Towards Granular Resource Management:

Northwest Territories and Yukon

Northern Granular Resources Program
Land Management Division
Natural Resources and Environment Branch
Indian and Northern Affairs Canada
6th Floor, Les Terrasses de la Chaudiere
OTTAWA, ON K1A 0H4

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NORTHWEST TERRITORIES
and
YUKON

Northern Granular Resources Program
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1.0 INTRODUCTION

The Department of Indian Affairs and Northern Development (DIAND) oversees the development of granular resources on most Crown lands in the Northwest Territories and Yukon and also in the adjacent offshore areas. The land portion of this northern region encompasses about 40% of Canada's land area and the major part of it is federal Crown lands. Large tracts of land are being transferred to private ownership through the settlement of aboriginal land claims, but more than 80% of the land will still be administered by DIAND after this process is completed.

The population base of this region is small (about 94,000), and sparsely distributed, except in the territorial capitals, Yellowknife and Whitehorse, which contain 33% of the total population. Despite the small population, the per capita demands for granular resources are significantly higher than in the south. This is due in part to the nature of the construction methods used in the north. Furthermore, the unique and significant environmental constraints on the availability of the resource heighten the demand requirements.

With the anticipated population growth in the north, the need for careful management of the resource becomes an imperative. Census statistics report a steady increase in population between 1976 and 1991 and forecast a continued population growth to the middle of the 21st Century (Figure 1). Given the forecast, the combined territorial population will have increased 170 percent over fifty years. This significant growth will create a greater demand for roads, buildings, airstrips, pipelines and other structures requiring granular resources. There are already shortages of suitable granular materials in some areas. We must plan now so that the remaining resources are managed in such a way that future requirements can be met.

This guide intends to explain resource management planning and provide advice on the preparation of granular resource management plans. The following chapters present an overview of granular resource management, an outline of the planning process and a description of the information required for the preparation of management plans.

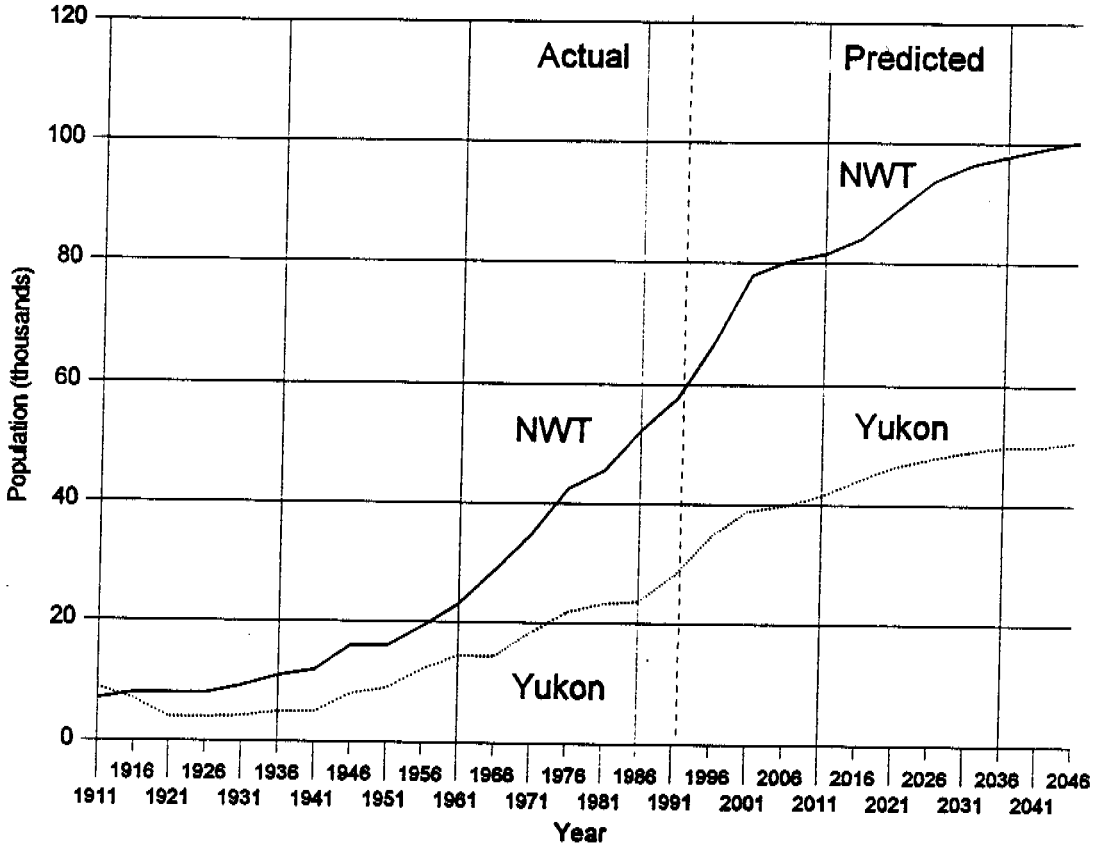

Figure 1: Population Trend for the Territories *(Source: Statistics Canada, 1991)*

1.1 PURPOSE

This document is intended primarily for use by the land resource managers who will initiate and guide granular resources management planning at the regional or community level. The information presented will help representatives from federal and territorial governments, communities, native organizations and other interest groups who will need to be involved in the management of granular resources.

This guide includes:

(1) a general description of the goals, principles, application and administration of a granular resources management process,

(2) a detailed description of the steps involved, including the roles and responsibilities of the parties involved, and

(3) an outline of the inputs to the process, including inventories of resources, restrictions on the availability of supply, forecasts of future demands for the resources, allocation of available supplies, and regulations that apply to the process.

This guide should be used with the general and operational guidelines publications available from DIAND offices (see section 5.2 DIAND Operational Guidelines Publications).

1.2 TERMINOLOGY

The following terminology is presented to provide a standard frame of reference for discussion of granular resources and their management. Several terms have been used to describe naturally occurring unconsolidated earth materials and bedrock used in construction projects. These terms are not widely used or precisely defined, consequently they are often used interchangeably.

"Construction materials" and "borrow materials" are two general terms that include a wide range of material types and particle sizes. "Construction materials" include fine-grained material (clay, silt) that can be used for fill, coarse-grained material (mostly in the sand and gravel size range), crushed bedrock, and specialized material (e.g. clay, rip-rap, and building stone). The term "borrow" implies that unconsolidated earth materials (sand, gravel, till etc.) are taken from one location (a borrow pit) and used for fill at another location. This contrasts with those construction materials excavated and used "on site" in a cut and fill operation (AGI Glossary, 1973).

"Granular deposits" and "granular materials" are more specific terms. "Granular deposits" include all naturally occurring accumulations of sand, gravel or other unconsolidated mixtures with a major proportion of the particles in the sand or gravel grain size range. The term "granular materials" is commonly used to refer to the gravel and sand-sized materials which are the primary constituents of granular deposits. "Granular aggregates" usually refers to gravel and sand-sized products produced by the processing of naturally occurring unconsolidated mixtures or by the crushing of bedrock.

The terms "granular materials" and "granular aggregate" are sometimes used as synonyms. However, in its strictest definition, the term "granular aggregate" describes hard construction materials both naturally occurring and man-made such as sand, gravel, crushed stone or slag which can be used for mixing in various size fragments to manufacture concrete, asphalt, mortar, plaster or used alone in railroad ballast or in manufacturing processes (AGI Glossary, 1973). Aggregate materials are generally defined by a precise gradational specification, and inherent to the definition is the processing of the original material.

Resource management planning refers to the dynamic process of conceptualizing, developing, evaluating, and setting-up a series of objectives, policies, and procedures for controlling the development of the resource. The application of this process will ensure effective use and conservation of a resource along with the protection of the environment.

In this paper, the term "granular resources" includes all potential "sources" of northern granular construction materials. A glossary is provided in the appendix to clarify any uncommon terms or program names used in the preparation of this document.

