Northwest Territories Public Works

TUKTOYAKTUK GRANULAR MANAGEMENT PLAN

SOURCE 155 NORTH DEVELOPMENT PLAN

Hardy BBT Limited
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SOURCE 155 NORTH - DEVELOPMENT PLAN
COMMUNITY GRANULAR MANAGEMENT PLAN
TUKTOYAKTUK, NWT

Prepared for:
Government of the Northwest Territories
Department of Public Works
Yellowknife, NWT

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September, 1989
YX00112

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1.0 INTRODUCTION

The Community Programs Group of the Transportation Engineering Division of the Government of the Northwest Territories, Department of Public Works and Highways (DPW&H) commissioned a study to develop a granular management plan for the community of Tuktoyaktuk, NWT. The study, which was initiated in 1986, has been conducted in four phases, with interim reporting and reviews between each phase. In accordance with the terms of Contract No. 86.32.1D41 (259) Hardy BBT Limited have undertaken Phases I, II and III of this study, and have subsequently been authorized to complete Phase IV. This report is the final report for the study. A listing of the previous reports is presented at the end of the text.

Due to some re-structuring within the Territorial Government, the Community Programs group, which has been directing this study, is now part of the Engineering Division of the Department of Public Works.

1.1 BACKGROUND

The Phase I report provided a summary and discussion on all previous granular resource studies in the Tuktoyaktuk region. In Phase II, the more prospective sources were inspected and test pitted in August 1986. The report recommended certain deposits for more complete investigation during the winter of 1987.

During a community meeting in February 1987, the Phase II recommendations were considered and it was agreed that only Source 155

North and South should be fully investigated. This investigation, conducted in March 1987, was reported in June, 1987, as part of Phase III.

A final comparison of all potential sources and specific recommendations for a designated community source was presented in May, 1987, essentially completing Phase III of the study. Source 155 North was clearly identified as the borrow source for both road surface and general embankment material for the community.

It had been intended that all concerned parties would review this final comparison and agree in principle to the designated borrow source prior to continuing with Phase IV. Attempts to convene a meeting in Tuktoyaktuk were unsuccessful and hence Phase IV is being completed without the benefit of further input with respect to potential local concerns.

This Phase IV report presents a borrow pit development plan for Source 155 North. Some relevant details on the deposits, based on our Phase III report, are re-introduced for completeness. Details are given for progressive development of the borrow source as well as recommendations for management and restoration.

This final report was presented in draft form in June 1988, and copies were circulated to interested parties for comments. It had always been intended that a follow-up meeting would be held in Tuktoyaktuk, to formally present the proposed development and management plan for Source 155 North. Beyond the adoption of Source 155 North as the designated source by the Community of Tuktoyaktuk, one of the major objectives of the study was to have the Community adopt and commit to the benefits of a controlled development and management of the source. The control would be jointly provided by the Community and the ILA.

It has not been possible to arrange a community meeting to address this last objective, and therefore, it has not been possible to promote the development and management plan. The extent to which the Community of Tuktoyaktuk, or the ILA, have adopted the development and management plan for Source 155 North is not known at this point in time.

2.0 SELECTION OF BORROW SOURCE

Earlier phases of this study have reviewed all potential granular sources within 80 km of Tuktoyaktuk. By process of elimination a small number of potential sources were identified for the required embankment and surface material. This process is summarized in the report "Phase III - Final Comparison of Potential Sources" dated May, 1987.

The final recommendations from the report stated that Source 155 North (A and B) be considered as the prime source of granular material for Tuktoyaktuk. The location of this source is shown in relation to Tuktoyaktuk on Figure 1 (at end of text). The available granular quantities were estimated as follows:

	Available	20 Year Requirement
Road Surface Material	100,000 m^3	100,000 m^3
General Embankment Material	288,000 m^3	400,000 m^3

Since Source 155 North can not provide all of the required embankment material it was recommended that Source 177 could be considered for additional embankment material. Alternatively, additional drilling in the area of Source 155 may prove more embankment material.

The granular material is relatively thin (1-2 m for the most part) and so a fairly large surface area would be disturbed to obtain the required volumes. Other relatively thin deposits close to the community have been discounted because of the greater disturbance effect. It is understood from the community meetings to date that the terrain disturbance in a more isolated area would be considered less critical.

3.0 DESCRIPTION OF SOURCE

The borrow investigation for Source 155 has been reported in detail in our report "Interim Report - Phase III - Winter Drilling Program - Deposit 155" dated June, 1987. Some of the details relevant to the development of Source 155 North are discussed in more detail in the following sections.

3.1 PHYSICAL FEATURES

The granular deposit consists of a glaciofluvial terrace or outwash plain. Ancient erosion has dissected the terrace or plain into distinct areas (i.e. A, B, C and D on Figure 2). The most suitable gravel strata in Source 155 North cover Areas A and B. The surface elevations shown on Figure 3 indicate that these areas are fairly level. The surface of the deposit is in the order of 8 to 10 m above surrounding lake levels. The maximum range of elevations on top of the granular areas is about 2 m. There is a very slight slope downwards from south to north. The edges of Areas A and B are quite steep-sided requiring the careful selection of an access route to the top.

3.2 OVERBURDEN THICKNESS

The overburden covering the granular deposits consists of peat, silt and fine sand and varies in total thickness from a few centimetres to 1.5 m with an average value of 0.6 m. Figure 4 shows the actual overburden thickness at each borehole location and overburden thickness isopachs have been interpolated from this data. The overburden appears to be less than 0.5 m thick over approximately half of the combined Areas A and B. The overburden thickness is greater than 1 m over only about 15% of the deposits.

Organic cover, included in the above total overburden thicknesses, ranges in thickness from 0.0 to 1.4 m, with an average of 0.3 m. Most of the area contains only 0.2 to 0.3 m of organic cover.

3.3 GRANULAR THICKNESS

Figure 5 shows the thickness of the suitable granular material as logged at each borehole location. Isopachs have been drawn to indicate the apparent distribution of the granular material within the deposits. The thickness is generally in excess of 1 m. Over about 20% of the area the thickness exceeds 1.5 m while over about 10% of the area the thickness is between 2 and 3 m.

The granular thickness assumed for extraction consists of all gravel and gravelly sands. These sands are generally well graded and contain from 14 to 40% gravel sizes.

3.4 OVERBURDEN TO GRAVEL THICKNESS RATIO

The ratio of overburden thickness to available gravel thickness is a very significant factor in assessing the potential for economic development of any granular source. The ratio between the overburden and gravel thickness is shown for each borehole location on Figure 6.

The ratio ranges from 0 to 1.33 over the deposit, with an average value from all boreholes of 0.38. This implies that on average, the thickness of overburden within this deposit is less than 40% of the thickness of the underlying gravel.

In general, the lowest overburden to gravel thickness ratio appears to be present in the northeast portion of the deposit while the highest values appear to exist in the south central area. It also appears that the highest ratio coincides with those portions of the deposit where the gravel stratum is thickest. The local presence of gravel in greater quantities would tend to offset the higher cost of stripping those portions of the site where the overburden is thickest.

