SACHS HARBOUR GRANULAR INVENTORY

FINAL REPORT: MARCH 1992

Phase A of Field Mapping of Potential Sand and Ground Reserves, Sachs Harbour and Holman, N.W.T.

Contract Report No. A17134-1-0019/01-ST

French Arctic Consultants Limited
249 First Avenue
Ottawa, K1S 2S5

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EXECUTIVE SUMMARY

Sufficient aggregate exists in the immediate vicinity of Sachs Harbour to satisfy predicted demand. The quality of granular resources is predominantly of fair quality (Class 3), consisting of poorly graded sands and gravels with a significant silt content. There is a distinct lack of high quality aggregate. Most aggregate occurs as a discontinuous veneer, 1-2 m thick, on the Sachs Harbour ridge, and is derived from local till, further degraded by the proximity of silty bedrock. The highest quality aggregate is to be found in a number of gravelly knolls (hills) on the lower slopes of the Sachs Harbour ridge. These materials are probably ice-contact in origin. Existing pits (SH-5A, SH-4B) contain sufficient aggregate for several years. Easily accessible resources of $\approx$70,000 m^3, mostly Class 3, have been identified and priorities for further extraction established. The Mary Sachs pit (SH-1) still contains large quantities of average quality aggregate (>200,000 m^3). It is recommended that aggregate source SH-5C be developed once the present community pit (SH-5A) is exhausted, and that the present community dump be infilled and buried in the next 1-3 years with aggregate from SH-4B. It is important that site rehabilitation be undertaken at all aggregate resource locations once they are depleted,

because the level of disturbance associated with aggregate extraction is unnecessarily high.

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1.0 INTRODUCTION

1.1 Background

The Inuvialuit Final Agreement (IFA) requires that the Inuvialuit and government develop jointly forecasts of public and community needs for sand and gravel in the vicinity of Sachs Harbour. These forecasts are to be revised on a periodic basis and formal reserves of granular material and any 'restricted development zones' are to be identified.

Funds have been made available under Task 7-Sand and Gravel Inventories of the IFA Implementation Program (IFAIP) to develop an inventory of sand and gravel reserves for each community in the Inuvialuit Settlement Region. The Department of Indian Affairs and Northern Development (DIAND) has been responsible for managing the work plan in co-operation with the Inuvialuit Lands Administration (ILA) and the Government of the Northwest Territories (GNWT). To date, two reports have been completed with respect to Sachs Harbour: a) by EBA Engineering Consultants Ltd. (1987), in which the known supply and twenty year demand for granular materials was forecast, and b) by Hardy BBT Ltd. (1988), in which a plan for the reservation and development of specific sources of granular materials was developed. In addition, a preliminary gravel investigation was conducted by ILA and DIAND personnel in September 1990 (Unpublished report:

S. Kerr). The present report is an extension of these earlier studies and has the following objectives:

1) to map and evaluate potential granular resource materials located in, or near, the community, and

2) to prepare a granular source evaluation statement which would include a discussion of the nature and extent of specific aggregate deposits, and an assessment of current resource utilization.

1.2 Acknowledgements

Included in this report are data collected not only during field investigations in late August-early September 1991, but also observations made during earlier studies of terrain conditions and geomorphic processes between 1969-1984 (e.g., French, 1974a, 1974b, 1975, 1976; French and Harry, 1983; French et al., 1982).

Appreciation is here extended to the large number of residents of Sachs Harbour who, over the years, have assisted me in permafrost and related geological studies in and around the settlement. In 1991 particular thanks go to Peter Sidney, who provided accommodation at short notice. Also, Joey Carpenter, Administrator, Sachs Harbour Community Corporation, and Charlie Haogak, Chairman, Sachs Harbour

Hunters and Trappers Committee, provided valuable initial orientation and much background information. Peter Esau, Mayor of Sachs Harbour, also provided perspective, as did Jane Bicknell, ILA, Inuvik. The base map for the aggregate mapping was provided by MACA, GNWT, Yellowknife, courtesy of Terry Hauft, Manager, Mapping and Surveys Division.

Fieldwork in earlier years could not have been done without the friendship and co-operation of many individuals. These included D. Nasagaolak, P. Esau, P. Sidney, A. Elias, M. Raddi and W. Lucas. In 1976, permission was granted to examine permafrost conditions in the communal ice cellar east of the settlement and in several smaller private ice cellars. This privilege is gratefully acknowledged and the results are included in this report. The present work was authorised by the Department of Supply and Services under DSS Contract No. A 17134-1-0019/01-ST. The Scientific Authority was R. J. Gowan, Geotechnical Advisor, Natural Resources and Economic Development, Indian and Northern Affairs Canada.

2.0 SACHS HARBOUR

2.1 Location

Sachs Harbour is located on the extreme southwest corner of Banks Island. The community is surrounded by ILA lands 7(1)(a) and 7(1)(b) (Figure 1). Sand and gravel rights are attached to both 7(1)(a) and 7(1)(b) lands.

The settlement is sited on gently sloping tundra which constitutes the lower, south-facing slope of an undulating ridge which can be traced both eastward and westward along the southern coast of Banks Island. To the east, the ridge overlooks the lowlands of the Sachs River and rises gradually to elevations in excess of 150 m a.s.l.; to the west the ridge intersects the coastline between Allan Creek Lagoon and the Mary Sachs River to form cliffs 15-30 m high. The airstrip at Sachs Harbour is located on the ridge. The elevation of the ridge at Sachs Harbour is 83 m a.s.l.

Figure 2 illustrate the geomorphological features associated with the Sachs Harbour ridge in the immediate vicinity of Sachs Harbour, and westwards to Allan Creek Lagoon.

2.2 Quaternary History

The Sachs Harbour ridge possesses a veneer of sandy and gravelly glacially-derived materials (till). These also mantle the south side of the ridge. Surficial drilling undertaking in 1973 adjacent to the airstrip indicated that these materials are thin and sometimes discontinuous, being rarely more than 2.0 m thick (French, 1975). According to

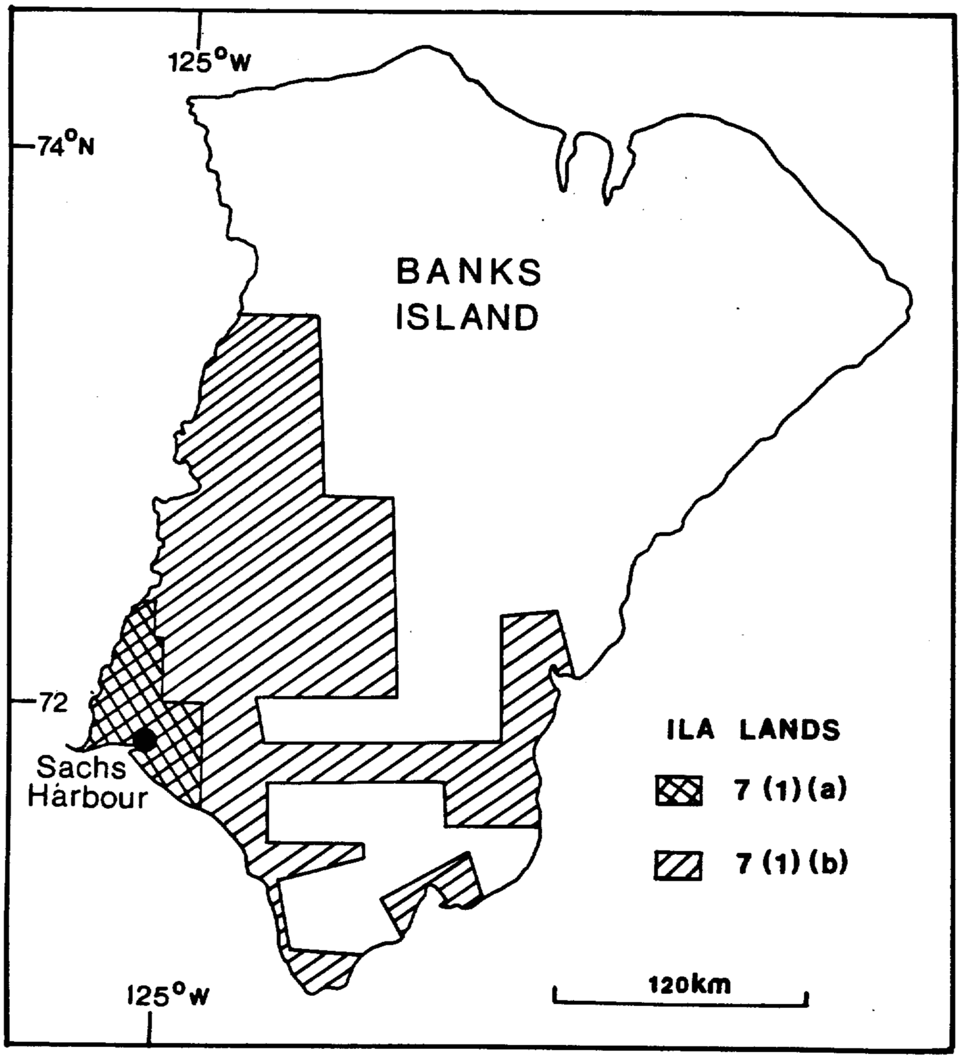

Figure 1. Location of Sachs Harbour and extent of ILA lands 7(1)(a) and 7(1)(b).