1.3 THE NEED FOR GRANULAR RESOURCE MANAGEMENT

The Northern Affairs Program (NAP) is responsible for the control and administration of most natural resources in the Northwest Territories and Yukon. This responsibility aims to ensure that resource development benefits all Canadians, while reducing the damage to the environment and enhancing the lifestyles of all northern residents. Without granular resources, development cannot take place in the north. It is therefore necessary to ensure that granular material, of suitable quality and quantity, exists to meet everyone's needs.

In the north, most surficial materials are included as part of the surface title, which means that those materials on Crown lands are administered by NAP. Pits are often opened initially for public projects but subsequent development usually involves a variety of public and private developers. A single source may then have to provide for all public and private needs of a community. The onset of a major resource development project and its unique requirements for granular materials can drastically alter the existing plans for supplying the needs of a community or region.

However, not all granular resources are managed by NAP. The Territorial governments also have jurisdiction over some granular resources in the north. They have their own regime for managing these resources. In addition, land claims are being settled. These agreements provide for the transfer of jurisdiction over the specified settlement lands and therefore, ownership of granular resources to the respective aboriginal people. Each land claim is establishing its own land management regime. This multiplicity of management regimes increases the possibility for confusion and ineffectiveness in the management of granular resources without co-ordination and joint planning. It is DIAND's responsibility to manage the granular resources under Crown administration and to provide information, support and leadership to others.

The granular resources under DIAND control extend across a vast expanse of land, containing a wide range of geological, environmental, sociological, economic and other conditions. For most of the area there is limited and sporadic baseline information. This lack of information can make it difficult to develop comprehensive resource management plans. However, efforts should be made to plan where resources are known to exist.

In many northern communities, processing equipment is unavailable, therefore materials tend to be used as found, whether or not that is the best use of the material. Figure 2 illustrates the predominant use of unprocessed aggregates in the territories as compared to the national usage. Remoteness tends to limit the availability and use of alternative engineering and construction methods which would require lesser quantities or lower qualities of earth fills. As a result, there is increased competition for high quality granular material, eventually leading to shortages of these materials.

Some issues related to the management of granular resource differ considerably between the two territories. The existing transportation network in the Yukon is relatively extensive, and because of a general abundance of granular materials close to where they are required, the availability of supplies is less of an issue. However, as shown in Figure 3, granular resources consumers in the Yukon are less likely than those in any other part of Canada to haul the material for longer distances. In the Northwest Territories, the lack of a transportation network and the relative scarcity of the resource pose different problems.

Other, non-economic issues have had an increasing influence on development of northern granular resources. Since the mid-1970s, there has been a much greater emphasis on environmental and social concerns at all stages of any development project. Aggregate source selection and development planning are no longer controlled solely by geological, materials engineering and economic concerns; there is an increasing expectation that greater consideration will be given to the potential environmental and social impacts of granular developments and site rehabilitation. In the early 1980's, increased consideration was given to socio-cultural issues, such as the inclusion of traditional pursuits like hunting, trapping and fishing as part of integrated resources management through land use planning. Finally, with the settlement of northern land claims, institutions and decision-making procedures have been developed that allow aboriginal people to share responsibility with government for management and decision-making on land, water, resources and (to a limited extent) in the offshore.

The current challenge is to ensure that granular resources are managed in a way that is consistent with the federal government's commitment to Sustainable Development. Sustainable development means seeking to meet "the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland

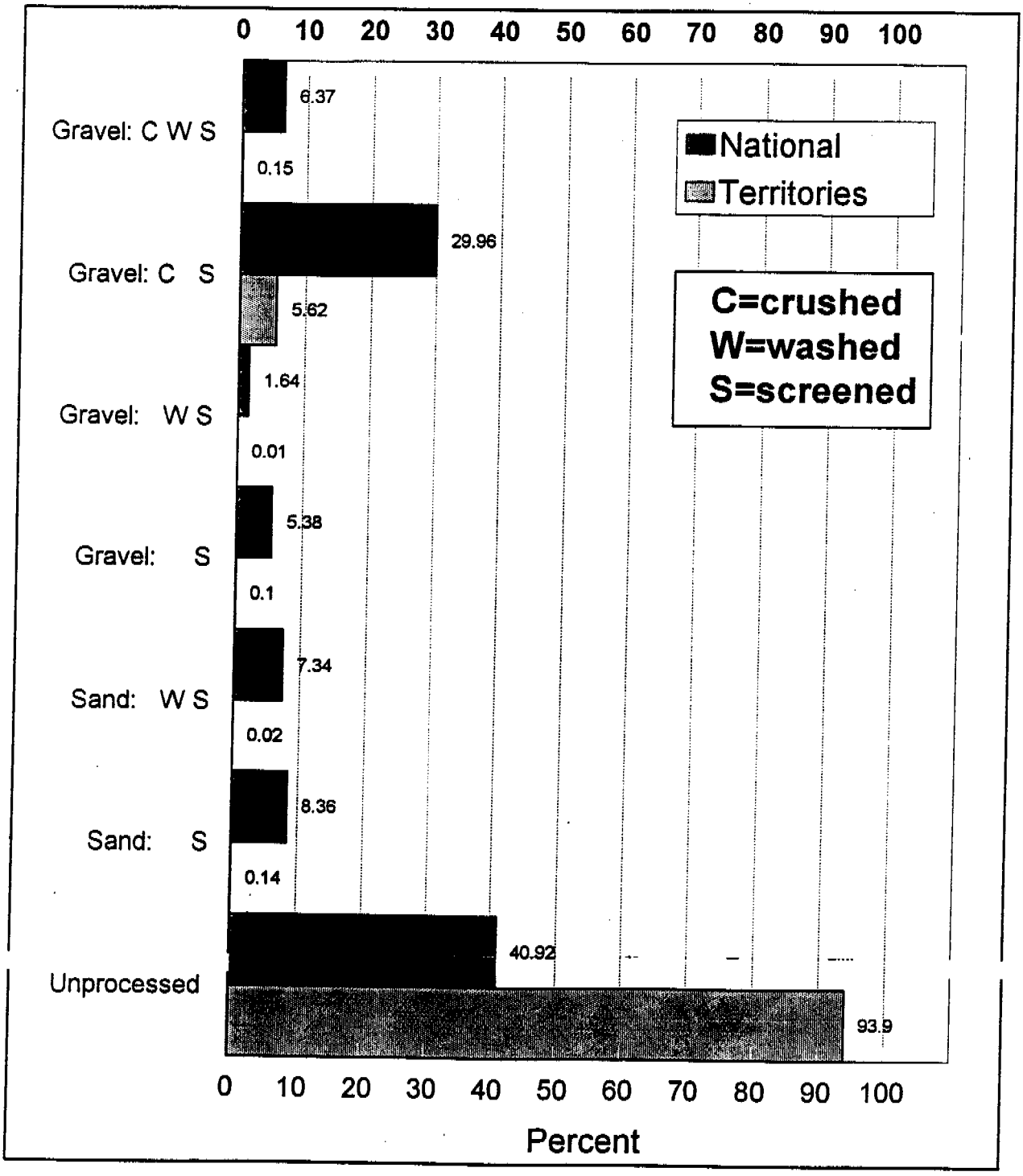

Figure 2: Significance of Unprocessed Aggregate in the North

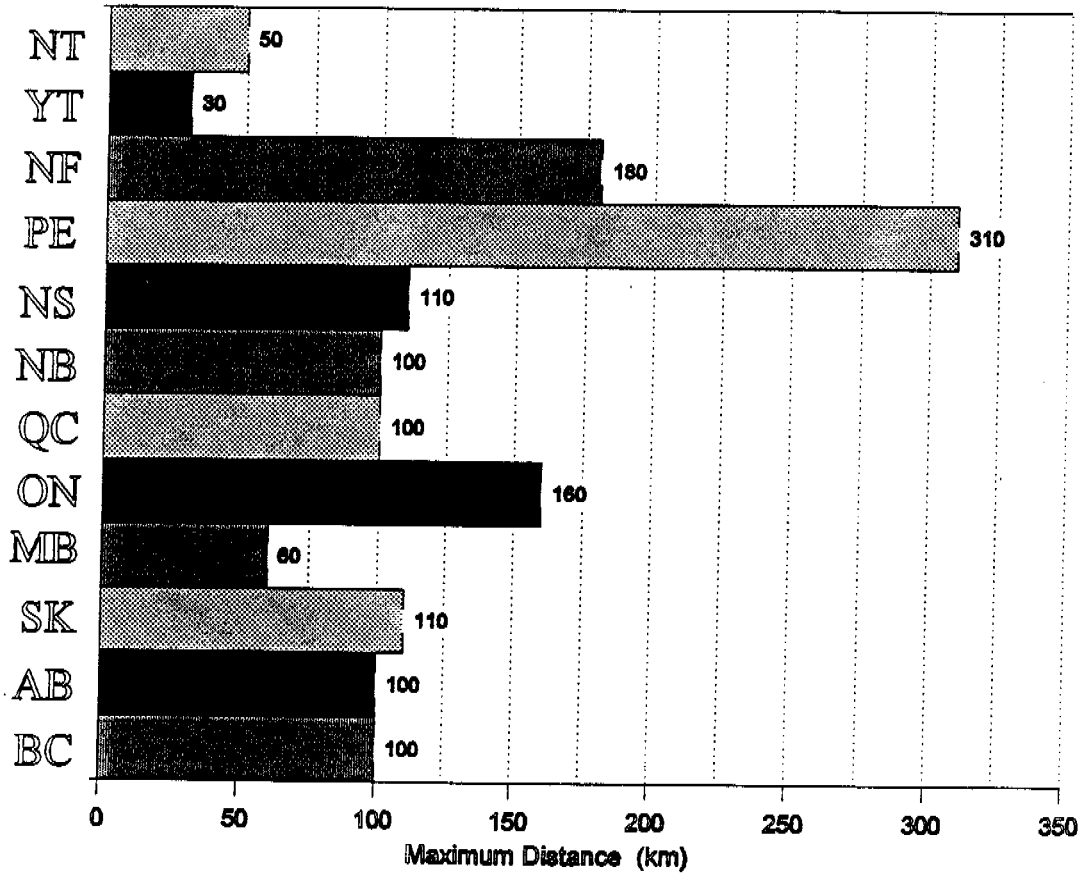

Figure 3: Maximum Truck Haul Distance for Aggregates by Province/Territory

Commission, 1987). There is a general consensus that this concept includes environmental, economic, socio-cultural and political dimensions. This approach is particularly relevant to the management of northern granular resources. A companion paper prepared by the Northern Granular Resources Program, entitled "Sustainable Development of Northern Granular Resources", investigates how this approach can be applied to a "non-renewable" resource. That paper shows what has already been done, and notes that adoption of the sustainable development approach to management of northern granular resources offers some new challenges for the granular program. It suggests also that the program should be expanded to include several additional program areas, primarily to address the environmental, socio-cultural and political issues that are part of sustainable development principles. Specific tasks for each of the granular program elements are listed in the paper.

Given the extent of northern Canada and its sparse population density, one might not expect to encounter land-use conflicts. However, certain potential granular sources (e.g., eskers) are usually in demand for a variety of uses. In areas of widespread permafrost, muskeg or other wetland, there is inherent conflict between developments requiring aggregate resources and those interests promoting protection of the land for other uses. In fact the same high, dry land suitable for transportation corridors, facilities siting and aggregate extraction has traditionally been used for burrowing, denning or nesting by small and large mammals and birds, or as campsites or burial grounds by aboriginal peoples and explorers. Many valuable granular deposits are included within areas for which complete protection from development is sought.

Permafrost, either continuous or discontinuous, occurs throughout the territories. The presence of permafrost affects both the supply and the use of granular resources in a variety of ways. Large quantities of granular materials are required simply as an insulating fill to prevent the permafrost from melting in the summer. Access to the resource can be limited to winter months so as not to disturb the coverings over the permafrost that could lead to summer melting. The granular materials themselves may be frozen in permafrost, limiting their availability.

All of these factors contribute to making the management of this finite resource more difficult with time. The preparation of formal granular resource management plans will help to limit future problems.

1.4 PRINCIPLES OF RESOURCE MANAGEMENT PLANNING

The management principles that have guided DIAND activities in the north over the years should generally continue to apply. These have evolved with time; some may be specific to DIAND or to government, but many apply to any resource management situation.

1. Planning Should Be Based on Regional Demands:

   Granular resource management planning activities should be based on area-specific or planning region demands. The highest priority should be given to areas where shortages of granular materials already exist and to areas where increased future demand is projected .

2. The Basis of Plans Should Be Local Strategies:

   Planning strategies should provide a framework for resource management prepared at the local (district or community) level. The plans should provide direction to resource management officers regarding resource allocation/usage and to headquarters regarding required changes to policy and legislation.

3. Plans Should Integrate All Stakeholder's Concerns:

   Plans must try to meet the needs and concerns of the people living in the planning area. This requires a thorough assessment of potentially affected parties and the involvement of other federal departments, territorial governments, native groups, industry, and interest groups.

4. Plans Should Address the Priority of Allocation:

   The public good must take precedence over private good. Plans must satisfy community and other public demands before resources are made available to meet private, commercial or industrial needs. Even if resources are plentiful, plans must allocate resources to ensure effective use.

5. Public Consultation Must Be Part of the Planning Process:

   Throughout the planning process, information must be made available in clear, non-technical language to ensure public participation in the development of the granular resource management plan. The plan is unlikely to be implemented successfully without public awareness and support.

6. Granular Plans Must be Integrated with Regional Land Use Plans:

   Granular resource management plans must be developed with the intention of being integrated as a component of regional land use plans. Neither should be developed in isolation, nor should they be controlled or limited by progress on the other.

7. Plans Must be Readily Adaptable to Changing Use Patterns

   Planning is a dynamic process and as such, plans should be flexible and subject to revision as conditions change or new information becomes available. Plans should be made for the short and long term, and make provisions for future options.

DIAND's Role:

DIAND's granular resource management program has clearly defined objectives, both in terms of departmental priorities and specific regional/district responsibilities which encompass all of the above principles. Granular resource management plans are essential to DIAND fulfilling its granular management responsibilities.

1.5 APPLICATION OF THE PLANNING PROCESS

The planning process can be applied by anyone managing granular resources. This process is being suggested for DIAND, but would be more effective with participation from all granular resource managers in the north.

It is anticipated that the DIAND regional offices will take the lead role in initiating and coordinating regional granular resources management and planning. From the operational standpoint, DIAND district and subdistrict offices will have a major role in the process. Advice on technical issues will be available from DIAND headquarters. The level of involvement of other participants will vary on a region-specific basis.

2.0 THE GRANULAR MANAGEMENT PROCESS

This chapter explains the planning process. It emphasizes the participation of potential granular resource suppliers, users, and other affected parties. While the planning process may differ from plan to plan depending on the goals of the participants, several common steps should be considered. These steps address the various inputs and evaluations that are essential to planning. They will produce the plan components that are described in the following chapter (Section 3).

It is anticipated that the need for, and level of effort that needs to be devoted to, each of the steps will vary. Determining factors will include the location and size of the planning area, the number of affected parties, the availability and level of detail of the various information sets needed to prepare a plan, and the original purpose and potential impact of the plan. The steps identified and outlined briefly in the following pages are presented as one example of a planning process towards a regional granular resources management plan.

2.1 STEPS IN THE PLANNING PROCESS

A series of 11 planning steps are identified and outlined briefly in the following pages and shown schematically in Figure 4.

Step 1. Identification of a Planning Area

One must first begin by selecting the specific area to which the particular management plan applies. In DIAND's case, this is likely to be on a district-by-district basis, although there will be cases (i.e., major developments) where a development corridor should be addressed.