3.5 FRIABLE ZONE

In some boreholes a distinct zone of more friable (i.e. not hard-bonded) gravel was noted. Beneath this layer and in other boreholes the gravel and sand appeared to be more bonded. Drilling was still possible with a solid stem auger, therefore, the bonding is not very strong. In contrast, the underlying fine sand was definitely hard-bonded.

The thickness of the friable zone appears to be typically related to the overburden thickness. As the overburden thickness increases the thickness of friable gravel decreases. Therefore, in areas of thicker overburden, for example, it may be necessary to rip the gravel in order to push it up.

3.6 ROAD SURFACE MATERIAL

For the purposes of this study a requirement of 100,100 m^3 of road surface material was established by the Transportation Engineering Division. For surface material, a certain amount of fines (silt and clay) are required to act as a binder. Specifications for untreated road surfaces are published by AASHTO (American Association of State Highway Transportation Officials). Designation M 147-65 can be simplified to: a maximum of 25 mm (1"); 8 to 25% finer than 0.075 mm (#200 sieve); a good gradation and a natural moisture content close to optimum for compaction (ideally less than about 10%). Four surface course gradations are provided by AASHTO ranging from as much as 50% gravel with an 8% fines content to sand with as much as 25% fines.

Based on these gradations virtually all of the granular material in Areas A and B is suitable, as pit run, for road surface course. (Some gravels in Boreholes 1, 2, 6 and 13 are too coarse and clean.) Moisture contents are generally in the range of 7 to 12%. Some moisture contents between 13 and 20% were encountered, however, they appear to be randomly distributed.

Local experience in surfacing roads will probably be the best basis for actually selecting the better surface material. It is intended that all granular material not selected for surface material would be used as general embankment fill.

3.7 GROUND ICE

3.7.1 Overburden

Visible excess ice contents in the peat ranged from 30 to 70%. In the silts and fine sands, the excess ice was in the order of 10 to 50% (moisture contents, 15 to 75%). Extremely high ice contents were encountered in the top 1 m in Borehole 155-N-46. Frozen saturated fine sands will be quite hard to excavate during winter stripping operations. Stockpiles of peat and overburden could be quite unstable if allowed to thaw.

3.7.2 Granular Source

The majority of the granular deposits appear to contain very minor amounts of visible ice. The visual estimate in the field averages at 5% with a rare maximum of 20% and a frequent minimum of zero. If excavation and hauling is performed in winter, random excess ice in the deposit will end up in the stockpile. When this excess ice thaws it is expected to drain readily and hence the occasional higher ice/moisture contents should not affect the overall quality of the granular material.

3.7.3 Underlying Sand

This fine sand is hard-bonded with typical visible excess ice ranging from 0 to 15% (moisture contents, 23 to 27%). Massive ground ice or sand with very high ice contents were encountered in five boreholes (155-N-12, 20, 29, 30 and 46). The thickness of massive ice was as much as 2.9 m in Borehole 20, and may be similar at other locations. This massive ground ice must be anticipated randomly beneath the granular deposits. The presence of this ice should have little impact on a given winter operation, being beneath the base of the gravel source. Thaw settlement may occur in the ice rich portions of the abandoned pit, requiring some planning for subsequent access. These areas will ultimately appear as natural ponds.

4.0 DEVELOPMENT PLAN

There will undoubtedly be specific restrictions and requirements stipulated by the Inuvialuit Land Administration as part of a land use permit for contractors operating in the proposed granular source. In addition, contractors should familiarize themselves with the "Environmental Guidelines - Pits and Quarries", and "Access Roads and Trails", published by Indian and Northern Affairs Canada. It is not the intention of this report to stipulate what will be covered by others in the regulatory process. Rather, the following sections present a plan for the development of Source 155 North, that relate to the physical and geological nature of the source.

A development plan is presented which assumes the granular resources can be excavated in winter using conventional equipment. Some alternate plans are also provided for the case where the deposits may be too well bonded for conventional winter excavation.

4.1 ACCESS TO THE SOURCE

The access route and temporary camp location which were used during the March, 1987 borrow investigation are shown on Figure 2. Access to the camp location was entirely on an ice road, Figure 1. A relatively narrow restriction, half way up Kittigazuit Creek, was passable but may not be ideal for a large scale hauling operation. The overland access from the camp location towards Source 155 North was steep in portions and lesser gradients may be required for haul trucks. It is assumed however that the main access would be as far as possible on an ice road and that the overland portion would be kept to a minimum.

The best overland access will have to be selected by the hauling contractor, however, it is not expected to exceed 5 km. Frozen lakes should be incorporated within the overland access wherever practical. Where frozen lakes are to be traversed, approaches must be selected so that bank disturbance can be avoided. Ramps of compacted snow should be used to protect the banks.

4.2 DEVELOPMENT DETAILS

The final approach to Areas A and B will possibly be from the lake to the west, however, access should not be by direct ramping up from the lake, unless it is entirely built up with compacted snow. Preferably, access should be from the sides of the Area as shown on Figure 7. As far as practical, access up the sides of the areas should not entail cutting deeper than the base of the granular source.

No excavation or terrain disturbance should occur within 30 m of any water body. A narrow 5 m rim should be left undisturbed along any border adjacent to a water body, as illustrated on Detail A-A' on Figure 7.

Drainage and erosion control must be considered in all phases of planning and development. Ideally, surface run-off would be drained from the borrow area in a controlled manner to the lower level. This may be difficult however, in soils susceptible to physical and thermal erosion. Alternatively, a perimeter rim, as recommended above, would provide the most effective means of containing surface run-off within the abandoned borrow pit. Retention of the water within the pit may require planning of drainage so that areas required for subsequent access or deeper excavation of granular materials are not inundated.

At access locations a perimeter rim could be left open during winter, however, at the completion at a seasons work the opening must be blocked off with mineral soil to a sufficient height and volume to prevent breaching during the thaw season.

4.3 PROGRESSIVE DEVELOPMENT

The extraction of the granular materials must be conducted in an orderly manner and must ensure complete removal of all suitable material. For a given volume of granular material required for a particular haul season, the gravel thickness isopachs (Figure 5) can be used to approximate the area of pit required. Ideally extraction would start at one edge and work systematically either across or around the source. As an example, Figure 7 shows a tentative progressive development plan for approximately 50,000 m^3 amounts of granular material. The actual order of progression indicated in Figure 7 is significant as the base of the granular deposit appears to dip slightly towards the northwest. The suggested progression should assist in keeping surface water away from subsequent phases of excavation. Some minor additional contouring may be required to assist in this regard.

4.4 OVERBURDEN HANDLING

The most important factor in planning the development will be to minimize the effort involved in stripping, stockpiling and subsequent replacement of two separate overburden materials, the organic mat and the fine-grained mineral soil. The proper salvaging and handling of these materials are critical to the success of the subsequent restoration program.

All vegetation should be included with the organic mat. It is recommended that the organic mat and overburden removal be carried out during the same winter season as the granular material extraction. Restoration of any exhausted portion of the pit is also recommended the same season. In a well planned borrow pit, overburden handling is minimized by covering up a mined-out area with the overburden from the next extraction area as illustrated in Figure 8. This can be achieved for virtually any scale of operation, within the one season. The organic mat, usually a relatively small volume, probably has to be handled twice, as shown on Figure 8. Other variations of the same principle would also be possible.