AIRSTRIP
0
1
2
3
4
5 km

TABLE 1

Legend for Landforms Map of Sachs Harbour

1. Beach
2. Low angled tundra slopes
3. Sachs Harbour ridge with veneer of gravelly and sandy glacial sediments
4. Upland tundra surface, sloping towards Kellett River
5. Steep, south-facing slope of Sachs Harbour ridge
6. Gravelly knolls (hills)
7. Man-induced thermokarst (airstrip)
8. Flat-bottomed valleys
9. Nivation (snow accumulation) hollows
10. Fans
11. Gullies and ravines
12. Large-scale contraction crack polygons
13. Non-sorted stripes
14. Non-sorted steps and hummocks
15. Non-sorted circles

Figure 2. Landforms map of immediate vicinity of Sachs Harbour. Compiled by H. M. French and L. Dutkiewicz, July 1979

Vincent (1983), they mark the maximum extent of a Middle or Late Wisconsinan age ice lobe which advanced westwards along Thesiger Bay and impinged on the south coast of Banks Island. These morainal sediments have been termed Sachs Till by Vincent (1983). Subsequent to their deposition, they have been modified, smoothed and redistributed down the southern flank of the ridge by gravity and mass wasting processes (rillwash, gullying and solifluction). Today, straight and/or smoothly concave slopes varying in angle from 15-20° in their upper sections to less than 3° on the lower slopes extend towards the present shoreline (Figure 3A). In places, more gravelly and boulder-strewn residual mounds remain on the ridge top and also at intermediate positions down the southern flank of the ridge. In these locations, the sand and gravel deposits are probably much thicker than on the ridge itself.

2.3 Geomorphology

A number of large gullies and hollows on the south side of the Sachs Harbour ridge are the site of extensive snowbank accumulations in winter (Figure 3B). These snowbanks persist late into the summer and, by providing an upslope source for percolating meltwater in summer, promote mass wasting and gullying on the lower slopes. Rates of near-surface movement of 1.0-2.0 cm/year have been

Figure 3A). View eastwards towards settlement showing Sachs Harbour ridge, gently sloping lower slopes and location of settlement.

Figure 3B). Large gully in Sachs Harbour ridge to west of settlement. Aggregate source SH-4B is on the far side of the gully (near truck).

recorded, suggesting volumetric downslope movement of 30 cm^3/cm/year (French, 1974a, 1976). Seepage of water also promotes gullying on the lower slopes (French, 1976). Periodically, as in 1975 and 1976, man-made disturbances to the tundra accelerate gully erosion and thermokarst. More recently, the incorrect installation of road culverts and road fill (subgrade) continue to cause localised erosion and wash-outs.

Figure 4 is a schematic section through the Sachs Harbour ridge in the vicinity of the settlement illustrating the general relationship between relief, surficial geology and the underlying bedrock. Figure 5 illustrates the nature of the sediments which compose the coastal bluffs adjacent to Sachs Harbour.

2.4 Permafrost and ground ice conditions

Apart from a small drilling program undertaken in 1973 (French, 1975) there is little information on permafrost conditions. The mean annual ground temperature (MAGT) is probably -10 to -12°C. The presence of weakly lityified bedrock, often silty in nature, means that ice contents may be high in the upper few metres of permafrost. Thermal contraction cracking is also a widespread process and ice wedges may underlie 5-7% of the terrain (French, 1975, 136). Thermokarst continues to operate in the

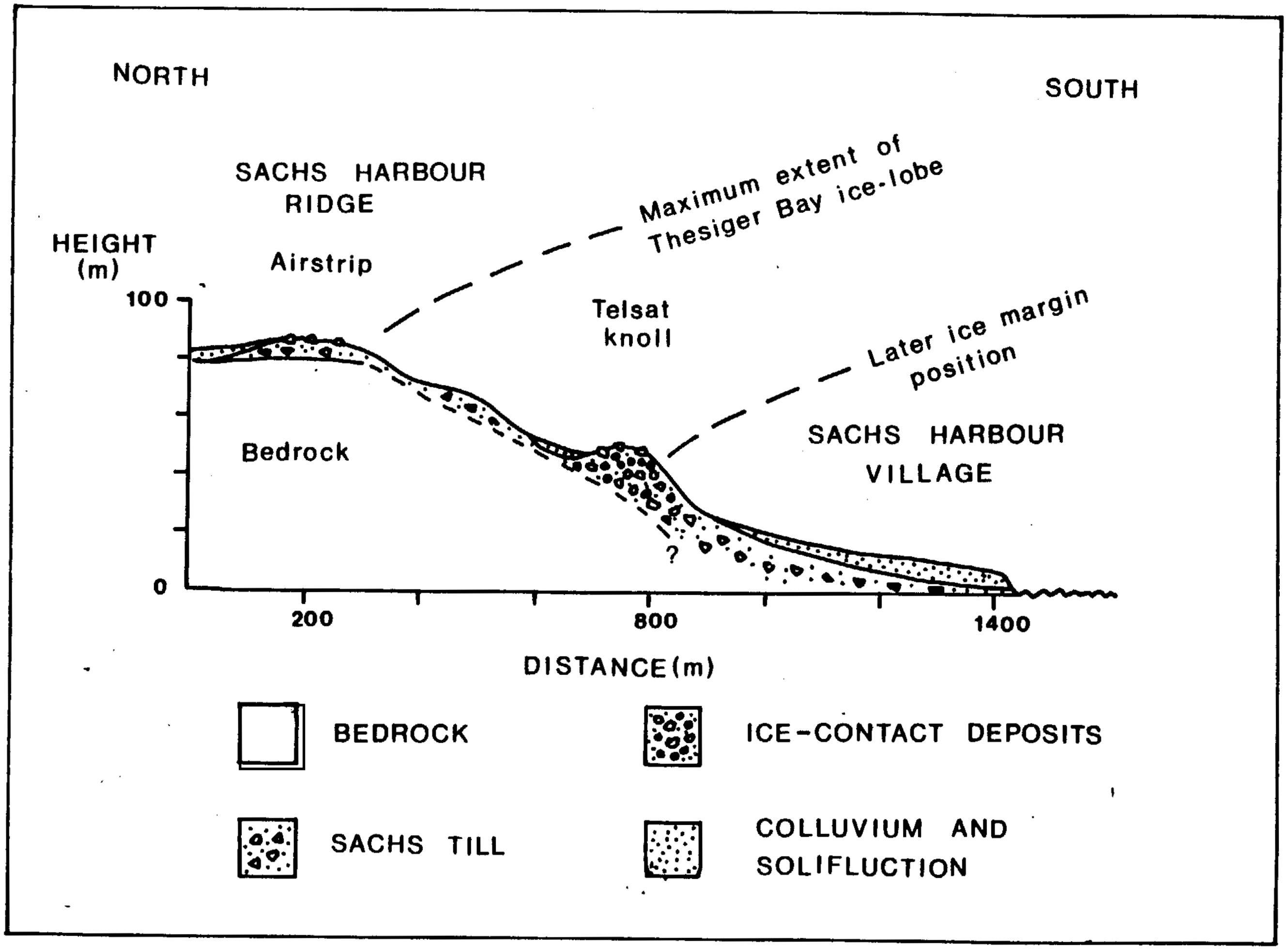

Figure 4. Schmatic cross-section through the Sachs Harbour ridge in the vicinity of the settlement.

