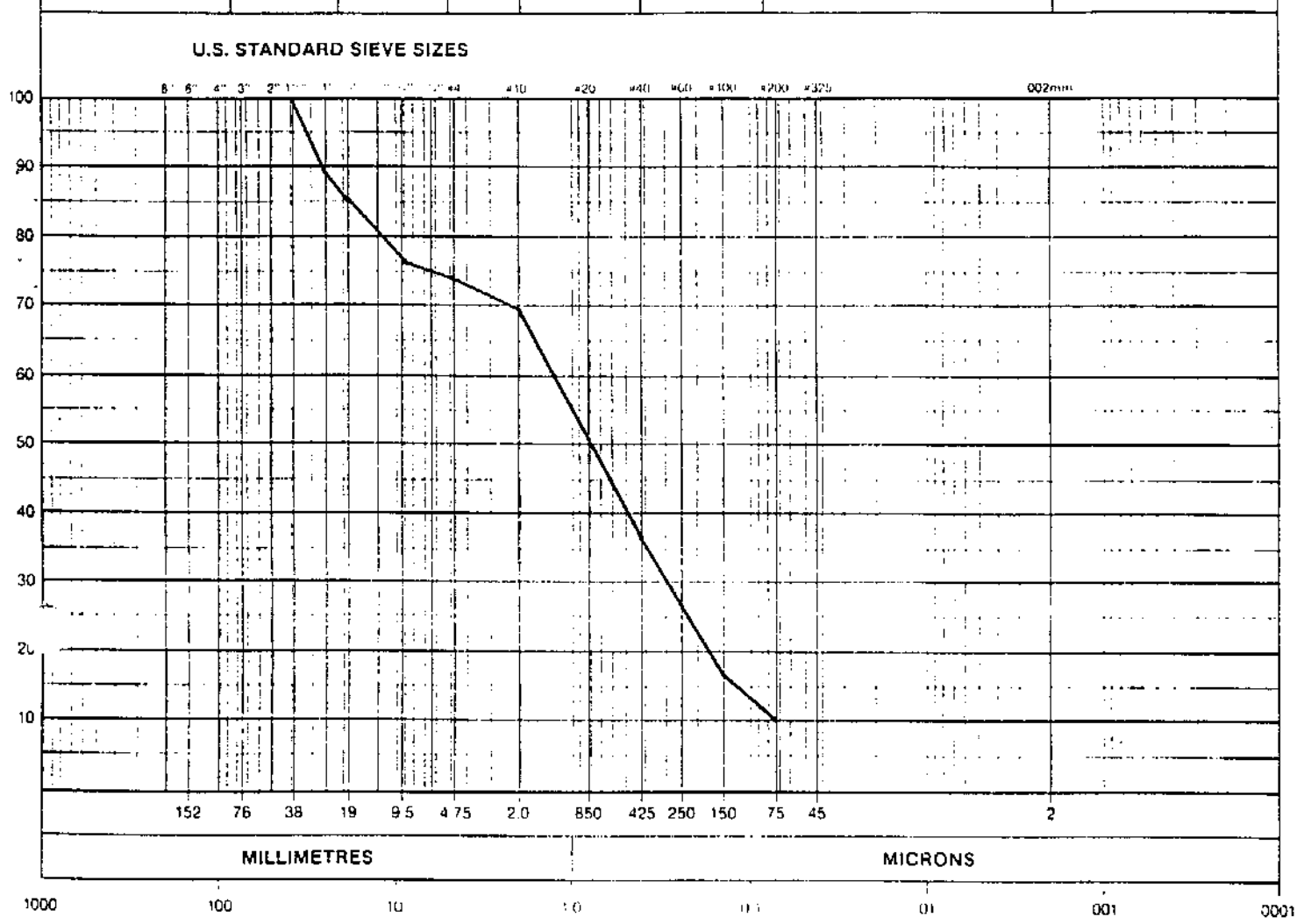


FIGURE 2 YX00342

APPENDIX #2

SOIL GRAIN SIZE ANALYSIS

COBBLES	GRAVEL SIZES		SAND SIZES			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE		