4.5 COMPLETE REMOVAL

The granular thickness isopachs on Figure 5 provide an approximate thickness of borrow that can be expected in a given area of the borrow source. It should be stressed that the assumed quantity of borrow material includes all gravel as well as sands which may contain as little as 14% gravel sizes. The base of the borrow source should be quite distinct as the underlying sand appears to be consistently a silty fine sand with no gravel and is definitely hard-bonded. Massive ground ice may also indicate the base of the granular material.

In order for the estimated volumes of granular material to be obtained from the source it will be important that the full thickness of the borrow be extracted throughout the deposit. If the lower portion of the granular material is too hard-bonded for conventional excavation, alternate development plans detailed in Section 4.8 may have to be implemented.

4.6 SELECTION OF SURFACE MATERIAL

Since almost the entire source is suitable for road surface material, the selection and separate stockpiling of surface material may not be necessary. However, within a given seasons extraction, there will probably be some more gravelly portions that would be generally more suitable. Again, local experience will provide the best guidelines as to the better material to stockpile separately, if warranted.

4.7 HANDLING MASSIVE GROUND ICE

It is not expected that massive ground ice will be encountered within the granular deposit. The presence of high concentrations of ice or massive ice was only observed in the overburden and in the fine sand beneath the granular source.

When massive ice is encountered during excavation of the granular material, the ice surface should be considered as the base of the deposit. During winter operations the ice will present no problems.

There is a potential for massive ground ice to thaw subsequent to borrow pit restoration. This is not considered a concern from the perspective of terrain stability. If thaw ponds were to be a concern it is suggested that areas where massive ice is exposed could be flagged during excavation. These areas could then be covered with a greater thickness of overburden and organics during restoration in an attempt to reduce the potential for excessive thaw settlement and ponding.

4.8 ALTERNATE DEVELOPMENT PLANS

If significant portions of the granular deposits are too well bonded for conventional excavation (i.e. too difficult to break up with a ripper), alternate plans could be attempted.

4.8.1 Alternate A

The same general progressive development plan (Section 4.3) should be adopted, however, the organic mat should be stripped a year in advance. Only the area to be worked the following winter should be pre-stripped. Some thaw settlement and local ponding of water may occur in the following summer. Depending on the contours exposed following the stripping of the organic mat, some ditching may prove beneficial to control meltwater and rainfall run-off.

Pre-stripping will allow a considerable deepening of the active layer and thawing into the deeper, more bonded granular deposits. This process may permit some drainage and a reduced bonding effect. It may, however, prove necessary to provide a network of drainage ditches in order to produce satisfactory results.

4.8.2 Alternate B

This alternate development plan would include the stripping of the organic mat and removal of the overburden in one winter season. During the following summer months, the exposed gravel material would then be pushed up and stockpiled. This would be accomplished by sequentially scraping off a layer as thaw and permafrost warming permits. This process was employed at the Ya-Ya Lake deposit for many years. Based on that experience (Hayley and MacLeod, 1977) the granular material should be placed as loose as possible in the stockpile, preferably using a conveyor. This procedure allows some evaporation of excess moisture as well. The potential for segregation of material sizes, using a conveyor, is considered less significant than the benefits gained from creating a loose, relatively dry stockpile. In this manner the frozen stockpile should be easier to handle during the following winter, for hauling into the community stockpile.

Once the granular material is removed and as thaw progresses into the underlying sands, the base of the deposit would gradually become almost untrafficable, especially where massive ice is encountered. With proper planning, however, there would be no need to use the base of the pit in summer.

Replacement of overburden and spreading of the organics should occur during the winter following complete extraction from a given area. The stockpiled granular material can be hauled out during any winter season. A stockpile left for a long period may, however, develop a bonded core as rain and snowmelt percolates into the cold interior.

5.0 RESTORATION PLAN

5.1 CONTOURING

At the completion of borrow extraction, working faces that will not be removed during subsequent development phases should be trimmed to a 3:1 (horizontal to vertical) slope. Although the granular material could be stable at a steeper angle, the overlying overburden may be locally unstable even at the 3:1 slope. This flatter angle is also preferable for replacing the overburden and organic cover and for seeding purposes.

5.2 OVERBURDEN AND ORGANIC COVER

Any granular material exposed in the backslope and all of the base of the borrow pit should be uniformly covered with overburden material. A thicker cover over massive ice can be considered in an attempt to reduce thaw settlement and ponding. Organics should then be uniformly spread over the entire slopes and the base.

5.3 REVEGETATION

To stabilize the restored surface and to assist in natural recovery, seeding and fertilizing is recommend. This would be most economically carried out at the end of the winter restoration. In this manner snow melt moisture is available to assist a good early catch of the seeds.

Commercially available grass species adapted to the Tuktoyaktuk region, should be used. The following seed mix and rates of application are recommended:

Species	Percent of Mix by Weight
Arctared Creeping Red Fescue	25
Revenue Slender Wheatgrass	33
Spring Rye	25
Nugget Kentucky Bluegrass	8.5
Tundra Bluegrass	8.5

The seed mix should be evenly broadcast using a cyclone hand spreader at a rate of 60 kg/ha. A 10-30-10 fertilizer should be broadcast at 400 kg/ha to provide sufficient nutrients for seeding establishment and first year growth.

6.0 COST OF GRANULAR MATERIAL

During Phase III, a survey of costs for several granular sources was reported. As explained in that report, the costs received from three regional contractors were not considered to be very reliable, however, when considered on average it was obvious there was not a large difference in the cost of granular material between different sources. For Source 155 the average costs were \$31.50 and \$29.70/m^3 for embankment and surface material, respectively (for a 50,000 m^3 haul contract). Only one contractor was aware of the location of Source 155 and it was clear that the other two contractors were quoting high because of unfamiliarity. For the purposes of this study a cost of \$30/m^3 (1987) could be assumed for the total cost of permits, haul road, stripping, extraction, hauling and restoration. However, if the degree of restoration is greater than normally provided by the contractors, additional costs may be incurred.

7.0 BORROW SOURCE MANAGEMENT

7.1 CONTROLLED DEVELOPMENT

The development plan outlined in Section 4 provides for an orderly extraction of all of the available granular material. With proper planning and field control, the source should be able to yield the full potential.

Planning will involve pre-selection of an approximate areal extend required to yield the volume of material to be extracted in a given season. A 10 to 15% contingency should probably be considered in selecting the area. The pre-selected area should then be clearly staked in the field so that operators know the limits of stripping and excavation.

Locations for stockpiling organics and overburden should be selected to provided for the most efficient materials handling, given the restoration requirements. In no event should organics or overburden be pushed over the edge of the deposit. In the case of a summer extraction and stockpiling operation, the organics and the overburden may become quite unstable upon thawing. Such stockpiles should be carefully located to minimize the impact of slumping and also erosion during summer rains.