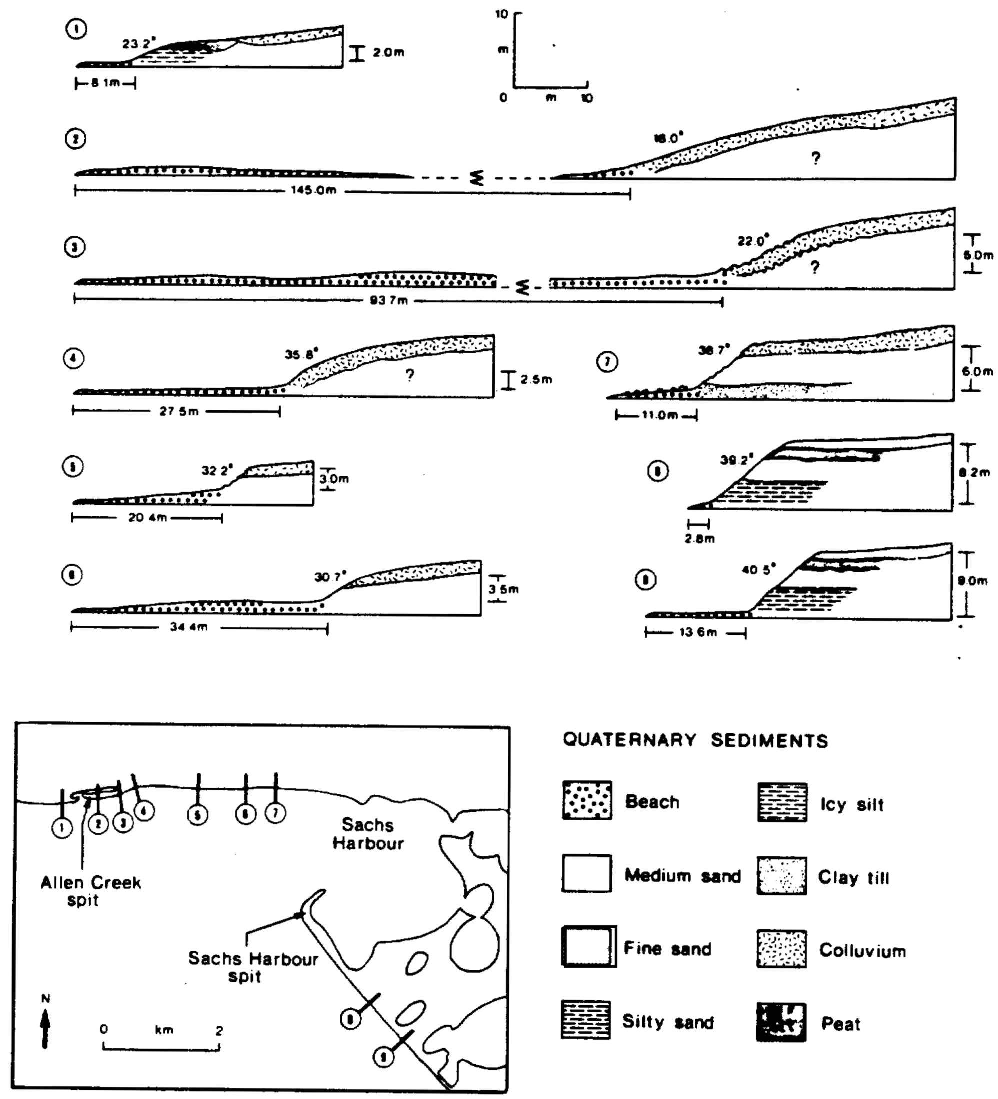

Figure 5. Generalised Quaternary stratigraphy, as exposed in coastal sections adjacent to Sachs Harbour (From: Harry, French & Clark, 1983).

disturbed terrain adjacent to the airstrip (see French, 1975) and elsewhere in the townsite. Melt-out along ice wedges and generally wet conditions are commonly encountered in many of the current aggregate pits (Figure 6). The ground ice conditions in the upper few metres of the terrain adjacent to the airstrip, as reported in 1975, are presented in Table 2. The silty nature of the material is indicated by the consistency limits obtained for a number of samples. In general, these data indicate that ice-rich silty sand interbedded with gravel underlies the immediate surroundings of the airstrip and the Sachs Harbour ridge. Excess ice values of between 10-35% and natural water contents of 50 to 150% are typical of the upper 2-5 m of permafrost.

The settlement of Sachs Harbour is located on the lower south-facing slopes of the Sachs Harbour ridge. The substrate is ice-rich colluvium which can be examined (with permission only) in a number of small ice cellars excavated to depths of 3-4 m by various Inuit families, and also in the larger communal ice cellar located approximately 800 m east of the townsite. Typical cryostratigraphic logs for these ice cellars are illustrated in Figure 7. Values of excess ice of between 20-60% are common, indicating the potential for thermokarst subsidence if thaw were artificially induced.

Figure 6. View of aggregate source SH-5B showing melt-out along ice wedges in floor of borrow pit.

TABLE 2

GROUND ICE CONDITIONS AND SEDIMENTS ADJACENT TO THE SACHS HARBOUR AIRSTRIP
(Source: French, 1975, Table 2 and Table 3)

Borehole	Sample No.	Materials	Depth (cm)	Excess Ice (%)	Natural Water Content (%)	Plasticity Range (%)
A Undisturbed Terrain S side of airstrip	A-2	Sand and gravel	75-110	20	63	-
	A-3	Silty sand	125-150		27	5.4
	A-4	Sand and gravel	200-250		26	4.3
C Disturbed Terrain S side of airstrip	C-2	Fine sand	75-110	60	129	5.3
	C-3	Fine sand	110-125	35	86	4.8
	C-4	Sand and gravel	130-145	35	40	7.1
D Airstrip shoulder	D-1	Fine sand	95-107	30	41	-
	D-2	Silty sand	110-140	95	>300	-
	D-3	Silty sand & gravel	140-190	90	>300	-
	D-4	Sand and gravel	190-215	70	352	-
F Undisturbed terrain, ice wedge depression N side of airstrip	F-1	Coarse sand and gravel	70-80	10	30	6.1
	F-2	Ice, foliated	125-150	95	>300	-