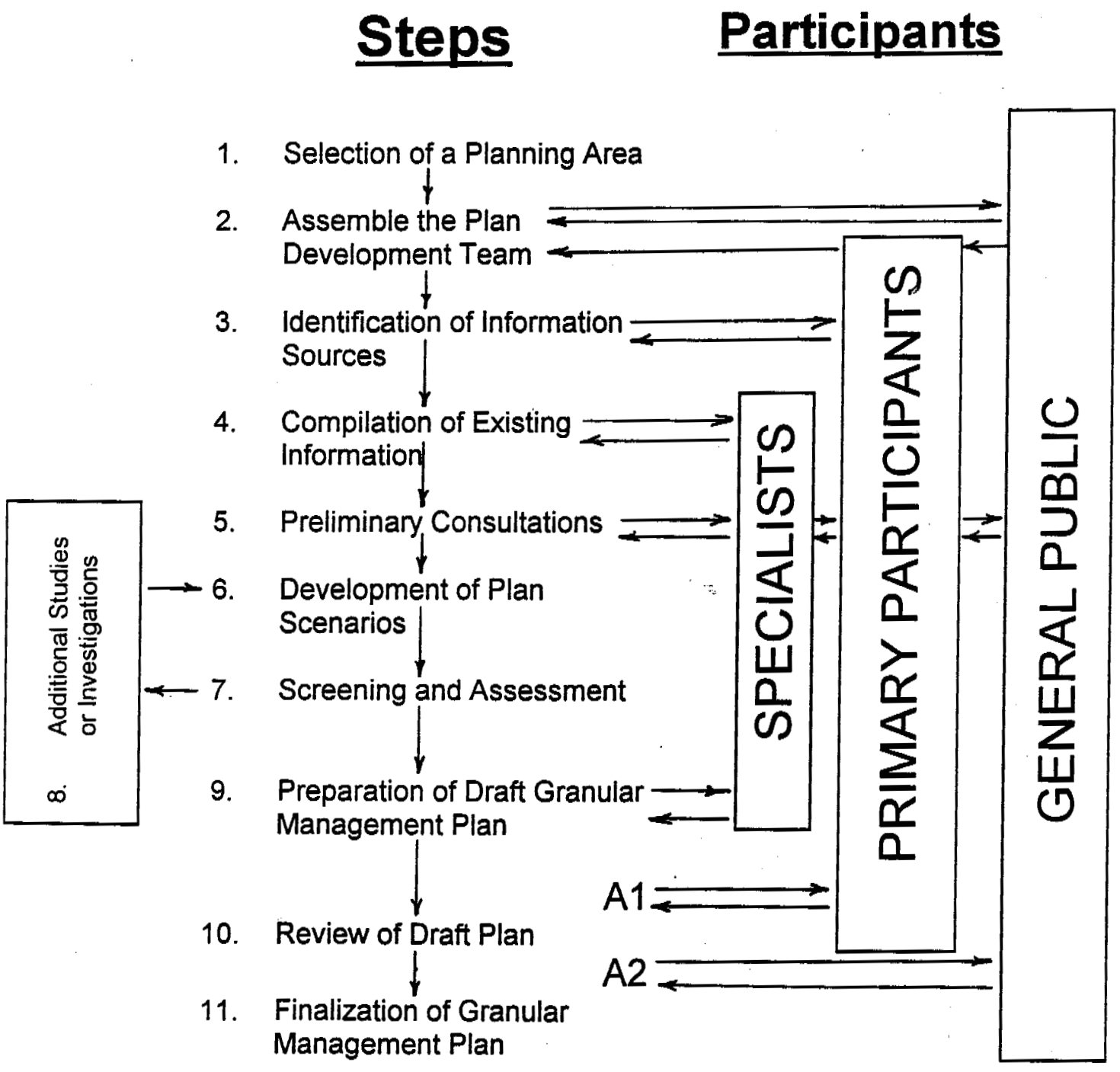

Figure 4: Granular Resources Management Process

Since large or linear planning areas, such as utility corridors, may cross a number of jurisdictions, their boundaries must consider several factors. These factors can include:

- existing administrative and jurisdictional control within the region,
- the current status of planning in the region (e.g. coincide with land use planning regions),
- existing resource management areas or plans,
- existing or expected future land ownership (consideration of land claims), and
- types of granular resources presently available and their potential development restrictions.

Priority for undertaking granular resource management planning is to be given to areas where critical shortages of granular materials already exist, to areas where increased future demand is projected, or where there may be direct competition for resources needed for public purposes.

Step 2. Assemble the Plan Development Team

The development of management plans must involve those responsible for, and those affected by the plan. The process provides also for public participation in the development of the plan. The plan development team includes, at a minimum, representatives of the following:

- pit operators and construction contractors who are likely to be the major suppliers of granular resources in the region,
- the major consumers of granular resources in the region, from both public and private sectors,
- the appropriate government agencies responsible for regulatory approvals, public consultations, and environmental screenings,
- native organizations representing the primary private landowners and others whose traditional use of the lands is likely to be affected by granular resource development,
- development planners who will be able to provide information on future requirements of resource development industries and public works,

- geotechnical specialists who will be familiar with, and able to advise about technical information on supply and demand,
- resource management officers, who will be responsible for implementing the plan, and
- other interest groups or community organizations such as hunters and trappers or tourist facility operators.

Step 3. Identification of Information Sources

All available information related to granular resources in the planning area must be assembled. The background information is critical to several components of the plan (see section 3.0 for information needs). This includes technical or scientific information from a variety of sources, as well as traditional knowledge and information on local issues and concerns. As with the participants, the type and amount of information available will vary from one planning area to another. The establishment of a clear boundary to the planning area ensures the identification of affected groups and any jurisdictional responsibilities. The main participants in the planning process will usually represent the primary sources of the information.

However, in advance of planning it is not always obvious to the managers of one type of resource that development in a specific area may have a serious effect on other interests. Therefore it may be worthwhile to identify **all** geographically-referenced information for the planning area, to contact those responsible for the information and to let them determine their interest in the process. Other sources to be considered include universities, colleges, libraries, archives, other federal and territorial agencies and major industrial clients. These groups would not normally be involved, as primary participants, in the granular resource planning process but each of them might well have an extensive collection of information that would contribute to the management plan.

Previously this may have been an immense task, however, this type of information is now readily available through NAP's Northern Information Network (NIN). NIN includes a detailed description of about 500 datasets covering the North, each described in terms of type, content, coverage, completeness, currency, accuracy, availability, etc., and provides contact persons responsible for the data.

Step 4. Compilation of Existing Information

Of critical importance to the planning process is the need for comprehensive information on supply, potential limitations on availability of supply, and demand. Resource management requires a knowledge of the quantity, location, type, and quality of granular resources. An up-to-date inventory simplifies the task of assembling this type of information. This step may require the participation of geotechnical or other specialists to evaluate and summarize the information. If proprietary information is involved, it would be evaluated and summarized by the specialists alone, since it cannot be made available for public viewing. After establishing the supply sources, any restrictions on supply will be identified including an evaluation of potential environmental and social impacts. This step can be completed most efficiently if a digital mapping or geographic information system (GIS) is used in the compilation of information on supply, limitations, and the location of future demands. Many low cost, easily used desktop mapping systems with the capability to handle this type of information are now available.

Along with an assessment of existing needs, an evaluation of demand forecasts is an important task in estimating future demands for granular resources. The per capita demand over the last ten years has fluctuated in the territories in response to the aggregate demand swings of economic booms. Despite the fluctuations, the per capita aggregate production remains significantly higher than the national average (EMR, 1982-89). This statistic emphasizes the need for demand forecasting, since minimal demands are high and can increase dramatically during short periods of economic development.

Step 5. Preliminary Consultations

Preliminary consultation with all participants begins as early as possible to allow confirmation of plan specifics and the identification of any additional information. All non-proprietary information assembled in the previous step would be presented in a format suitable to the participants (e.g. mailings, workshops, Internet). Additional advice and assistance from departments, companies, organizations or individuals with specialist knowledge or expertise must be solicited from the beginning, and throughout the process. Potential granular material users must be consulted regarding their preferences for resource allocation. Widespread knowledge that a development plan is in progress will encourage involved parties to bring their relevant information forward.

Step 6. Development of Plan Scenarios

Granular management plan scenarios are typically based on resource allocation priorities (communities, public projects, industrial uses) and options (reservation of specific supplies for specific users/ uses, multi-user pits or first come-first served). The plan options must consider all foreseeable resource development projects, their potential impacts and their mitigation as part of resource allocation process.