The success of any development plan is highly dependent upon the control exercised by the regulating authority and the degree of commitment to the plan by the developers and contractors. Nothing can be accomplished without the full cooperation of all parties and continued monitoring throughout the operation.

In the past, when maybe little geological information was available on potential gravel sources, it was difficult to plan and control the development. For Source 155 North, the designated source of granular material for the Tuktoyaktuk roads, there is sufficient information now available to properly plan and control the development of this source. In this manner it is believed that the maximum quantity of the appropriate granular material can be obtained from the limited resources in the region.

7.2 INVENTORY OF GRANULAR VOLUME

It is recommended that subsequent to each excavation season, the actual volume of granular material obtained be recorded. It will be important to note whether or not the full thickness of available gravel and gravelly sand was extracted. If applicable, the reasons why complete extraction could not be completed should be noted. Comparisons should be made between the actual volumes and that which could be assumed based on Figure 5. As with any new borrow operation, a review of the first years operation should be carried out by the regulatory authority, the developer, the operator and the consultant providing the geological information. In this manner it is believed the optimum development plan can be achieved.

Based upon the above review, the actual volumes within the deposit may require adjustment once operation commences. Keeping a record of subsequent extraction volumes provides an ongoing inventory of available remaining volumes.

Respectfully submitted,

Hardy BBT Limited

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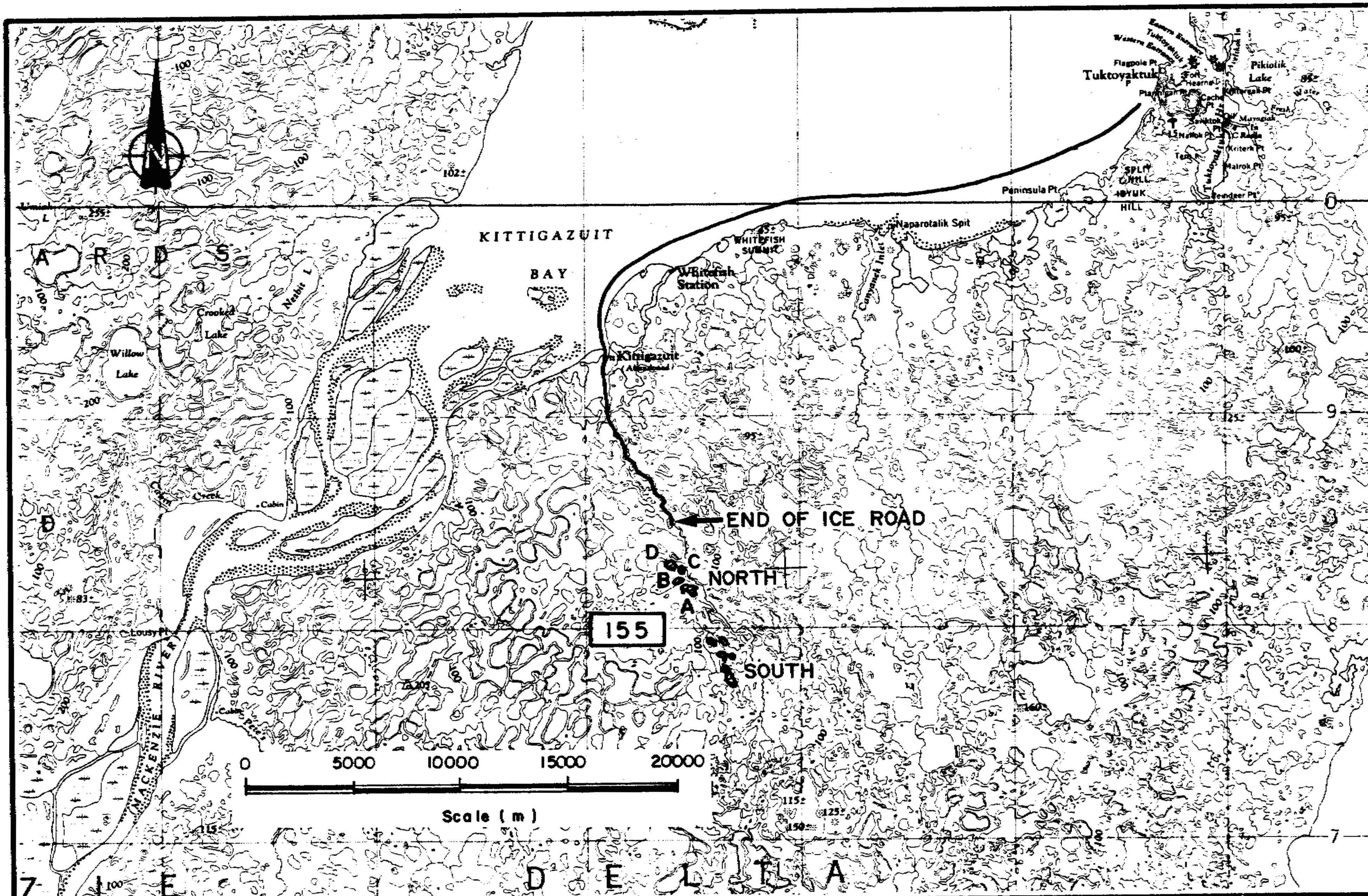
COMMUNITY GRANULAR MANAGEMENT PLAN
TUKTOYAKTUK, NWT

LIST OF REPORTS ON THIS STUDY
Hardy BBT Limited

Date	Title
July, 1986	Interim Report - Phase I.
November, 1986	Interim Report - Phase II. Field Reconnaissance.
May, 1987	Phase III. Final Comparison of Potential Sources.
June, 1987	Interim Report - Phase III. Winter Drilling Program. Deposit 155.

REFERENCE

Haley, D.W. and N.R. MacLeod (1977). Evaluation and development of granular construction materials in the Mackenzie Delta region. 79th Annual General Meeting of CIM-1977 - Industrial Minerals Division.