EMARKS: Clyde River #3

Moisture Content - 7.2%

Source A

OTE. UNIFIED SOIL CLASSIFICATION SYSTEM

SUMMARY

D_{10} =	0.075	mm	GRAVEL	26.0 %
D_{30} =	0.30	mm	SAND	63.8 %
D_{60}	1.50	mm	SILT & CLAY	10.2 %
C_U	20	mm		
C_C	0.8	mm		

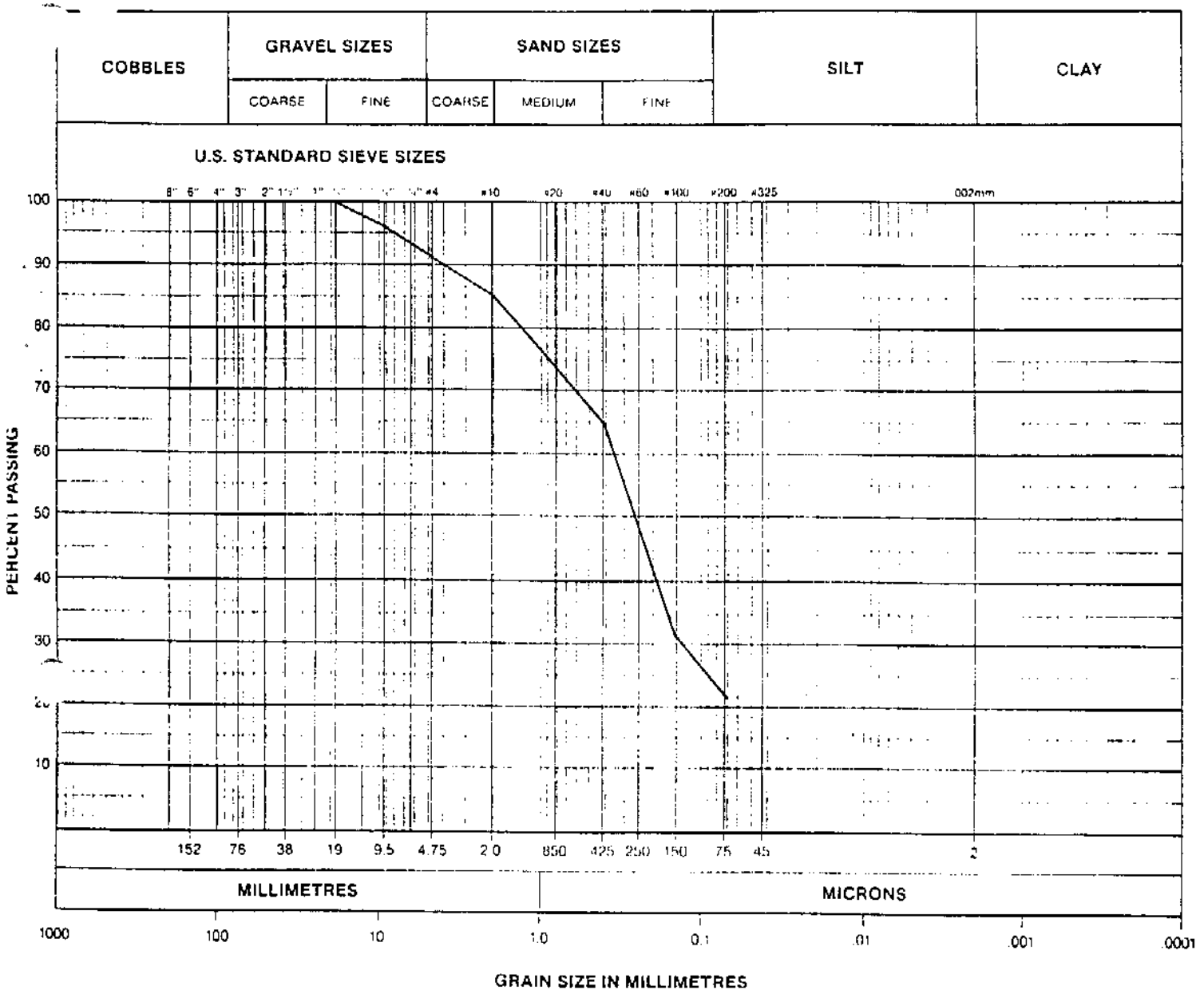
HBT AGRA Limited
Engineering & Environmental Services

SEWAGE LAGOON DECOMMISSIONING
GEOTECHNICAL STUDY
CLYDE RIVER/BROUGHTON ISLAND

Test Hole No. ..... Sample ..... Depth .....