Once information on the available supply and the projected demand are known, the main task of resource management becomes the allocation of resources to ensure that their utilization is effective and consistent with departmental objectives. This requires the comparison of the location and quantities of demand for the various qualities of materials against the known supplies, while considering the full range of anticipated development scenarios. Once again, the use of digital mapping and GIS will be particularly useful, whether to simply overplot the various scenarios, or to undertake a detailed "what -if" analysis of each scenario.

Where potential shortages of any quality of material are found, priorities for allocation are established based on the plan's objectives, historical considerations, the certainty of the proposed development and its potential impact.

Step 7. Screening and Assessment

The screening and assessment step requires the evaluation of potential environmental and social impacts of each of the various options for resource allocation included in the plan's recommendations and their possible mitigation. Depending on the scope and objectives of the plan, this step may involve the "specialist" participants, the primary participants or the general public. For example, if the plan is intended simply to allocate the remaining resources in a series of existing pits among a number of known operators, then the screening might be limited. However, if the plan will recommend specific, new sites then a formal assessment is required. In either case, the established department screening procedures for assessment of pit and quarry site proposals are to be followed, while considering any other requirements and procedures for screening that may exist within the plan area (e.g., those required by Land Claims). It is feasible that the results of this assessment may include recommendations for further investigation.

Step 8. Additional Studies or Investigations (if necessary)

Additional studies may be required if, during Step 7, the existing information on supply, demand, potential impacts and/or mitigation is found inadequate to warrant the acceptance of the preferred (or perhaps any) of the plan's options. Such studies can include additional field work, use of different demand models, referral to other departments, or revision of the options proposed (e.g., the reservation of certain supplies needed by a community, or the removal, from the granular resource allocation proposals, of preferred supplies until a pipeline proponent undertakes additional investigation). The completion of additional studies would be subject to the same time limitations as specified in the established department screening procedures for assessment of pit and quarry site proposals.

Step 9. Preparation of Draft Granular Management Plan

A granular resource management plan summarizes available regional supply and restrictions, presents demand forecasts and allocation plans, outlines potential impacts and mitigative measures and if necessary, provides recommendations on the management of specific individual deposits. The draft plan would incorporate the results of screening, assessment and any additional studies, as well as considering the development scenarios identified. A more detailed description of the component parts of the plan is contained in Section 3, which follows. The draft plan will normally include a formal report with an accompanying series of maps, as well as supplemental reports or supporting documentation.

Step 10. Review of Draft Plan

Depending on the scope and objectives of the plan, as well as the procedures and results of the screening and assessment undertaken in Step 7, this task may be completed by the primary participants that were identified in the second step. Otherwise, it is expected that the draft plan will be subject to full public scrutiny. Should this be the case, established department screening procedures are to be followed. The process should allow for at least one additional iteration of the review step, particularly where the plan is complex or where there are numerous participants.

the planning area) for which they have responsibility for granular resource management, then the plan will be more complete. Where the plan has undergone formal screening and review, and includes recommendations on the management of specific individual deposits, then the resource managers would be authorized to implement the recommendations.

Effective implementation of any granular resource management plan requires the ongoing monitoring of demands and source development. This monitoring assists in evaluating whether management plans are satisfactory and that they are properly carried out.

2.4 PLAN AMENDMENTS

The dynamic process of resource management planning often requires periodic amendments to the original plan as circumstances dictate. The amendment process can be separated into two levels, minor and major amendments, which will be defined in the original objectives of the plan. Examples of definitions for amendments are provided in the glossary (Appendix C). Amendments must state clearly the nature of the change proposed, the reason for amending the plan, and the objective of the amendment. This makes it clear which process is to be followed.

Minor amendments generally consist of "housekeeping," corrections or changes that do not alter the original intent of the document. These amendments can normally be made internally and the changes gazetted to ensure that the public is notifed. The incorporation of minor amendments into the formal report of the management plan would be undertaken at predetermined intervals, ideally every five years. At this time, a status report on the management plan and the amendments made over the period would be prepared and published. Major amendments are those that will significantly affect the goals and objectives of the resource management plan. Consequently, major amendments should parallel (but not duplicate) the planning process.

Step 11. Finalization of Granular Management Plan

DIAND will incorporate any revisions to the plan as required by the final review and complete the Granular Resource Management Plan for the specific planning area. It is intended this document will be the established guideline for allocation and distribution of granular resources in the designated planning area.

The final plan includes a formal report with an accompanying series of maps, together with a variety of supplemental reports or supporting documentation. The formal report and maps for the management plan are published, distributed to all participants and made available to the public. The original and master copies of all data and background information, and of the reports and maps is maintained at a single location, generally the district office for the planning area.

2.2 PROCESS DOCUMENTATION

Proceedings documentation is an integral part of the planning process. It establishes an open process and fosters public participation. To permit the full participation of all those concerned with granular resources in the subject planning area, procedures must be developed to ensure the confidentiality of any proprietary information used in the process.

Beyond the preparation of a final granular management plan, as described above, the results of consultations, screenings and review should be recorded to ensure full documentation of the process. The public should be able to review the documentation at a district or regional office.

2.3 IMPLEMENTATION

An implementation strategy is essential for the effective and efficient delivery of any plan. The strategy must state how the plan is to be accomplished through the various programs and activities of the regional offices. Sectorial granular resource plans are needed for effective management of these essential materials. Granular resource plans need to be considered in the preparation of regional land use plans and vice versa. Should the territorial governments and native groups choose to include in the plan, any lands (within

3.0 THE CONTENTS OF A RESOURCE MANAGEMENT PLAN

Effective management of granular resources necessitates a knowledge of existing granular materials supply, up-to-date forecasts of potential demands for granular materials, management plans, adequately trained resource managers and appropriate legislation on granular materials. This chapter focuses on these elements of a management plan. The first section outlines the key components to a granular resource management plan and the support documents likely to be included. The remaining sections discuss the plan components and associated information requirements in greater detail.

3.1 THE GRANULAR RESOURCE MANAGEMENT PLAN

The planning process will produce a variety of reports, maps and digital databases containing the results of the various steps. The early stages of the process are likely to include several detailed reports, maps and databases containing at least summaries of the entire information used in the process. The final plan should include a report containing descriptions of the process, results, and recommendations along with a series of maps of sources and allocations. The following framework outlines the basic components of a management plan with additional topics to be added by the regions or districts to reflect their needs and concerns.

Components of a Granular Resource Management Plan

A. Objectives
   - ▸ describes the objectives and the planning process

B. Area
   - ▸ describes the setting: communities, transportation facilities, local and regional activities, and growth potential
   - ▸ geology: explains the natural distribution and availability of materials

C. Supply
   - existing information: historical and recent
   - evaluation of current supply

D. Limitations to Access and Availability of Supply
   - gaps in information
   - environmental and regulatory constraints

E. Demand
   - historical usage
   - forecasts

F. Development Scenarios
   - considers the impacts of speculative projects
   - anticipates changes in management/ownership of lands

3.2 OBJECTIVES AND AREA

The objectives and the delineation of the management area provide the limiting framework for the establishment of a granular resources plan. The development of a precise set of objectives requires an accurate description of the planning area, whether a community, DIAND district, transportation corridor, etc. The typical area, in DIAND's case, is presumed to be the district or the sub-district, where appropriate. Once an area has been clearly defined, the objectives can be developed for the specific area and the planning process, participants, and timing established.

In addition to the map boundaries delineating the resource management area, a description of the setting is needed. This includes information on communities, transportation facilities, economic activities, growth potential and other background information deemed necessary . This information provides a context from which the supply, demands, and development scenarios can be assessed.

The geology of the area determines the availability of granular resources. At this stage, a summary of the area's general geology including the overall granular resource potential and the type of material available will establish the basic context. A more detailed assessment is provided in the supply component.

It is important to establish the overall potential of an area to provide granular resources, based on its geology. This provides a basic context to understanding the importance of the supply/demand differences which are outlined in detail during the planning process. The general type (such as unconsolidated earth materials or bedrock) of granular resources available in an area is crucial to the management plan.