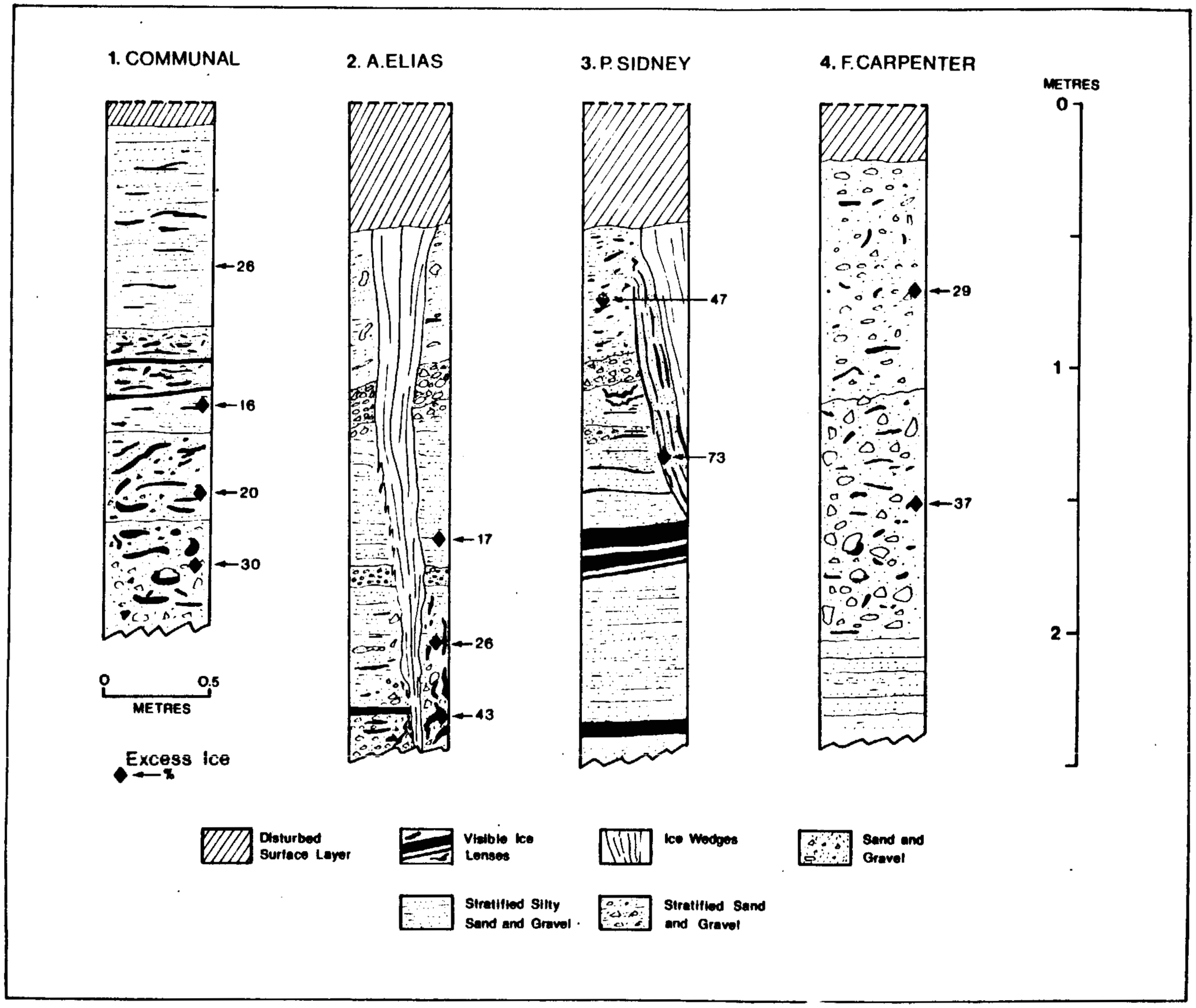

Figure 7. Cryostratigraphy of sediments in ice cellars in townsite of Sachs Harbour, and communal ice cellar 800 m to the east of townsite.

Such observations have relevance to sand and gravel exploitation, since thermokarst subsidence in the floors of borrow pits may limit the volume of potential aggregate which can be extracted.

3.0 MAPPING PROGRAM

3.1 Classification of granular resources

Granular resources are considered in terms of five classes of material:

Class 1	Excellent quality material
Class 2	Good quality material
Class 3	Fair quality material
Class 4	Poor quality material
Class 5	Bedrock, felsenmeer and talus

Table 3 describes these five classes in detail.

Classes 1-4 are defined in terms of the gradation of the deposit, i.e., the relative sizes of particles in the deposit. A 'clean' well graded granular deposit has approximately equal amounts of sand and gravel sizes but little or no silt or clay sized particles (fines). A poorly graded granular deposit has an excess of some particle sizes and a shortage or lack of others, or has nearly all particles the same size. The desirability of locating and

TABLE 3

DESCRIPTION OF GRANULAR RESOURCES, CLASSES 1-5
(Source: Hardy BBT, 1988)

CLASS 1	Excellent quality material consisting of clean, well-graded, structurally-sound sands and gravels suitable for use as high-quality surfacing materials, or as asphalt or concrete aggregate, with a minimum of processing.
CLASS 2	Good quality material generally consisting of well-graded sands and gravels with limited quantities of silt. This material will provide good-quality base and surface-course aggregates or structure-supporting fill. Production of concrete aggregate may be possible with extensive processing, except where weak materials such as shale are present.
CLASS 3	Fair quality material consisting of poorly-graded sands and gravels with or without substantial silt content. This material will provide fair-quality general fill for roads, foundation pads, or lay-down yards.
CLASS 4	Poor quality material generally consisting of silty, poorly-graded, fine-grained sand with minor gravel. These deposits may also contain weak particles. These materials are considered suitable for general (non-structural) fill.
CLASS 5	Bedrock of fair to good quality, felsenmeer (open areas of broken rock), or talus (broken rock at the bottom of a slope). Potentially excellent sources of construction material, ranging from general fill to concrete aggregate or building stone if quarried and crushed. Also includes erosion control materials such as rip-rap or armour stone.

using well graded materials lies in the fact that well graded materials settle well, with finer particles fitting between coarser ones, thereby reducing void spaces to a minimum. The absence of fines is a further advantage since ice lensing and frost heaving is reduced in well drained, coarse soils. The presence of ground ice is also a hindrance in resource utilization since thermokarst can develop in the borrow pit.

3.2 Previous Work

No largescale maps of sand and gravel aggregate exist for the immediate vicinity of Sachs Harbour. An earlier report by EBA Engineering Consultants Ltd. (1987) however, identified possible aggregate bodies and made provisional estimates of supply. These were termed SH-1 to SH-13. With the exception of SH-13, a small sand body adjacent to the Sachs River approximately 10 km ESE of Sachs Harbour, these sources can be grouped into two locations:

a) those occurring along and adjacent to the Sachs Harbour ridge and coast, mostly 10 km to the west of the settlement, and

b) those occurring in the valley of the Kellett River, approximately 9-18 km to the north of the settlement.

In this report, the aggregate deposits in (a) above were investigated on a priority basis because they are closest to the settlement. In addition, the road to Mary Sachs River and Duck Hawk Bluffs, along the Sachs Harbour ridge, provides relatively easy and quick access.

Table 4 summarises the potential supply reported by EBA Engineering Consultants in 1987 for all thirteen of the aggregate sources. It was concluded that only one locality (SH-13) contained Class 2 material, the vast majority being Class 3 material. No Class 5 (bedrock) is available in the general vicinity.

The potential demand volume for the period 1987-2006 was calculated by EBA Engineering Consultants to be 60m^3 (Class 1), 31,400 m^3 (Class 2), 89,350 m^3 (Class 3), and 9,350 m^3 (Class 4). A proposed utilization plan was established, here reproduced in Table 5. Tables 4 and 5 indicate a shortfall of high quality aggregate (Classes 1 and 2) but an abundance of average quality aggregate (Class 3) at Sachs Harbour. This survey was undertaken at a time of relatively high actual or projected activity. Lower

TABLE 4

POTENTIAL SUPPLY OF AGGREGATE IN VICINITY OF SACHS HARBOUR, ACCORDING TO EBA ENGINEERING CONSULTANTS LTD. (1987), TABLE 15

Source	Distance (km)	Site	Quantity (m^3)	Comments
*87-SH-1	9	Mary Sachs Pit	170,000	Currently under development
*87-SH-2	6	Mary Sachs Ridgecrest	30,000	Near road
87-SH-3	4	Sachs Harbour Ridgecrest	25,000	Near road
*87-SH-4	1	Knolls to W of Settlement	50,000	
*87-SH-5	1	Knolls to N & E of Settlement	30,000	Partially depleted, uncertain volume
*87-SH-6	4		20,000	Difficult access, isolated
*87-SH-7	10.5	Baymouth Bar, Mary Sachs	20,000	Coastal environment
87-SH-8	4		200,000	Coastal environment, marginal quality
87-SH-9	10	Kellett Valley	2,000,000	River environment
87-SH-10	9	Kellett Valley	4,500,000	River environment
87-SH-11	13	Kellett Valley	6,500,000	River environment
87-SH-12	18		100,000	
87-SH-13	10	Sachs Lowlands	30,000	Coastal environment, limited size

(Sources indicated by * are subject of this report)

TABLE 5

PROPOSED UTILIZATION PLAN FOR AGGREGATE RESOURCES IN VICINITY OF SACHS HARBOUR
(Source: EBA Engineering Consultants Ltd. (1987), Table 27 including Notes)

Material		1987-1991	1992-1996	1997-2001	2002-2006
CLASS 1	Demand m^3	50	10		
	Source(s)	87-SH-13	87-SH-13		
CLASS 2	Demand m^3	16,400	5,000	5,000	5,000
	Source(s)	87-SH-13	87-SH-13	87-SH-13	87-SH-13
CLASS 3	Demand m^3	29,150	20,200	20,000	20,000
	Source(s)	87-SH-1/2/3/4/5	87-SH-1/2/3/4/5	87-SH-1/2/3/4/5	
CLASS 4	Demand m^3	9,350			
	Source(s)	87-SH-1/2/3/4/5			
CLASS 5	Demand m^3	0			
	Source(2)				

Notes:

1. Source 87-SH-13 is located in a coastal setting but is the only Class 2 material source. As there are no sources of Class 1 borrow material it is recommended that 87-SH-13 be developed and that material be processed to Class 1 criteria as required.