GRAIN SIZE DISTRIBUTION

JOB NO. YX00342



REMARKS: Clyde River #1

Moisture Content - 7.6%

Source At Land fill

NOTE. UNIFIED SOIL CLASSIFICATION SYSTEM

SUMMARY

D_{10}	N/A mm	GRAVEL	7.9 %
D_{30}	0.14 mm	SAND	69.8 %
D_{60}	0.37 mm	SILT & CLAY	22.3 %
C_U	N/A mm		
C_C	N/A mm		

HBT AGRA Limited
Engineering & Environmental Services

SEWAGE LAGOON DECOMMISSIONING
GEOTECHNICAL STUDY
CLYDE RIVER/ BROUGHTON ISLAND

Test Hole No. Sample Depth

GRAIN SIZE DISTRIBUTION

JOB NO. YX00342

APPENDIX #3

HAMLET EQUIPMENT RATES

Hamlet of Clyde River
Rental Rates - 1992/93

Equipment	Dry	W/O Operator	W. Operator
Pick-up	24.50	31.37	58.90
Case Loader	122.50	134.00	161.50
Cat Loader	89.90	101.30	131.99
Bulldozer	112.90	131.15	158.65
Grader	99.30	116.40	143.85
Dump Truck	48.30	56.90	84.40
Garbage Truck	25.25	32.10	59.60
Water Truck	89.95	99.80	127.30
Sewage Truck	59.40	69.40	96.60
Dirt of Gravel	18.50 m3		
	1.99 ft3		
Buildings			
Garage	~~6.00 min. — Parking seat~~		
	9.60 per hr. " "		
	72.00 per day " "		
Misc.			
Welder	12.99		
Generator	6.90		
Concrete mixer	8.10		
Air compressor	13.75		
Trailer	6.00		
Pionjar	12.00		

Adminstration fee of 15% applies to the above rates. 6.5% to government agencies. 7% GST excluded.

APPENDIX #4

WATER SAMPLE LABORATORY ANALYSIS

- Place material and push in place with a dozer or loader.

- Compact the material with rubber tired equipment, such as a dump truck carrying a gravel load.

- Maintain material moisture by applying water.

The above operation will provide a cap with an expected hydraulic capacity of 10^{-3} to 10^{-4}.

2.3 History of Site Operations

The waste disposal area is located on the face of a ridge to the southwest of the community. The area is accessible year round by a road which runs along the spine of the ridge. To the north of the landfill is the Hamlet cemetery. The relative locations of the road, community, cemetery, and landfill are shown on **Photo Plate 1**.

The landfill area consists of a granular plateau with a 10 m high bluff on the south face. The foreman stated that the landfill was operated by pushing the waste over the edge of the bluff and capping the waste mass with granular material. According to the Hamlet foreman, the waste mass extends 30 m to 50 m into the plateau area and there is approximately 1.0 m of cover material over the waste mass. At the base of the bluff is a natural drainage course that drains snow melt water through a bog and into the bay. The plateau and drainage area can be seen in **Photo Plate 2**.

The landfill cover material used by the Hamlet is from the north side of the plateau, shown as '**G**' on **Photo Plate 2**. The material is stock piled with a dozer and then placed with a loader over the waste mass.

In discussion with the Hamlet foreman, the waste placed in the landfill includes all domestic and sewage waste from the community. To his knowledge no waste from the D.E.W. Line Operation has ever been disposed of in the landfill.

During the site investigation, the working face of the landfill as shown in **Photo Plates 3 and 4**, had typical waste of a northern community:

- barrels, fuel tanks, and scrap metal

- organic waste, and animal carcasses

- honey bags

Some litter and miscellaneous waste was noted to be scattered on the slope down from the working face. This litter consisted of wind blown paper and rags, as well as barrels, snowmobile parts, and miscellaneous metal.