COMMUNITY GRANULAR MANAGEMENT PLAN
TUKTOYAKTUK , NWT

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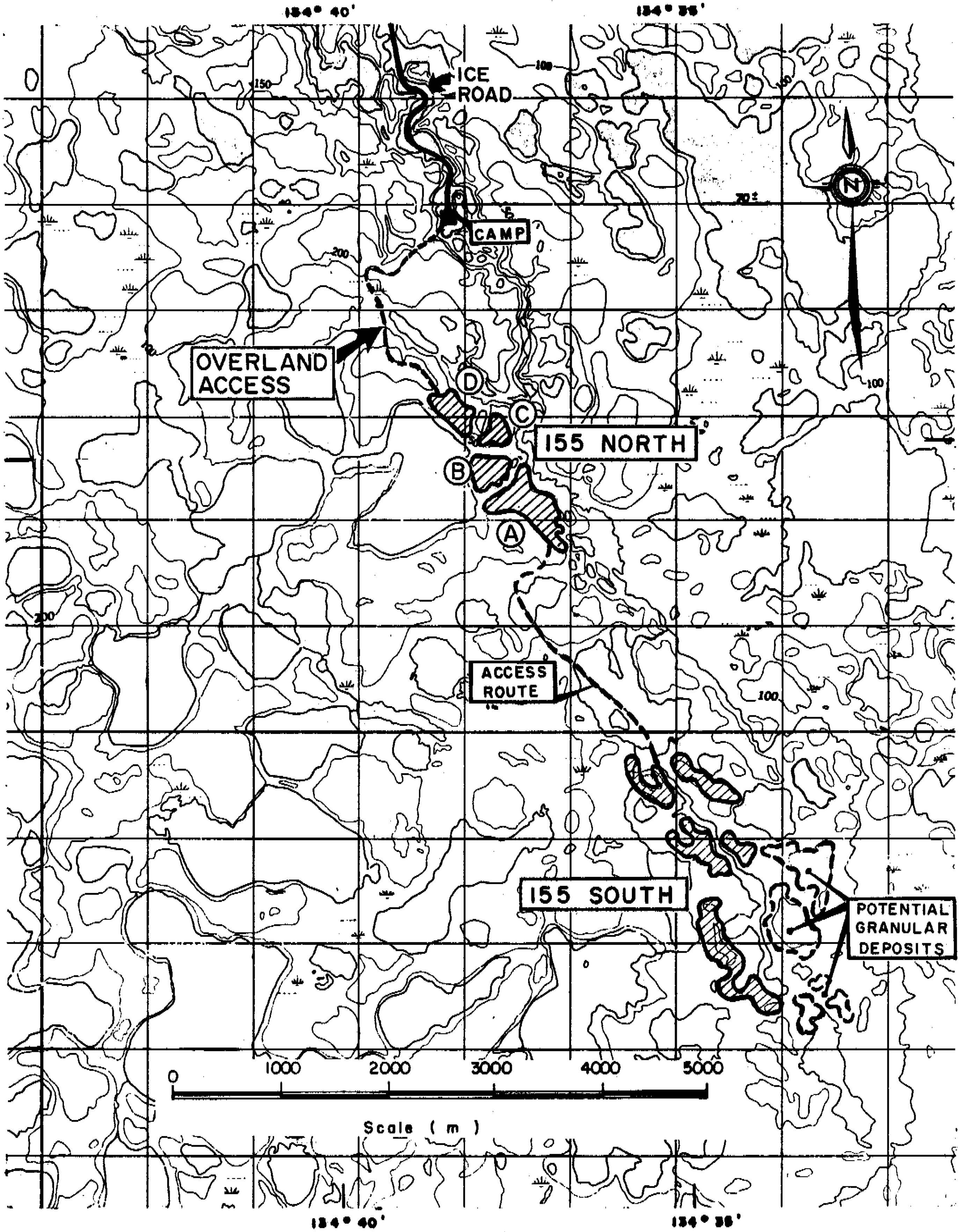
KEY LOCATION PLAN
DEPOSIT 155

CG 14096

FIGURE 1

HT84-82/03



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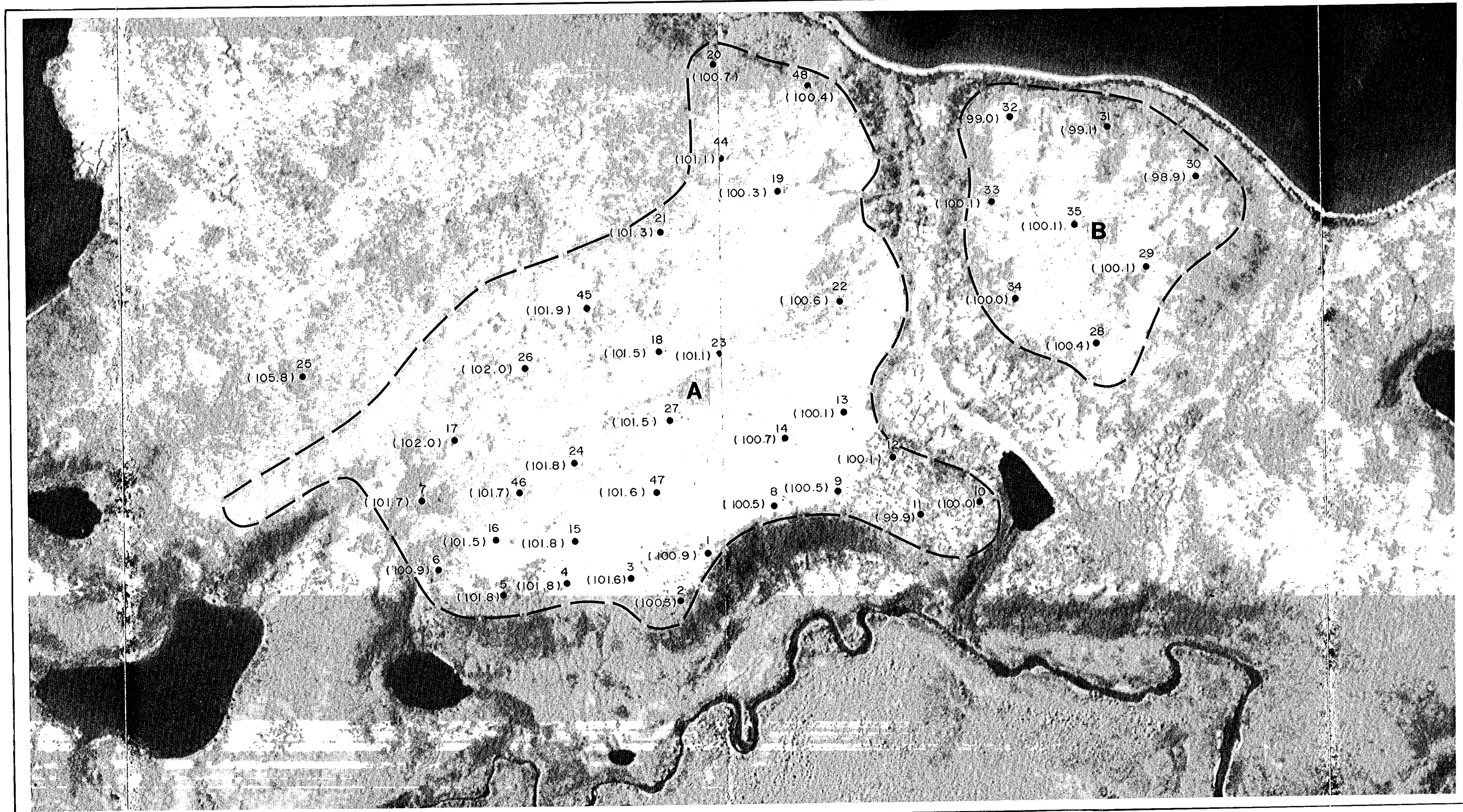
COMMUNITY GRANULAR MANAGEMENT PLAN
TUKTOYAKTUK, NWT

LOCATION OF DEPOSITS
155 NORTH AND 155 SOUTH

CG14096

FIGURE 2



LEGEND

21 ● BOREHOLE NUMBER

(100.1)● SURFACE ELEVATION (Local Datum Borehole # 10 = 100.0 m)

SCALE 1:3000 APPROX.