2. Source 87-SH-1 is the largest close source of Class 3 material. Sources 87-SH-2, 3, 4 and 5 are all currently under development but the volumes thought to be remaining are unknown. It is recommended that the latter sources continue to be developed until depleted and restored. Source 87-SH-1 should then be worked as the prime source of Class 3 granular material. However, if large volumes of material are required for any project, the use of either Source 87-SH-9 or 10 (located adjacent to the Kellett River) is recommended to protect the town's supply of granular material.

activity in recent years suggests that these demand volumes may be overestimates.

A second report, prepared by Hardy BBT Ltd. (1988) recommends a strategy to reserve and develop supplies of sand and gravel on Inuvialuit lands in the vicinity of the townsite. The granular resources to the immediate west of the townsite were identified as those which should be reserved for public, community and Inuvialuit use because they are located in an area where environmental, wildlife and harvesting impacts would be minimized and where developmental costs were considered to be the least. However, this report also recommended that the quality and quantity of such resources, especially the availability of Class 2 aggregate, should be more fully investigated.

3.3 This Study

Within the context of these two earlier reports, the present report describes new work undertaken in 1991 which assessed the extent, nature and quality of aggregate resources in the vicinity of the townsite and to the immediate west as far as Mary Sachs River. Black and white air photographs at a scale of 1:5,000 (A 26358-169-197), taken in 1983, were used during field mapping and information subsequently transferred to an air photo mosaic, scale 1:10,000. The latter was compiled by IMC Consulting

Group Ltd. for GNWT-MACA and used photographs flown in 1987. The photomap covers the townsite of Sachs Harbour and the area immediately west as far as Mary Sachs River. Wherever possible, detailed stratigraphic logs were compiled and these data are now entered in the aggregate data bank at IAND, Ottawa, together with UTM grid references for all the sites. Aggregate samples were analysed in the laboratory to confirm the quality assessments made in the field. The entire area along the Sachs Harbour ridge as far as the Mary Sachs River was subject to detailed field scrutiny. Unused, depleted and currently exploited sites were all visited. The lack of drilling equipment, however, means that the extent, thickness, volume and quality of the aggregate still remains speculative to a degree. In this report, conservative estimates are reported. The location, extent and quality of granular reserves are indicated on Figure 8 (back folder).

4.0 SAND AND GRAVEL RESOURCES

4.1 General

Sand and gravel appears to be widespread in the vicinity of Sachs Harbour but this is deceptive since it is frequently just a veneer, less than 1.0 m thick, which has been transported and redistributed across underlying bedrock by mass wasting (solifluction) processes. As a consequence, it is sometimes difficult to distinguish between glacigenic surficial materials senso stricto and underlying weakly lithified silty sandy bedrock. In the absence of drilling, the position of the underlying bedrock topography is inferred subjectively.

With the exception of gravelly knolls (hills) on the south flank of the Sachs Harbour ridge and small areas on the ridge crest itself, it seems best to assume that bedrock is relatively near to the surface at all localities. This limits the quantity of aggregate thought to be present. There are several reasons which suggest that bedrock is close to the surface: 1) Sands of Eureka Sound Formation are exposed on the north side of Kellett River 8 km north of the settlement, and bedrock also outcrops at Duck Hawk Bluffs, 12 km to the west. 2) A small exposure of silty sand, recognized as Eureka Sound Formation, occurs in a gully on the southern slope of the Sachs Harbour ridge near gravel locality SH-4D, approximately 1 km west of the village. 3) An apparent bedrock-controlled structural surface, recognisable on air photographs (see Figure 8), occurs immediately north of the airstrip. 4) Man-induced thermokarst in the various borrow pits on the Sachs Harbour ridgecrest indicates melt of ice-rich silty strata lying immediately beneath a thin veneer (1-2 m thick maximum) of gravelly, soliflucted glacigenic material.

The quality of the granular resources in the vicinity of Sachs Harbour is predominantly Class 3 and relatively little Class 2 (see Table 5 for definitions). The reason for the inclusion of most aggregate in Class 3 undoubtedly is the presence of a significant percentage of fines. These reflect the derivation of the aggregate from locally-derived till (Sachs Till). Most aggregate sources on the Sachs Harbour ridge itself are in this category (i.e., morainal in nature), further degraded by the proximity of silty bedrock. Thermokarst in the borrow pits is typical once the upper 1-2 m has been removed (e.g., SH-1, Mary Sachs Pit; SH-5, Community pit). By contrast, the gravelly knolls (hills) on the lower slopes of the Sachs Harbour ridge are probably ice-contact in origin (i.e., glacio-fluvial) and possess fewer fines. As a result, these deposits undoubtedly constitute the best aggregate in the vicinity (e.g., SH-4C, SH-4F). The schematic cross section illustrated earlier (Figure 4) emphasises the existence of these two types of aggregate source. Unfortunately, several of the gravelly knolls cannot be further exploited because of construction (e.g., hill on which Telesat building and fuel storage tanks are situated) or other uses (e.g., hills on which the graveyard and navigation beacon are situated).

The largest source of granular aggregate currently being used is SH-1 (Mary Sachs Pit), located on the Sachs Harbour ridgecrest 8 km west of the settlement. It is on Inuvialuit 7(1)(a) land. This source is thin (2-3 m thick maximum) but extensive. A conservative estimate is that 200,000 m^3 of Class 3 aggregate exists in this general vicinity. With relatively easy access by road, this source must be regarded as the main aggregate source for major projects. Reserves here are sufficient to meet community needs for at least five to ten years; however, the costs of transportation to the townsite make localised and smaller sources nearer the townsite more attractive.

It should also be noted that current field investigations also indicated that significant quantities of Class 2, and possibly Class 1, probably exist at lower elevations in the coastal bluffs in the vicinity of SH-1. Access to the bluffs, and environmental concerns related to shoreline protection, will limit development of this aggregate, however.

Two sources in the townsite are currently being utilized: SH-5A (community pit) and SH-4B (garbage dump pit). Both are semi-depleted with approximately one to three years life left in each. The remaining aggregate at SH-4B is relatively good quality (Class 3, possibly some Class 2) but the community recommends that this should be reserved for infill of the garbage pit once it is full within the next two years and the new garbage location on the Mary Sachs Road comes into operation. The remaining aggregate at SH-5A will soon be exhausted but if it is combined with aggregate at source SH-5B, to the immediate east, the volume available is approximately 20,000 m^3 of Class 3 material. This is a suitable reserve for only two to three years at rates of consumption predicted by EBA Engineering Consultants Ltd. (1987).

To summarise the quality of aggregate resources currently being used, Figure 9 shows grain size compositions of typical Class 3 aggregates taken from SH-1, SH-5A and SH-4B. A silt and clay fraction (<0.083 mm) is present in all samples. It should be emphasised however that a wider range of aggregate quality exists at SH-1 than just Class 3, especially if the lower slopes and the coastal bluffs are considered.

4.2 Location, quantity and quality of granular aggregate

Figure 8 (back folder) indicates the location of the various aggregate sources considered in this report. Their characteristics are summarised below.