According to the Hamlet, in 1992 they had a barrel crusher on site. The crusher belongs to the Department of Indian and Northern Development (D.I.A.N.D.), and will travel to each of the communities in the Baffin Region over the next several years. The community undertook a crushing program of old waste oil barrels. These barrels are still located on the beach, shown as location '**I**' on **Photo Plate 2.**

Water samples downstream of the landfill area were taken at locations '**J**' and '**K**', shown on **Photo Plate 2.** The results of these samples are included in Appendix #2. **Table #1** shows the results of these tests and previous testing by D.I.A.N.D. These samples indicate high levels of ammonia and are typical of the municipal sewage being disposed of in this area. We understand that by fall 1993 the sewage will no longer be disposed of at this location.

The water test results are preliminary only and many parameter analyses were not completed at the time of this report. Final analysis and reporting is expected in mid to late August.

TABLE #1 - Water Sample Results

Location	CR-02	CR-02	CR-04	CR-04	#1	#2
Lab #	Lab	920863	900737	920867	930572	930573
Sample Date	08/14/90	08/13/93	08/14/90	08/13/92	06/15/93	06/15/93
pH	7.13	7.60			6.71	6.81
Conductivity (umho/cm)	1780.0	1720.0			444	374
Dissolved Oxygen						
Turbidity (NTU)		260.0			75	22
Colour		500.0			100	65
Suspended Solids	45.0	280.0			168	159
TDS Residue		624.0			210	41
Calcium		12.00				
Magnesium		4.60			2.61	3.33
Total Hardness ($CACO_3$)		49.00				
Total Alkalinity ($CACO_3$)		674.00			132	93.5
Sodium		101.00				
Potassium		37.20				
Chloride		81.80			26	23
Sulphate		68.0			29	36
Fluoride						
BOD 5	500.0					
COD						
Carbon IC						
Carbon TOC						
Ammonia Nitrogen					27.8	19.5
Nitrate + Nitrate	0.060	0.040			<0.008	<0.008
Ttl Kjeldahl Nitrogen						
Phosphorus O-P					2.94	1.93
Phosphorus Tot.	17.000	20.400			3.21	2.11

Location	CR-02	CR-02	CR-04	CR-04	#1	#2
Silica						
Total Cyanide						
Available Cyanide						
Total Resid. Cl						
Sulphide						
Oil & Grease						
Phenols						
Arsenic				0.50		
Cadmium			0.20	0.20		
Copper			2.00	2.00		
Iron			46.00	53.00		
Lead			1.00	1.00		
Mercury (ug/l)					.10	<0.02
Nickel			1.00	1.00		
Zinc			1.00	1.00		
Chromium			1.00	2.00		
Manganese						

* Note: Values are expressed in ug/l unless noted

Locations:

CR-02 - Sewage run-off at landfill site.

CR-04 - 25 m downstream of landfill site.

#1 & #2 - Locations as shown on Photo Plate #1.

3.0 REGULATORY REQUIREMENTS

Several government agencies regulate the disposal of waste. Their prime concerns, as related to our site inspector at the time of inspection, are described by agencies below:

Baffin Regional Health Board

The Health Board's mandate is to prevent human contact with substances that may have harmful effects. With respect to landfills, the contact could be direct, or indirect through the migration of material (wind blown litter) or from leachate. The current regulations require that all waste disposal areas be located a minimum of 450 m from the community, and that appropriate signs be in place to warn the public of the potential hazards.

In discussion with Dave Paradis, Environmental Health Officer of the Baffin Regional Health Board the following items were confirmed:

- A 450 m set back is required for active sites. This set back may be reduced if:
    - the site is no longer active.
    - the site does not have exposed waste.
- The site should be well marked and located on the community plan to prevent inappropriate future land use on the site.
- A leachate monitoring program be established.

Department of Fisheries and Oceans

The D.F.O. regulates the release of all substances to a salt water body. In particular, the substance should not be deleterious to the fish stock. From the disposal area this is defined to include surface run off water, leachate, and waste material that is carried into the sea by wind or water erosion.

Department of Indian and Northern Development

The D.I.A.N.D. regulates all activities carried out on Federal land including regulating the disposal of waste to minimize the effect on land and water resources.