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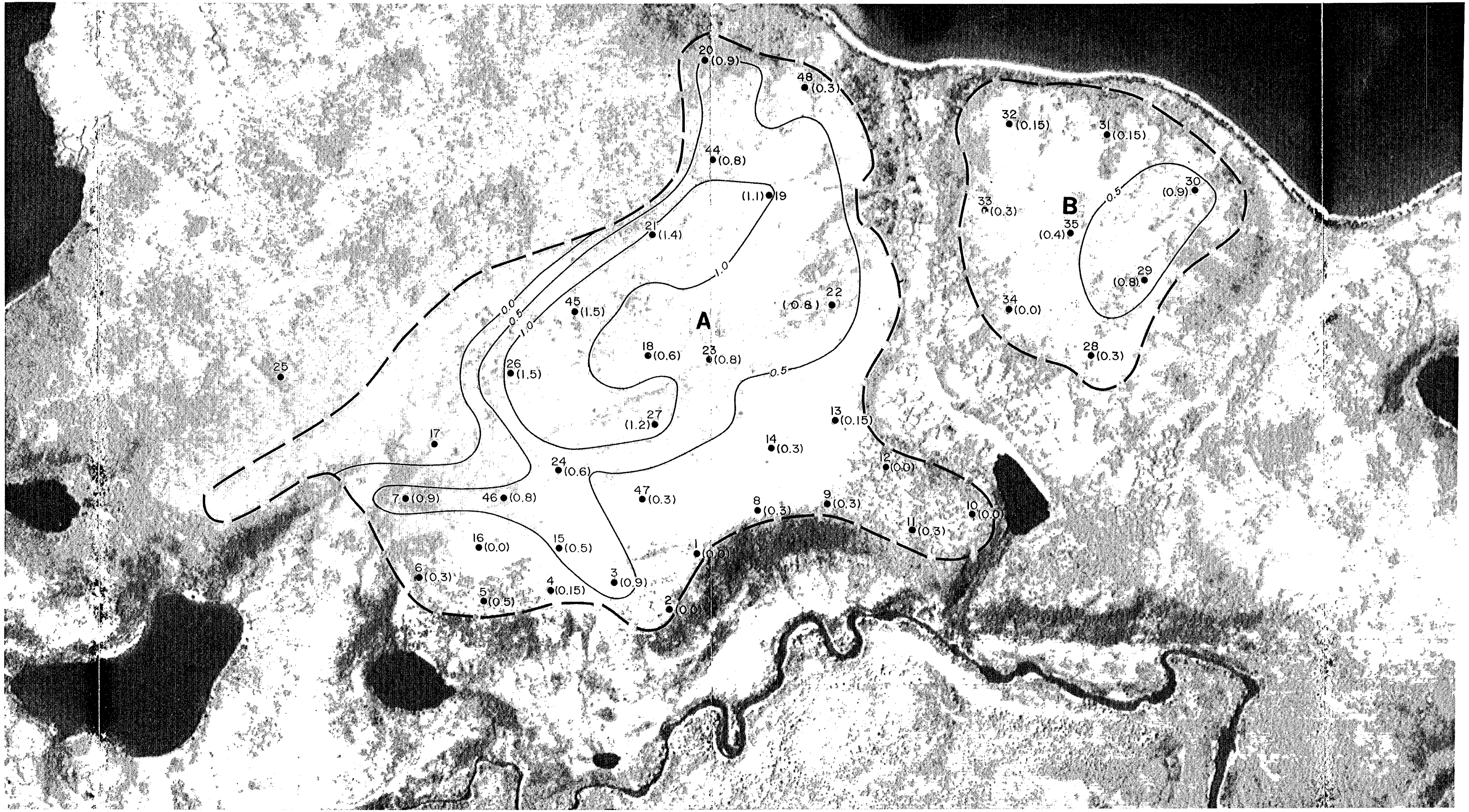
COMMUNITY GRANULAR MANAGEMENT PLAN

TUKTOYAKTUK , N.W.T.
SURFACE ELEVATIONS
BORROW SOURCE 155 NORTH
(AREAS A & B)

YX00112

FIGURE 3



LEGEND

21 BOREHOLE NUMBER

•(1.4) OVERBURDEN THICKNESS

0.5 ISOPACH

SCALE 1:3000 APPROX

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TUKTOYAKTUK, N.W.T.