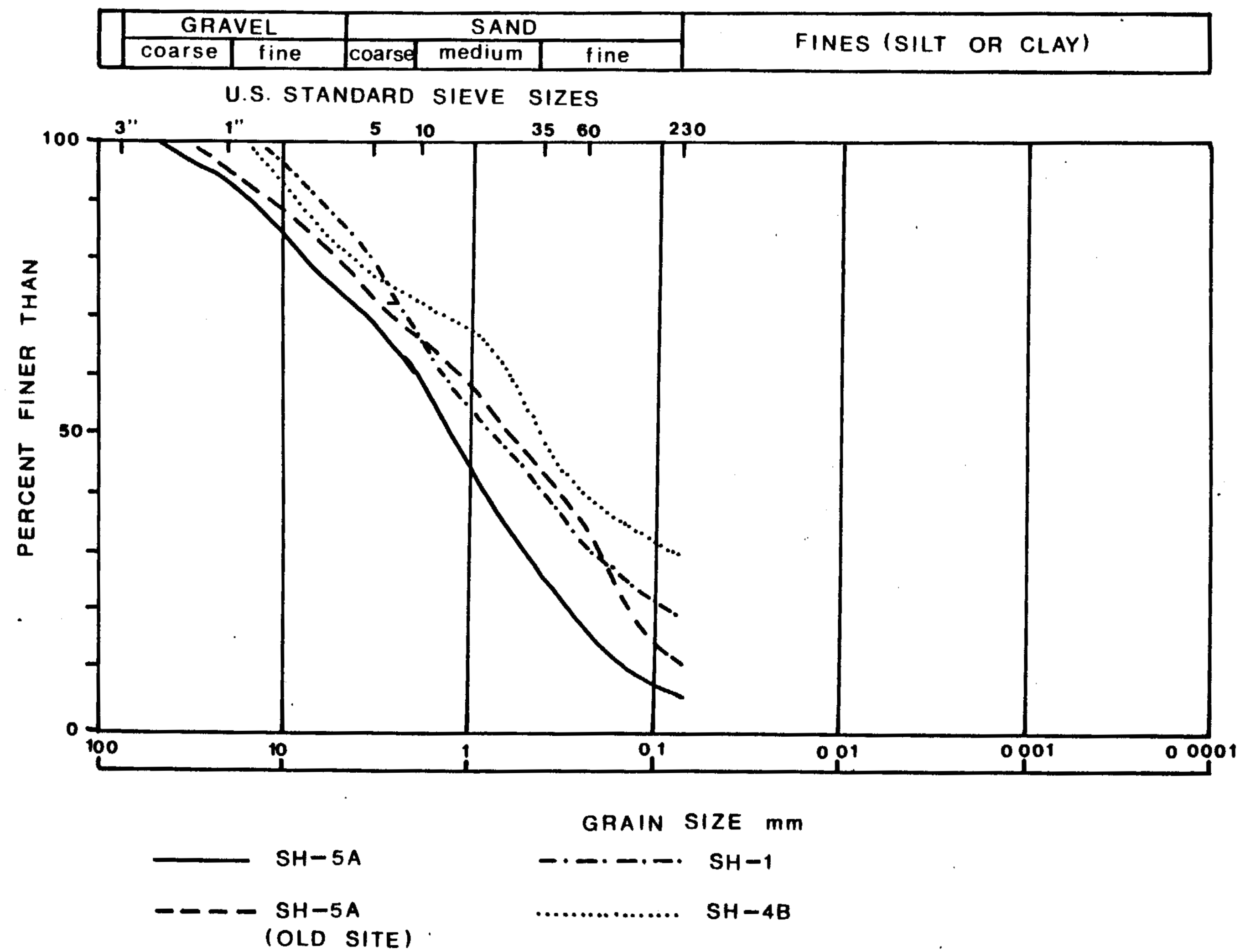

Figure 9. Typical grain size compositions of Class 3 aggregate currently or previously being used at Sachs Harbour. SH-1 = Mary Sachs Pit; SH-5 = Current community pit; SH-4B = current garbage dump.

4.2.1 SH-1 Mary Sachs (ILA Lands 7(1)(a))

This is the largest aggregate source currently being exploited. The aggregate is of glacial (i.e. morainal) origin and occurs as a thin discontinuous veneer 1-2 m thick on the ridge crest between Allan Creek and Mary Sachs River (Figure 10A). It is predominantly Class 3 but small quantities of Class 2 are also present. Based on a maximum thickness of 2 m, a conservative estimate is that 200,000 m^3 are available at this location. However, the deposit is highly variable. In places, fines exceed 15% of the deposit and coarse cobbles and boulders are completely absent (Figure 10B); in other localities a wider range of grain sizes is present but nowhere are these ridge top aggregates either gravelly or stoney. Undoubtedly, the degree to which the till has been washed and redeposited by proglacial streams flowing northwards into the Kellett River valley is the cause of this variability. The silty nature of the underlying, weakly lithified bedrock and the fines present in the aggregate itself further contribute to the dominance of average quality materials. Thermokarst frequently occurs in the borrow pit floors and hinders exploitation.

If extraction were extended to the coastal bluffs between Allan Creek and Mary Sachs, considerable quantities of Class 2 and additional Class 3 aggregate would be

Figure 10A). View eastwards along aggregate source SH-1 (Mary Sachs) showing depleted borrow area.

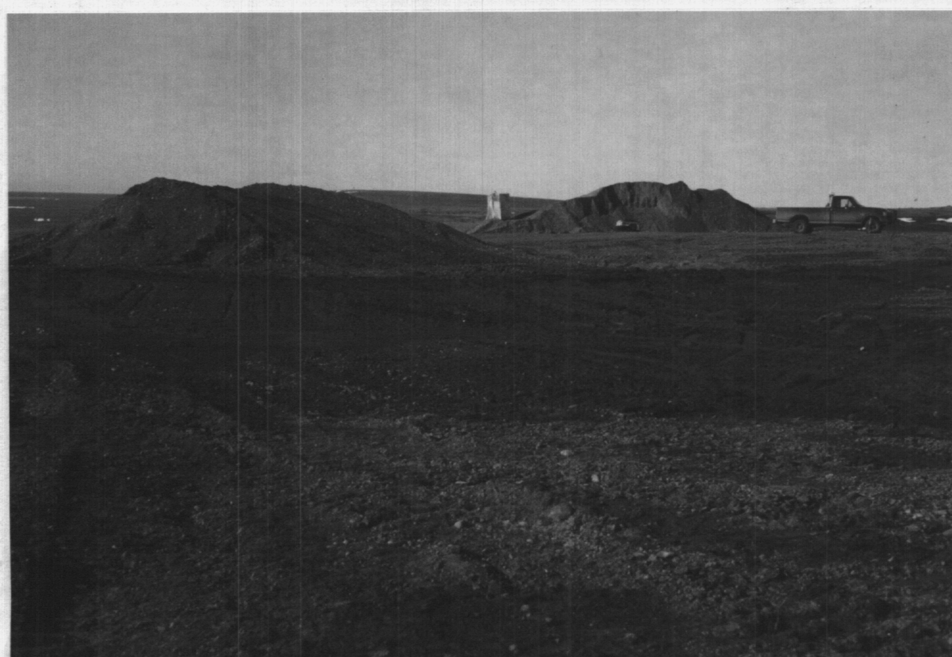

Figure 10B). Stockpiling of Class 3 aggregate at SH-1 (Mary Sachs).

available. However, the risks of disturbance must be carefully assessed, and access would need to be established. Although the aggregate appears to be thick, often 5-10 m in places, the bedrock topography is unknown and the volume of aggregate difficult to quantify. Its ice-contact origin, banked up against the Sachs Harbour ridge, has resulted in a relatively cleaner and better graded deposit. Even if only a conservative estimate of 50,000 m^3 of Class 2 aggregate were to exist, this would be a definite asset to Sachs Harbour.

4.2.2 SH-4 Gravel hills west of Sachs Harbour (ILA Lands 7(1)(a) and Townsite Lands)

A number of small isolated gravelly hills between Allan Creek and the townsite constitute localised sources of Class 3 and possibly Class 2 aggregate. The gravel hills are interpreted as ice-contact or kame deposits which have been subsequently degraded by mass wasting and further isolated from each other by gully development. Together, they represent a valuable aggregate source for Sachs Harbour on account of 1) their relatively high quality and 2) their proximity to the townsite and relatively easy access.