In discussion with Andy Theriault, the District Manager for the Department of Indian and Northern Development, the following issues related to the Clyde River landfill were identified:

- The crushed barrels located on the beach (location '**I**' on **Photo Plate 2**) should not be entombed in place. The material can be entombed if it is relocated away from the water front. The most favourable location for burial of the waste is the new landfill facility with the barrels segregated from the domestic waste mass.

- The landfill waste may be entombed in place provided there is minimal risk of the waste and capping material being eroded by wind and water.

The Northwest Territories Water Board

The N.T.W.B. governs the use and release of water to and from a fresh water body. This includes the release of any substance that may have a deleterious effect on the water quality contained in a fresh water body.

Hamlet of Clyde River

In discussion with the council the following concerns were raised by members of the community:

- There is a need to monitor the water from the landfill area so the people know if they can fish in the bay.

- The community would like to see the site cleaned up and the littered waste disposed of properly.

- No reported health concerns have been related to the consumption of fish stock from the Bay area.

4.0 CLOSURE CONCEPT

The closure concept is developed, based on the regulatory requirements and on the findings of our site investigation. The concept will:

- Relocate the barrels along the water front to the new barrel disposal area.
- Collect and entomb wind blown litter at the base of the old site.
- Cap and entomb the working face.
- Provide signs around the site to notify people of the disposal area.
- Monitor ground water downstream of the site on an annual basis. Samples taken at the locations shown in **Photo Plate 2** are to be forwarded to the D.I.A.N.D. lab in Yellowknife for analysis.

5.0 CAPITAL WORK PLAN

5.1 General

A work program with estimated costs for manpower and equipment is required to establish funding requirements. The workplan is also set out to match the funding available to the Community and permit the use of Hamlet operated equipment for the closure work. M.A.C.A. does not desire the work to be completed by an outside contractor. The available equipment operated by the Hamlet and the applicable hourly rates are shown in Appendix #3.

The following sections outline the disposal methodology for the closure concept and lists the estimated manpower and equipment requirements for the proposed workplan. Detailed estimates of manpower and equipment are shown in Appendix #5.

5.2 Barrel Dump

Area 'I' on **Photo Plate #2** shows the location of the crushed barrel dump. These barrels were generated over a period of years and crushed in 1992, using the D.I.A.N.D. barrel crusher. These are to be relocated to the new barrel disposal area located at the new waste disposal facility.

The barrels are to be loaded into a dump truck using the loader. Barrels are to be hauled to the dump along the Community road system.

MANPOWER AND EQUIPMENT REQUIREMENTS

MANPOWER AND EQUIPMENT	HOURS	HOURLY RATE	COST
Loader	25	$ 161.50	$ 4,037.50
Truck	25	84.40	2,110.00
Labour	4	15.00	60.00
		TOTAL	$ 6,207.50

5.3 Landfill Area

The work involved in the old landfill area consists of two (2) tasks:

- Collection of windblown and scattered waste and disposal in the waste mass.
- Capping and emtombing the waste mass.