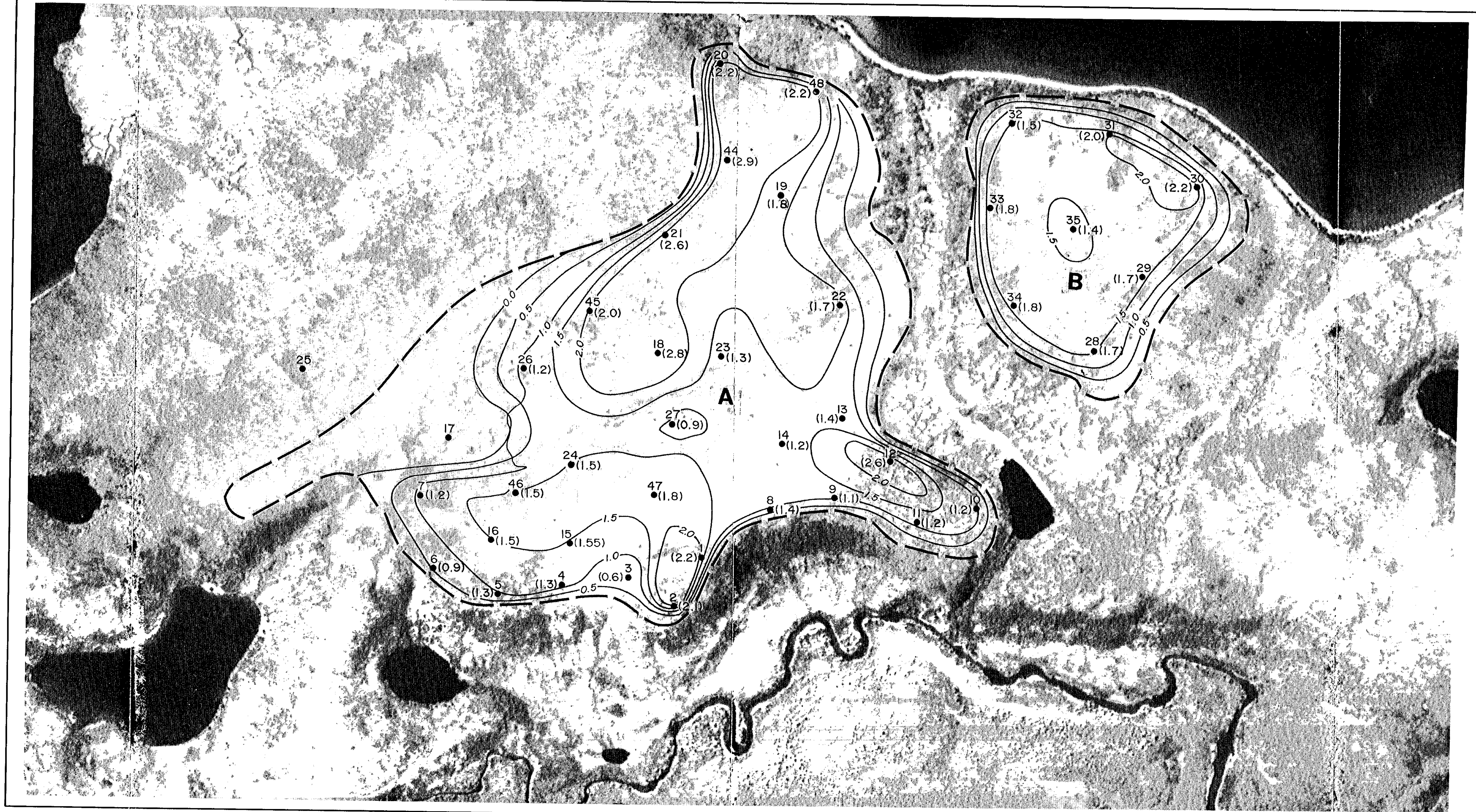
OVERBURDEN THICKNESS ISOPACHS

BORROW SOURCE 155 NORTH

(AREAS A & B)

YX00112

FIGURE 4



LEGEND

21 ● BOREHOLE NUMBER

●(1.2) GRANULAR THICKNESS

—0.5— ISOPACH

SCALE 1:3000 APPROX.

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COMMUNITY GRANULAR MANAGEMENT PLAN

TUKTOYAKTUK, N.W.T.

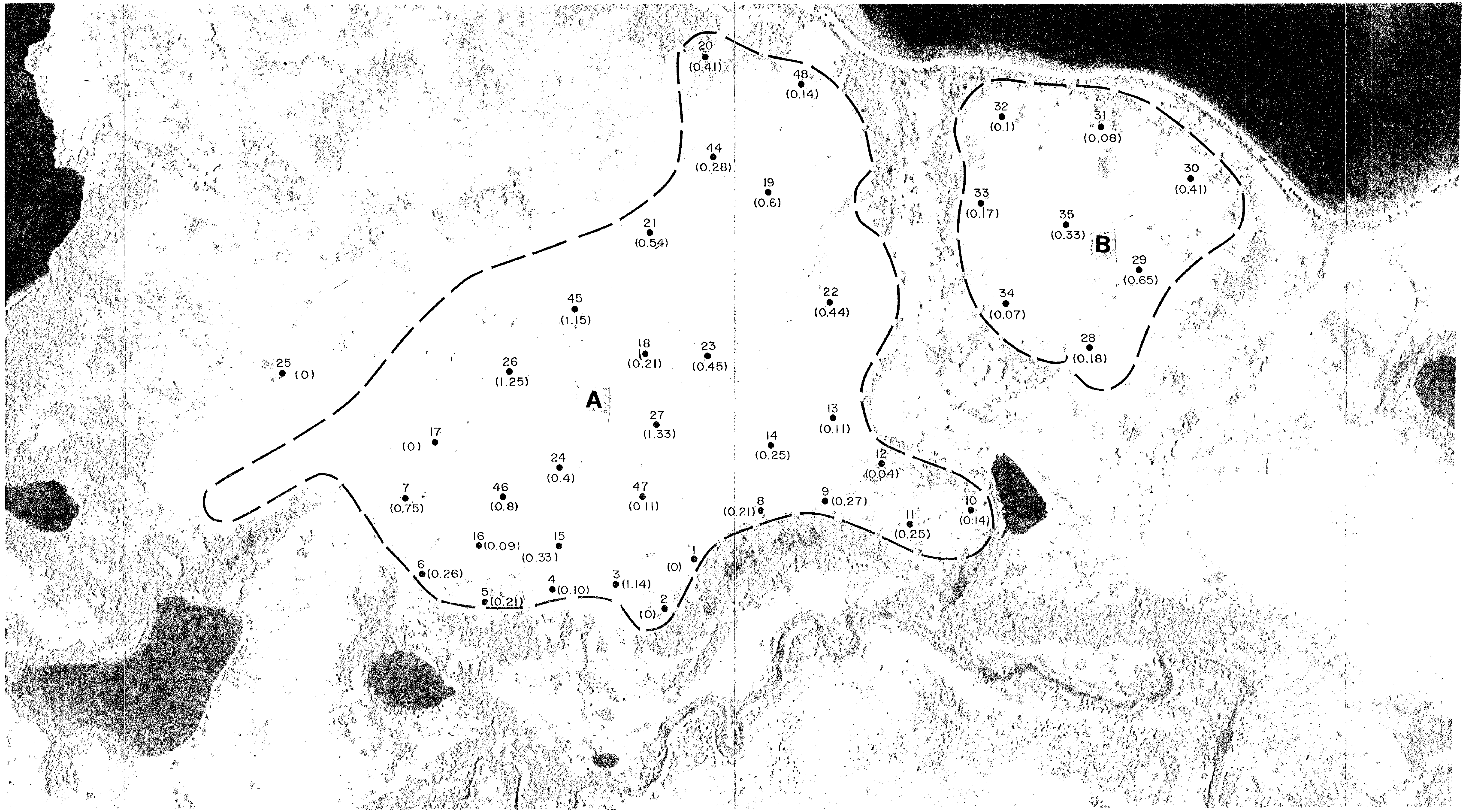
GRANULAR THICKNESS ISOPACHS

BORROW SOURCE 155 NORTH

(AREAS A & B)

YX00112

FIGURE 5



LEGEND

21 BOREHOLE NUMBER

(0.54) RATIO - OVERBURDEN THICKNESS TO TOTAL GRANULAR THICKNESS

SCALE 1:3000 APPROX.