3.3 SUPPLY

Supply refers to the granular resources (defined in section 1.2) known at a given time, and available for allocation to the resource user. The availability of supplies of granular materials varies with the scope of the plan (region, community), the users' needs (type and extent of development in the region) and with the users' ability to transport them from where they occur to where they are needed. Supply information is critical to the effective management of the finite amount of the resource that is available in the planning region. Supply is determined from the analysis of an extensive collection of data in a granular resource inventory.

The preparation of a granular resource inventory is generally a six-step process, that builds with each successive step (Figure 5). The first three steps delineate the widest range of possible granular resources in an area. The remaining three steps identify usable sources of supply and distinguish between types of material and the quality and quantity of each type available. An explanation of the terms and categories by which quantity and quality are subdivided is given in Appendix A.

The vastness of the North and high cost of field activities has prevented the development of a complete inventory of surficial resources. To date, the department has adopted a systematic, priority-based approach to granular material inventory based on proposed, planned and scheduled development projects. The level of detail in any of the steps shown in Figure 5, at a given time, varies depending on development activity in that particular area. In some areas, reasonably complete supply information exists, while in others, the inventory consists of only an estimate of additional undiscovered supplies. In some areas, there is no accurate record of materials used from sources that have been explored in relative detail and therefore no certainty of what remains. As a result, there

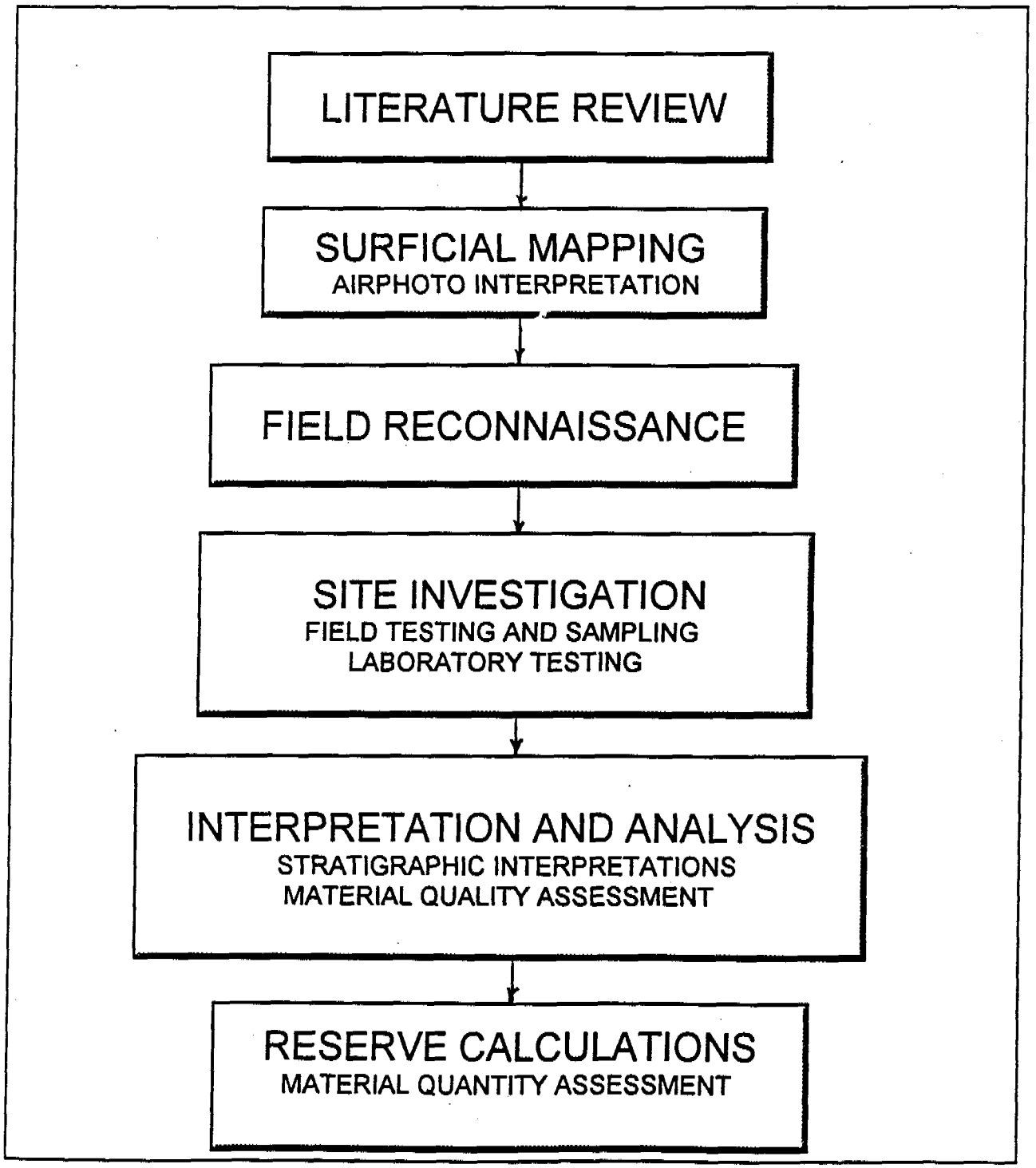

Figure 5: Inventory Analysis Process

is an ongoing requirement to update the inventories of the various types of materials and to maintain records on use of granular materials.

Inventories may also vary considerably in their geographical scope. They are commonly prepared at levels ranging from the community, district, or region to territorial and national levels. Community level inventories tend to identify supplies that are in close proximity to the community and that will satisfy municipal needs for a relatively long term. The regional studies often respond to a large but shorter term demand for certain types of material for proposed development in a specific area. This type of study includes the planning and initial construction of a major transportation facility like the Mackenzie Valley Pipeline or the Dempster Highway. The need for a specific type or quality of material, the degree of competition for the resource and the size of the area studied will also influence the level of detail in an inventory.

3.3.1 Geological Diversity of Supply Source

As indicated previously, the geological setting of the study area has an important influence on supply. The Northwest Territories and the Yukon Territory include four major physiographic regions; cordillera, interior plains, Canadian shield and Queen Elizabeth islands (Figure 6). The Yukon Territory is almost entirely within the cordillera, while the Northwest Territories comprises the remaining three physiographic regions. Each of these regions exerts different geological controls on the distribution, quantity and quality of potential granular resources.

The location of granular resources depends upon the predominating landforms of the region and their accessibility. The physiography of each region will determine the type and nature of landform features occurring. The landforms can be remnant features of past geological processes, such as continental glaciation or active features, such as talus slopes. A brief description of the deposit types and their associated landforms is provided in Appendix B.

3.3.2 Likely Sources of Granular Material

Many geomorphic processes have contributed to the development of the landscape in the territories including slope, fluvial and glacial. Each of these geomorphic processes