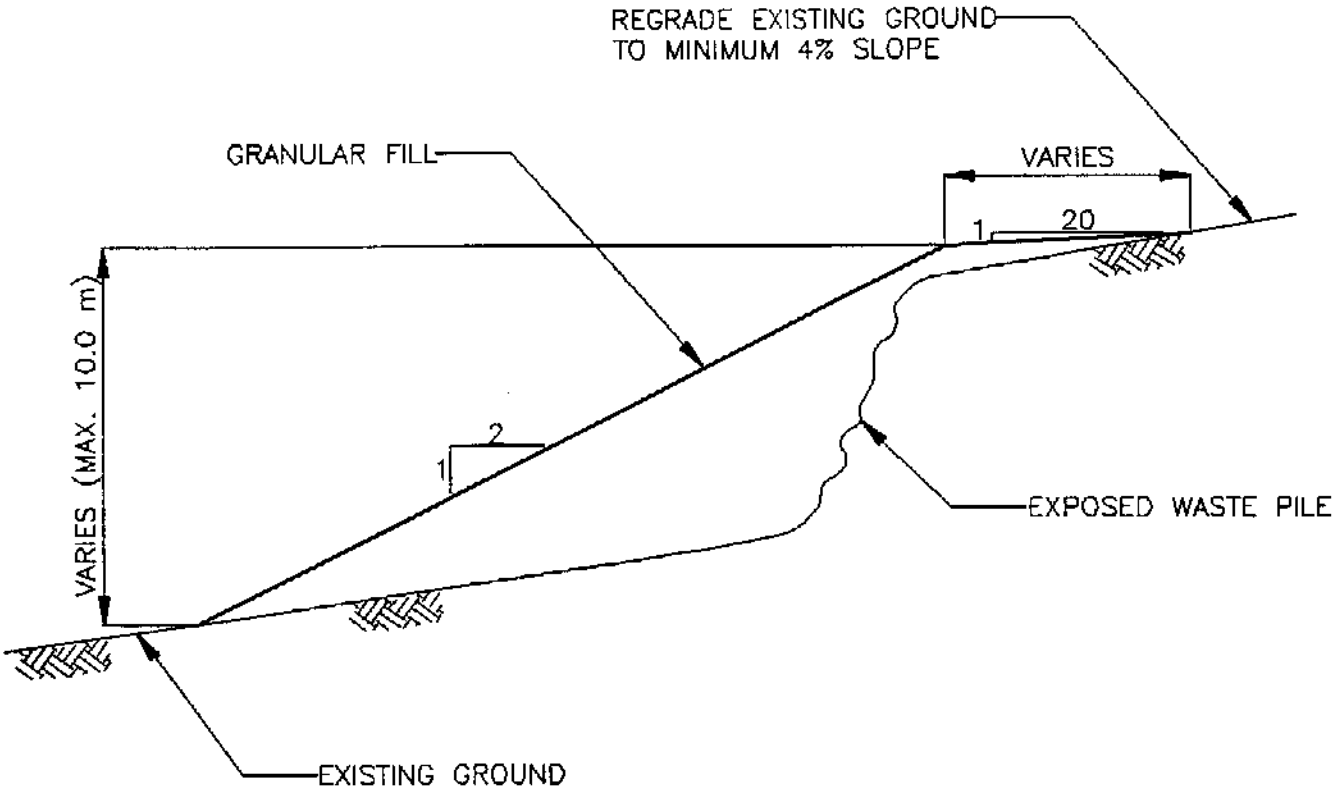
To complete the collection of the scattered waste, labourers are required to pick up the exposed waste. The litter is generally at the base of the working face and towards the Bay. Labourers are to be equiped with appropriate safety gear, including, but not limited to: gloves, safety boots and eye protection.

The waste removal may require heavy equipment. In this case, the dozer is to be used since the area at the time of inspection was wet and inaccessable with a loader or truck.

The working face is to be entombed with the borrow material located adjacent to the landfill. The final slope of the face is to be 2:1 (H:V) and 20:1 (H:V) on the plateau, as shown in **Figure 1**. The material is to be placed and spread with a dozer. The face compaction is to be achieved using several passes with the dozer. The plateau is to be compacted with a dump truck loaded with borrow material.

The following is the manpower, equipment and material requirements for this work:

MANPOWER AND EQUIPMENT	UNIT	UNIT RATE	COST
Scattered Waste:			
Labour			
1	24	$ 15.00	$ 360.00
2	24	15.00	360.00
Dozer	8	158.65	1,269.20
Landfill:			
Dozer	120	158.65	19,038.00
Truck	16	84.40	1,350.40
Granular	7,500	0	0
		TOTAL	$ 22,377.60



NOTES

1. PUSH GRANULAR MATERIAL IN PLACE.
2. COMPACT 2:1 SLOPE WITH DOZER.
3. COMPACT 20:1 SLOPE WITH DUMP TRUCK.

Northwest Territories	DILLON Consulting Engineers · Planners Environmental Scientists	TITLE: SECTION OF CAPPING OPERATION	PROJECT NUMBER: 92-1232
	DATE: AUGUST 1993	PROJECT: CLYDE RIVER SANITARY SITE CLEAN UP	FIGURE NUMBER: 1

5.4 Monitoring

Monitoring of the leachate and surface from the closed landfill is recommended for the period of the closure activities and for three (3) years after the completion of the closure works. Water samples are to be taken on an annual basis at the location indicated in **Photo Plate #1**. These samples are to be analyzed for routine potable water and heavy metal parameters. Results of the analysis should be included as part of the annual reporting for the Hamlet water licence.