The furthest, and most westerly, mapped as SH-4F, has already been partly depleted, and constitutes Class 3 and some Class 2 material (Figure 11). The last 30 m of the

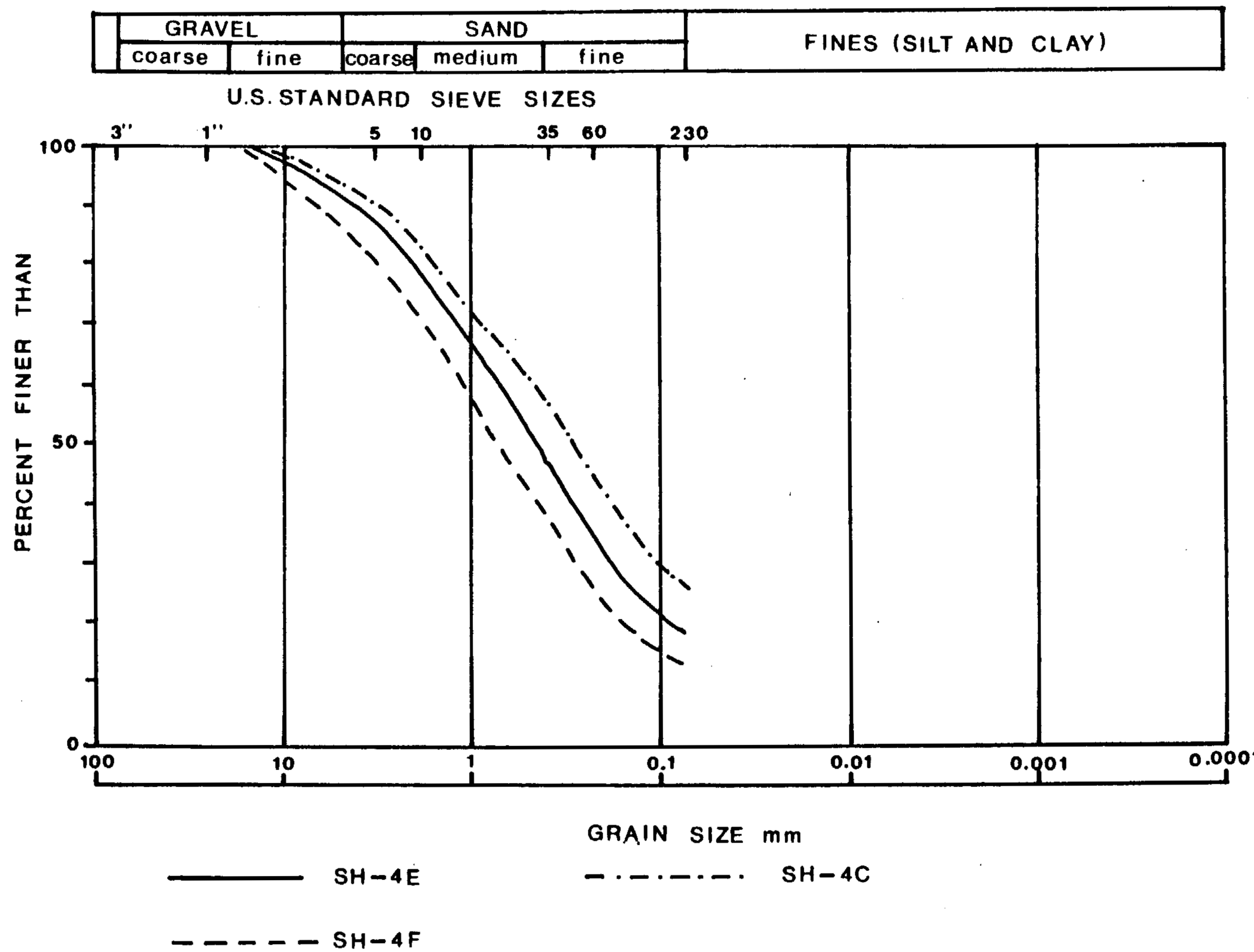

Figure 11. Typical grain size composition of aggregate at locality SH-4.

access road at this site is severely thermokarsted, presumably due to the proximity of underlying icy sandy bedrock, and the source is currently abandoned. Conservative estimates, assuming the bedrock surface is parallel to regional slope, are that only 4,500 m^3 remains at this site, but if a slight change in the bedrock topography is assumed, that volume would increase substantially.

Locality 5H-4E is an undisturbed knoll (hill) approximately 300 m east of SH-4F. In the absence of drilling, volume estimates are difficult but a conservative approach would indicate as much as 12,500 m^3, probably equally divided between Class 2 and Class 3.

Locality SH-4C consists of two knolls (hills) which together constitute a linear spur extending downslope from the main Sachs Harbour ridgecrest. A deep gully immediately to the east of the spur separates it from source SH-4B (see below), the current Sachs Harbour garbage dump location. Again, the absence of drilling makes volume calculations difficult, and the deep gully complicates visual assessments of the position of the underlying bedrock topography. A conservative estimate is that the larger knoll contains 50,000 m^3 and the smaller 5,000 m^3 of Class 3 material. The larger, situated upslope of the smaller, is composed predominantly of moderately graded medium/coarse sand and gravel. However, the cobble fraction is absent and a significant fine fraction is present (see Figure 11), thereby reducing the quality of the resource. The smaller knoll appears to be better graded but is considerably smaller in size.

Locality SH-4B, the site of the present townsite dump, is a much-depleted Class 3 deposit. Approximately 9,000 m^3 of aggregate remains and the community recommends that this should be reserved for burial and infill of the dump site once it is full.

Collectively, localities SH-4F, SH-4E and SH-4C represent accessible and immediate granular reserves of mostly Class 3 amounting to approximately 70,000 m^3 by volume. Locations SH-4E and SH-4C are on community lands; the other (SH-4F) is on ILA-7(1)(a) lands.

4.2.3 SH-5 Gravel Hills north and east of Sachs Harbour (ILA Lands 7(1)(a) and townsite lands)

A number of localised sandy gravel deposits, located in close proximity to the townsite constitute a source of Class 3 and possibly Class 2 aggregate. Two deposits form indistinct linear ridges at intermediate positions on the southern flank of the Sachs Harbour ridge between the airstrip and the village - SH-5A/5B, the present community gravel pit, and SH-4A, the old community gravel pit, now 90% depleted and currently abandoned. The remainder of the aggregate sources in this general vicinity constitute gravelly hills similar to aggregate sources SH-4F, SH-4E and SH-4C described in the previous section.

Source SH-5A is currently utilized by the community. The aggregate is Class 3 (Figure 12) and approximately 20,000 m^3 remains. The deposit extends, in a discontinuous fashion, towards the east (Figure 13), mapped as granular source SH-5B, and on the ridge crest, mapped as granular source SH-5C. In all probability, the deposit is thin, but additional reserves of 18,000 m^3 of Class 3 aggregate probably exist (SH-5B:10,000 m^3; SH-5C:8,000 m^3). SH-5C is on ILA lands 7(1)(a).

Aggregate source SH-4A is mostly depleted and is not considered further in this report.

The three gravelly knolls which exist immediately upslope from the centre of the village and which constitute the intermediate slopes behind the Co-op building constitute limited, but unexploitable, sources of aggregate of possibly Class 2. One knoll (SH-5D), on which the Telesat building and the gasoline tanks are located, was already partially depleted prior to construction of these facilities. However, approximately 17,000 m^3 of Class 2 aggregate probably remains at this site but cannot be used. Likewise, the graveyard knoll, mapped as area SH-5E, and the adjacent