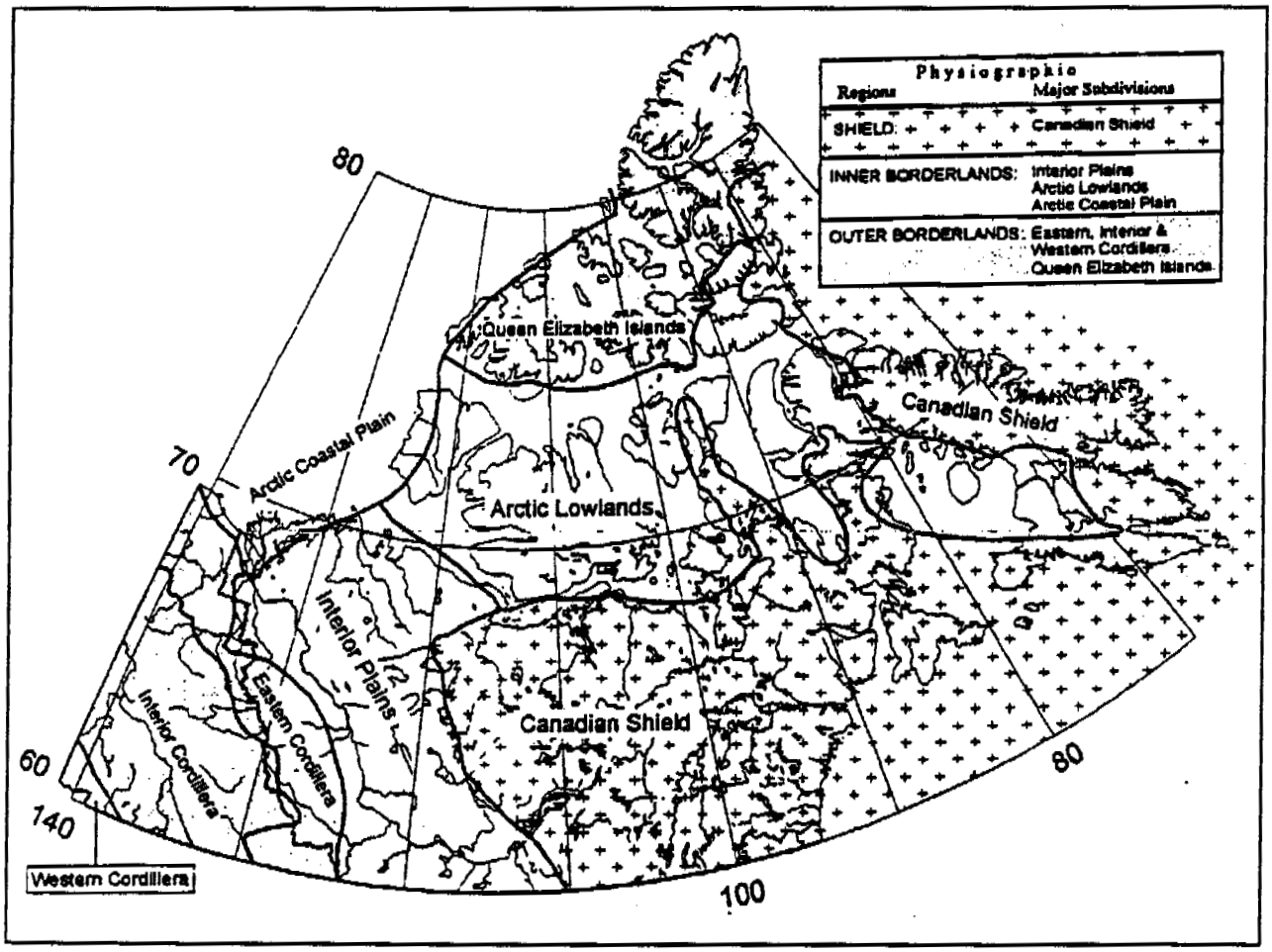

Figure 6: Major Physiographic Regions of Northern Canada
(Source: GVM Geologicial Consultants, 1994)

produces distinctive landforms and deposits with varying granular resource potential (Figure 7). Slope degradation is an ongoing process producing talus or scree slopes at the base of bedrock cliffs. Active fluvial processes create two important depositional landforms in terms of granular resources, floodplains and terraces. Floodplain deposits form horizontal landforms created during an active depositional period in a channels history, whereas terrace deposits represent former floodplains formed by the downcutting action of channels. Both landforms can contain significant amounts of well-sorted sand and gravel depending upon the sediment source, distance from source, and hydraulic conditions.

Of the three geomorphic processes, glacial processes have had the most dramatic impact in the last hundred thousand years. The most recent glaciation, Late Wisconsinan, modified the surface through erosion and deposition of material across all of the territories except parts of Yukon. The character and distribution of glacial deposits divided into four depositional environments, morainic, glaciofluvial, glaciolacustrine, and glaciomarine. Morainic deposits are sediments deposited directly "in contact" with the glacier. The glaciofluvial deposits result from the action of meltwater flowing away from the glacier. Glaciolacustrine deposits form in glacier-dammed lakes fed by meltwater streams, while glaciomarine deposits were deposited on the sea floor in front of temperate glaciers. Of the above mentioned depositional environments, glaciofluvial and the more recent fluvial deposits are often the "first choice" or primary areas of quality potential granular sources.

3.3.3 Existing Supply Information

In recent years, inventory work has concentrated on the task of compiling, standardizing, summarizing, and analyzing the available information from previous granular resource studies, and identifying significant gaps in information for several critical development areas. This task required the cooperation of other agencies and industry to obtain access to their data, much of which is proprietary. These parties recognize the value of this cooperative approach and have increased expectations for DIAND to provide a comprehensive inventory. This inventory should readily provide current detailed information on the location, type, quality and quantity of material, and additional work requirements for each known source.

PROCESS	TYPE OF DEPOSIT	LANDFORMS	SEDIMENT CHARACTERISTICS
Glacial	Morainic	End Moraine	- till, unsorted to poorly sorted, stony matrices, gravel, sand, silt and clay
		Ground Moraine	- till, unsorted, stony matrices, gravel, sand, silt and clay
	Glacio-fluvial	Esker	- well sorted silts through sands and gravels
		Kame	- silts through sands and gravels with occaisional till inclusions
		Outwash	- sand and gravel
	Glacio-lacustrine	Delta	- silt to fine sand
		Beach	- variable, mainly sand, silt and clay
	Glacio-marine	Seafloor Deposits	- wide range of sediments (till or gravel), stratified sands and gravels restricted to deltas and subaqueous outwash fans
Fluvial		Floodplain	- well sorted silts through sand and gravel (source dependant)
		Terrace	
Slope		Talus/Scree	- poorly sorted angular gravel to boulder rubble

Figure 7: Type and Characteristics of Potential Granular Resource Deposits

Comprehensive field data and computerized inventory data now provide substantial information for the following regions and corridors:

(a) Dempster Highway Corridor
(b) Alaska Highway Corridor
(c) Mackenzie Valley Highway and Pipeline Corridors
(d) Norman Wells Pipeline Corridor
(e) Mackenzie Delta Region
(f) Inuvialuit Settlement Region
(g) South-Central Beaufort Sea
(h) Most of the DIAND Districts in Yukon
(i) Slave Geological Province

In the future, greater access to the existing inventory data will be achieved through computerized databases. The resulting ability to undertake more timely, thorough and detailed analysis of the granular resources based on revised demand forecasts and to overlay other geographic data (i.e., environmental constraints or land claims) will enable management planning to minimize potential multi-use conflicts or accomodate changed planning areas. Planned administrative changes are easily redefined, along with the associated granular data, in computerized databases because the data is georeferenced. This system should facilitate the efficient transfer of granular resource data, in a more usable form, to the territorial governments and to native organizations as part of devolution and the implementation of land claims settlements.

There remains a requirement for additional field investigations to ensure ongoing availability of supplies. It is expected that industry and territorial governments, as the main consumers of granular supplies, will continue to undertake most fieldwork. However, DIAND regional offices, native organizations, and communities are likely to investigate important local sources to maintain and update local inventories of materials for communities and infrastructure to ensure supplies for all activities.

To ensure that the information on existing supply is available for the planning process, it is important that a comprehensive central inventory be maintained. The DIAND inventory program aims to plan, develop, maintain, and update existing databases so that effective management of the use of these resources is possible and to ensure granular resource

supplies are effectively used in the public interest. The identification of these supplies will provide government with an indication of resources available to support industrial and economic development in the north.

3.4 INFLUENCES ON THE AVAILABILITY OF RESOURCES

The physical presence of suitable quality granular materials does not ensure their availability. Management plans must examine known and potential restrictions based on the utilization of the resource. These restrictions can include legal, regulatory, operational, environmental, social or economic restrictions.

The most significant restriction to public availability of granular resources in recent times has been the change in ownership of the resources because of land claims settlements. For supplies located on some aboriginal lands, this represents a fundamental change in the resource management approach from support of economic development to one of revenue generation. The result has been a significant increase in the cost of granular materials. DIAND has historically charged $0.10 per cubic yard for sand and gravel, and government was not charged at all. The native organizations are now charging in the order of $3.00 per cubic yard and DIAND has recently increased royalties to between $1.25 and $1.50 per cubic metre. Market demand and market prices will have a much stronger impact on availability in the future than has historically been the case. Land claims settlements have also produced a variety of management regimes that may include a range of limitations on government, private, and general public access to supplies.