6.0 RECOMMENDATIONS

The Hamlet of Clyde River intends to undertake a sanitary site clean up of the old waste disposal facility. The recommended closure concept, as described in Section 4.0 consists of:

- Removing the crushed barrel dump to the new landfill facility.
- Picking up of scattered waste at the base of the old facility working face.
- Entombing and capping the exposed waste.

The estimated cost to complete the work plan for the closure concept is $ 28,600.00.

DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT
WATER RESOURCES DIVISION, YELLOWKNIFE, NORTHWEST TERRITORIES
RESULTS OF LABORATORY ANALYSIS

LICENSEE/ PROJECT: Municipal & Community AFFAIRS	LICENCE NUMBER	LOCATION
DATE SAMPLED	DATE RECEIVED: June 28/93	DATE COMPLETED

STATION NUMBER	Clyde R. #1	Clyde R. #2	BI #3	BI #4	
LABORATORY NUMBER	930572	930573	930574	930575	
ANALYSIS REQUIRED					
pH (units)	6.71	6.81	5.69	6.68	June 29/93 KA
Conductivity (umho/cm)	444	374	25.1	424	
Dissolved Oxygen					
Turbidity (NTU)	75	22	10	4.5	June 29/93 KA
Colour (colour U.)	100	65	45	150	
Suspended Solids	168	159	3	217	JULY 9/93 AS
TDS, Residue	210	91	<10	3	
Calcium					
Magnesium	2.61	3.33	0.39	6.59	JULY 9/93 MT
Tot. Hardness ($CaCO_3$)					
Tot. Alkalinity ($CaCO_3$)	132	93.5	<0.3	11.0	June 29 KA
Sodium					
Potassium					
Chloride	26.	23	5.2	92	July 6/93 DH
Sulphate	29	36		20	
Total Coliform (count/100 ml)					
T Coli (count/100 ml)					
Fecal Strep. (count/100 ml)					
Std. Plate Cnt (cnt/ml)					
BOD_5					
COD					
Carbon, IC					
Carbon, TOC					
Ammonia Nitrogen (as N)	27.8	19.5	<0.002	0.094	July 2/93 DH
Nitrate + Nitrite (as N)	<0.008	<0.008	<0.008	0.045	June 29/93 DH
Total Kjeldahl N (as N)					
Phosphorus O-P (as P)	2.94	1.93	0.600	0.003	JJ2
Phosphorus Tot. (as P)	3.21	2.11	0.604	0.028	JJ2
Silica Reac. (as SiO_2)					
Total Cyanide					
Available Cyanide (WAD)					
Sulphide					
Oil & Grease					
Phenols					
Arsenic T (ug/L)					
Arsenic D (ug/L)					
Cadmium T (ug/L)					
Cadmium D (ug/L)					
Copper T (ug/L)					
Copper D (ug/L)					
Iron T (ug/L)					
Iron D (ug/L)					
Lead T (ug/L)					
Lead D (ug/L)					
Mercury T (ug/L) PPB	.10 .006	<2.02	<2.02	<2.02	ONLY 9/93 <2.02
Mercury D (ug/L)					
Nickel T (ug/L)					
Nickel D (ug/L)					
Zinc T (ug/L)					
Zinc D (ug/L)					
Chromium T (ug/L)					
Chromium D (ug/L)					
Cobalt T (ug/L)					
Cobalt D (ug/L)					

PRELIMINARY RESULTS ONLY.
NOT YET APPROVED.

APPENDIX #5

DETAILED COST ESTIMATE

BARREL DUMP

Distance to landfill via roadway is 2.2 km

Assume: 10 km/hour
20 min. loading
10 min. dumping

$\frac{2.2}{10} \times 60 + 20 + 10 = 43.2$ mins - say 45 mins.

Waste mass $\pm$ 150 m^3

Trip Quantity = 4.5 m^3

Time: $\frac{150}{4.5} \times \frac{45}{60} = 25$ hours