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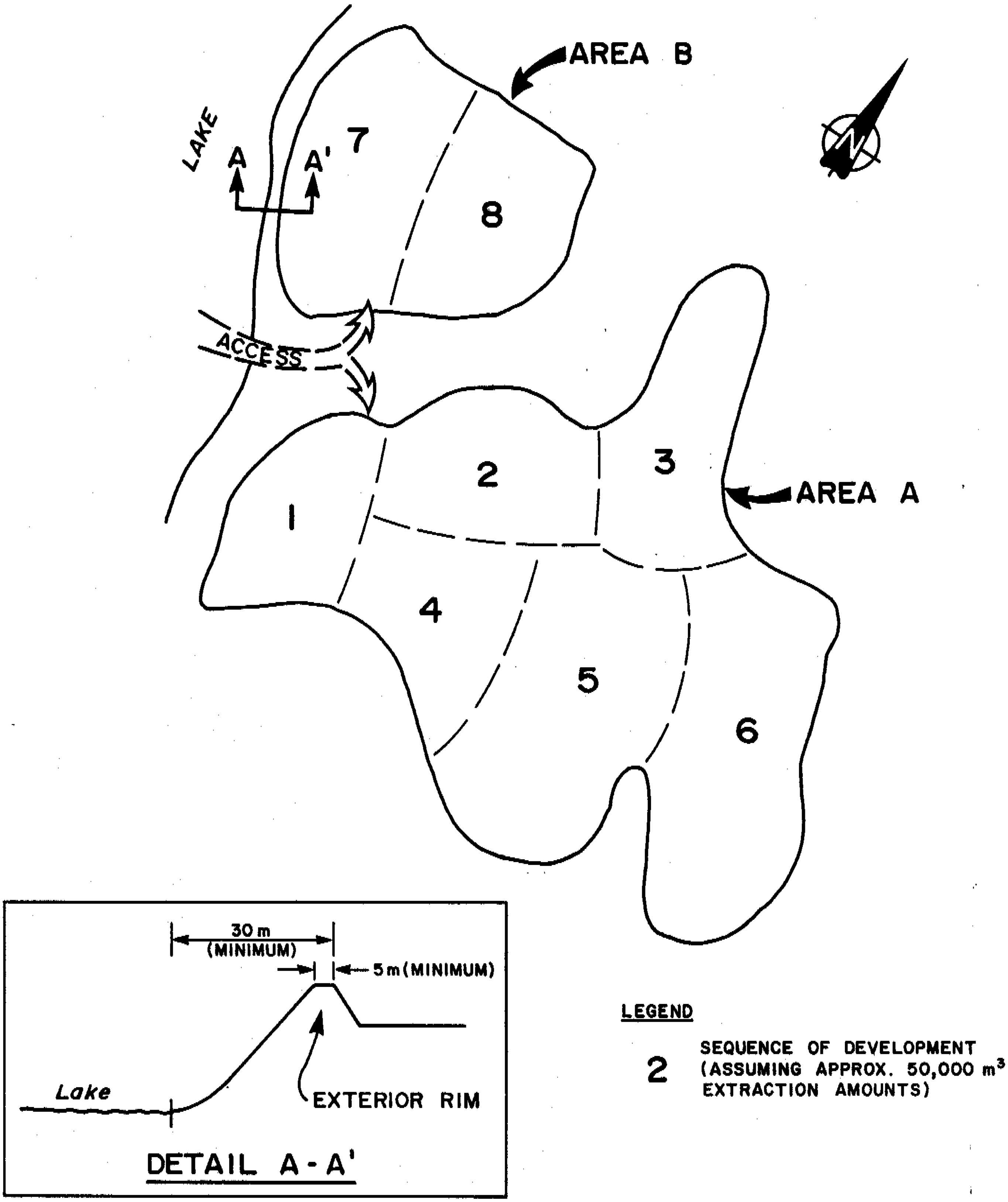
COMMUNITY GRANULAR MANAGEMENT PLAN

TUKTOYAKTUK , N.W.T.
RATIO - OVERBURDEN TO GRANULAR THICKNESS
BORROW SOURCE 155 NORTH
(AREAS A & B)

YX00112 FIGURE 6



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COMMUNITY GRANULAR MANAGEMENT PLAN

TUKTOYAKTUK, N.W.T.
PROGRESSIVE DEVELOPMENT
SOURCE 155 NORTH

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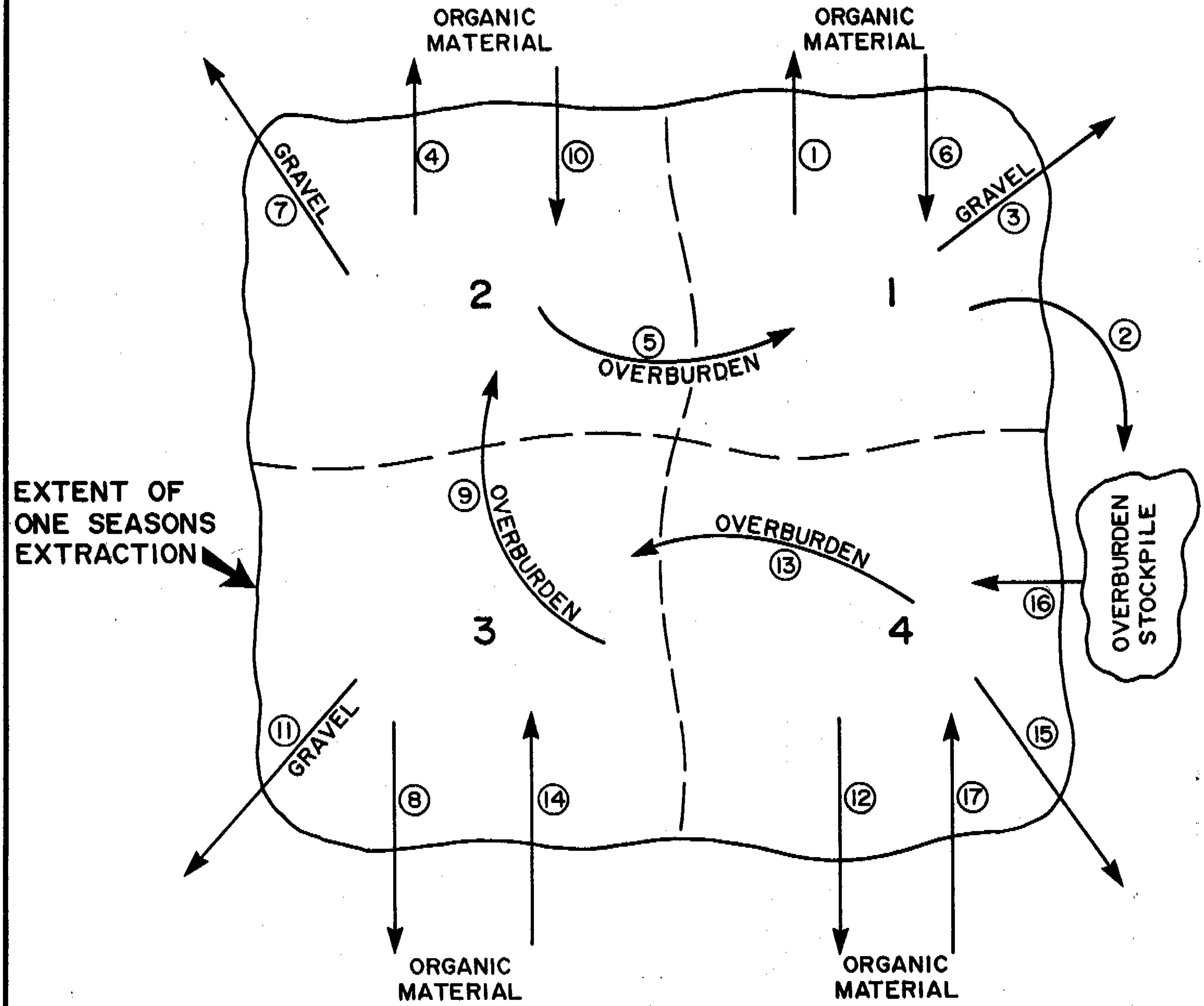
FIGURE 7



LEGEND

① SEQUENCE OF OPERATION (ALTERNATIVELY ALL ORGANIC MATERIAL COULD BE REPLACED AT END OF SEASON)

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COMMUNITY GRANULAR MANAGEMENT PLAN
TUKTOYAKTUK, N.W.T.
POSSIBLE PIT OPERATION FOR ONE SEASON

CG14096

FIGURE 8