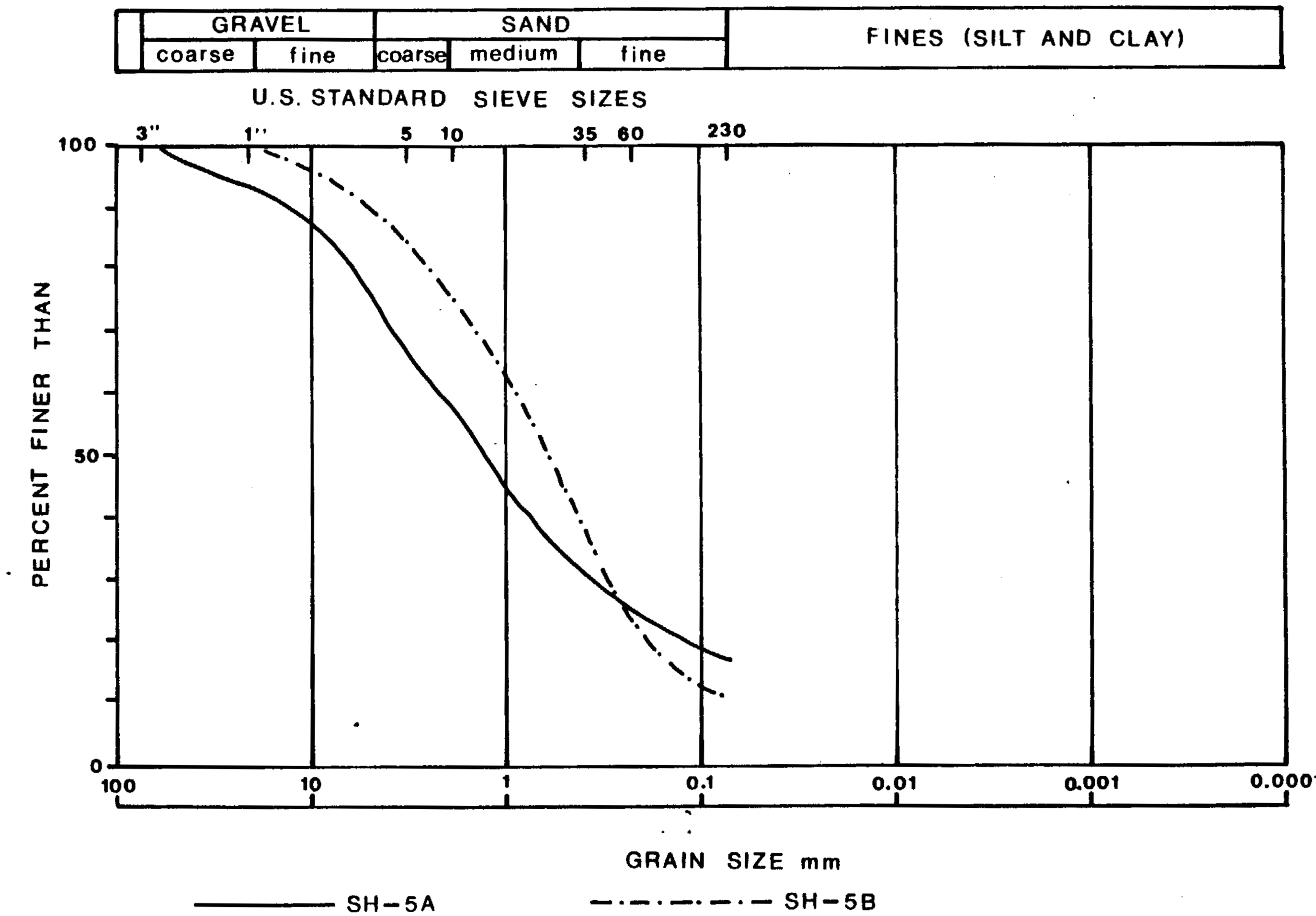

Figure 12. Typical grain size composition of aggregate in SH-5A (community pit) and SH-5B (potential aggregate source to immediate east).

Figure 13. View of potential aggregate source SH-5C. The deposit is 1-2 m thick and constitutes a discontinuous veneer on the Sachs Harbour ridge.

knoll, on which the navigation beacon for the barge is located (SH-5F), each probably possess 10-12,000 m^3 of Class 2 or Class 3 material.

4.2.4 Beach aggregates

Limited quantities of beach aggregate exist in the immediate vicinity of Sachs Harbour, mostly coarse sand and fine gravel. Lacking coarse material and relatively well sorted, these deposits represent Class 3, even Class 4 aggregates. The sand at Allan Creek Lagoon and the baymouth bar at the Mary Sachs River (EBA SH-7) are the largest resources, but environmental considerations, their poor quality and their limited volumes dictate that these not be considered in the aggregate assessment for Sachs Harbour.

Source SH-7 was visited and detailed volume estimates made. These agreed closely with the estimates of EBA Engineering Consultants Ltd. (1987).

Aggregate source SH-13, identified by EBA Engineering Consultants Ltd. (1987) as a Class 2 deposit adjacent to the Sachs River was not examined. In all probability, these deposits are ice-contact rather than marine in origin and, therefore, of relatively high quality. In any case, the Hardy BBT Ltd. (1988) report concluded that exploitation of this resource was a low priority on environmental and social grounds.

4.2.5 Summary

The quantity and quality of aggregate resources existing in the vicinity of Sachs Harbour are summarised in Table 6. Although there is a definite lack of good quality aggregate (Class 1; Class 2), it is clear that:

a) sufficient aggregate exists in existing pits (SH-1; SH-5A; SH-4B) for a number of years. They are predominantly Class 3 in quality.

b) Aggregate sources SH-4E (12,500 m^3), SH-4C (55,000 m^3) and SH-5C (8,000 m^3) constitute easily accessible reserves, mostly of Class 3, but probably also including some Class 2 materials.

The community recommends that existing source SH-4B (9,000 m^3) should be reserved for use in the final burial and close-down of the present community dump. Existing source SH-4F, currently abandoned, still contains approximately 4,500 m^3 of Class 3 and Class 2 material, probably in equal proportions, and should be utilized before new aggregate sources are opened up.

Class 5 aggregate is completely lacking from the Sachs Harbour region. Beach deposits are also limited in quantity, and not of high aggregate quality, and should not

TABLE 6

SUMMARY OF SAND AND GRAVEL RESOURCES IN VICINITY OF SACHS HARBOUR

Source	Name	Location	Proven Volume (m^3)	Quality	IIA Lands
SH-1	Mary Sachs Pit	Sachs Harbour Ridgecrest (Coastal Bluffs ?)	200,000 (50,000)?	Class 3 Class 2	7(1)(a) 7(1)(a)
SH-4F	West of Settlement Partially depleted	Knoll (abandoned)	4,500	Class 2-3	7(1)(a)
SH-4E	West of Settlement	Knoll	12,500	Class 2-3	Townsite
SH-4C	West of Settlement	2 Knolls	55,000	Class 3	Townsite
SH-4B	Community Garbage Dump, Partially Depleted	Knoll	(9,000)	Class 3	Townsite
SH-5A	Community Pit	Sachs Harbour Ridgecrest	20,000	Class 3	Townsite
SH-5B	East of Village	Sachs Harbour Ridgecrest	10,000	Class 3	Townsite
SH-5C	East of Village	Sachs Harbour Ridgecrest	8.000	Class 3	7(1)(a)
SH-5D	Telesat Site	Knoll	(17,000)	Class 2	Towsite
SH-5E	Graveyard	Knoll	(10-12,000)	Class 2-3	Townsite
SH-5F	Navigation Beacon	Knoll	(10-12,000)	Class 2-3	Townsite
		TOTALS:	310,000 (96,000)		

Note: Figures in brackets indicate resources currently not exploitable.

be used without careful consideration of the environmental and aesthetic implications. Any modifications to the coastal bluffs and beaches should be avoided if possible.

5.0 CONCLUSIONS AND RECOMMENDATIONS

1. Sufficient granular aggregate exists in the immediate vicinity of Sachs Harbour to serve community uses for at least the next five to ten years, based on predicted use.

2. The majority of these aggregate deposits are of only average quality (Class 3) and there is a distinct lack of Class 1 and Class 5 aggregate. The Mary Sachs Pit (SH-1) contains large quantities of aggregate, albeit mostly average, quality, for most major projects that might be envisaged for Sachs Harbour.

3. Existing sources currently being utilized (SH-1, SH-5A) should be fully exploited before new resources are developed. This is because the general level of disturbance associated with granular resource extraction is already high.

4. There is no immediate need to consider exploitation of aggregate resources in the Kellett River valley or beyond.

5. The most easily accessible reserves of aggregate are located in SH-4F, SH-4E, and SH-4C to the west of the village (total of 70,000 m^3), and in SH-5B and SH-5C to the east of the village (total of 18,000 m^3).

6. It is important that site rehabilitation be undertaken at all aggregate resource locations, once they are depleted. The level of disturbance associated with aggregate extraction is unnecessarily high, yet aesthetics and a pleasing landscape are important for potential tourism in the community.

7. The remaining aggregate at SH-4B should be reserved for infill and burial of the present community dump in the next two to three years, once it is full.

8. In the interest of minimizing further terrain disturbances in and around the townsite, it is recommended that granular aggregate source SH-5C be

developed once the present pit (SH-5A) is exhausted. Easy access to SH-5C could be made by extending the present road along the ridge for approximately 0.5 km.

9. To further quantify granular resource, and to firm-up reserves, it is desirable that surficial drilling be undertaken on an opportunity basis at sites SH-4C and SH-5C. Also, drilling at SH-1, combined with detailed stratigraphic studies along the coastal bluffs at that point, would further quantify the volume and quality of aggregate at that location.

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