Regulatory and operational restrictions can include:

- the existence of previous mineral claims on lands containing granular resources,
- standard terms and conditions of permits which while protecting the environment or wildlife, may hinder effective utilization of the resources,
- other environmental and social restrictions (protection of critical wildlife habitat, archaeological sites or sensitive terrain,
- conflicts in land uses between such activities as recreation areas, traditional hunting or trapping areas, and
- the common aesthetic and operational (traffic, dirt and noise) concerns.

Other physical factors restricting the availability of granular resources can include the amount of overburden, ice or water content and also the length and condition of access routes from source to end use.

3.5 REGULATIONS

The Territorial Quarrying Regulations provide for the disposition of a Crown resource. Due to the increased demand and competition for granular resources in the north, it is necessary to revise the regulations to facilitate effective granular resource management and environmental protection.

The draft Northern Pits and Quarries Regulations address resource conservation and environmental protection both onshore and offshore. These proposed regulations include, the provision to require a detailed site development plan (including site rehabilitation), the ability to set conditions on type of material extracted, a more reasoned fee structure based on type of material extracted, the ability to set operational procedures, and provide for the collection of a security deposit to ensure protection of the environment.

The implementation of land claims settlements, devolution, and division of the territories will result in several different landowners managing granular resources throughout the territories. These different landowners will have to cooperate to ensure the effective management of granular resources. A universal policy or management plan reflecting the landowners' respective responsibilities and regional needs would benefit all managers of granular resources.

3.6 ENVIRONMENTAL MANAGEMENT

There are many environmental concerns which could be associated with the extraction of granular resources, including soil erosion, mass wasting, destruction of permafrost, siltation of water-bodies, disturbance of land, disturbance of wildlife, dust, noise, contamination of soil or water, and aesthetic deterioration. Careful planning and operation are required to prevent these concerns from becoming reality.

To help in planning an environmentally sound operation, DIAND produced a publication called Environmental Guidelines - Pits and Quarries. This publication recommends procedures for all aspects of pit and quarry development, including planning, design, operation, and restoration along with permafrost protection. The guidelines should help operators plan an efficient and environmentally sound operation.

All pit operators must obtain a Land Use Permit and a Quarry Permit before commencing operations. As part of the application for the permits, the operator is usually expected to submit a site development plan. The administrator can then identify any potential problem areas that might arise and prescribe mitigative measures to ensure environmental integrity. The site development plan can include information on the layout of the operation, the physical and biological nature of the surrounding area, permafrost features, hydrological features, and abandonment plans.

The abandonment plans are an important part of the site plan. They prescribe the final state in which the site will be left. A permanently abandoned site should be recontoured to a stable state. Revegetation may be helped or may occur naturally, depending on the nature of the site. Whenever possible, native plant species should be used in revegitation; this is effectively done by the respreading of the original, removed topsoil over the restored site. For sites located near communities, site contouring and revegetation after abandonment should conform to some planned use.

Inspection and monitoring are both important components of environmental protection. Regular inspection enforces the conditions of the permit, and can discover problems before they escalate. Currently, inspections occur during the operation of the pit and during abandonment. Abandoned sites should also be monitored periodically to ensure rehabilitation objectives are being met and that any required corrective action is taken.

3.7 DEMANDS

Accurate and up-to-date forecasts of future demands for granular materials are integral to resource management planning. These forecasts have traditionally been based on surveys of the anticipated needs of communities, requirements of infrastructure, and the likelihood of major public or private projects for each 5-year interval during a 20-year

forecast period. This procedure was intended to ensure adequate long-term supplies, while minimizing the effort required to update demand forecasts.

3.7.1 Types of Demand

Community infrastructure and industrial development account for most of the demands for granular resources. The community infrastructure requires granular resources for buildings, transportation networks (airports, roads) and other uses such as waste disposal. The industrial demands arise principally from the development of minerals and hydrocarbons in the north. From the extraction of offshore hydrocarbons (i.e., artificial islands) to the distribution network (i.e., pipelines), the demands on granular resources can be significant and erratic based on the particular phase of development.

A granular resource management plan must identify, as much as possible, the particular types of demand within the designated planning area. The identification of the type of demand will help in figuring out the balance between the long-term and short term demands, and subsequently, the allocation of granular resources.

3.7.2 Historical Uses

An understanding of the historical usage patterns can help in the evaluation of future demands. The per capita demand over the last ten years has fluctuated in both territories in response to the aggregate demand swings associated with times of rapid economic development. Despite the fluctuations, the per capita aggregate production/use remains significantly higher than the national average. (Figure 8).

The historical usage can be determined through an examination of quarry permit records and similar records kept by other agencies, such as the highway's department of the Territorial Governments. The single consistent consumer of granular resources is the transportation network. Similarly, the ongoing needs of a community can be determined and reasonably estimated for the future from records kept by the appropriate agencies.

Industry demand for granular resources is more difficult to predict. The predominant industry, hydrocarbons, has historically been an important, although erratic consumer during all phases of development, exploration, extraction, and distribution. Figure 9

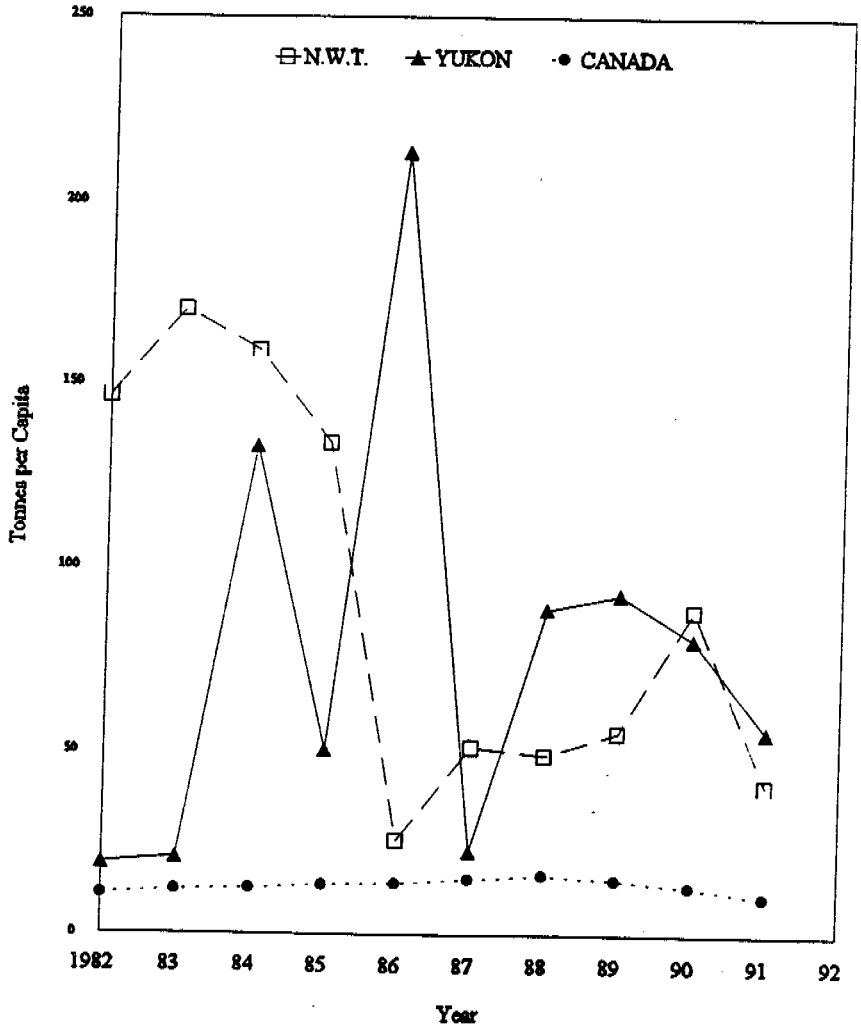

Figure 8: Per Capita Aggregate Production in the NWT, Yukon and Canada

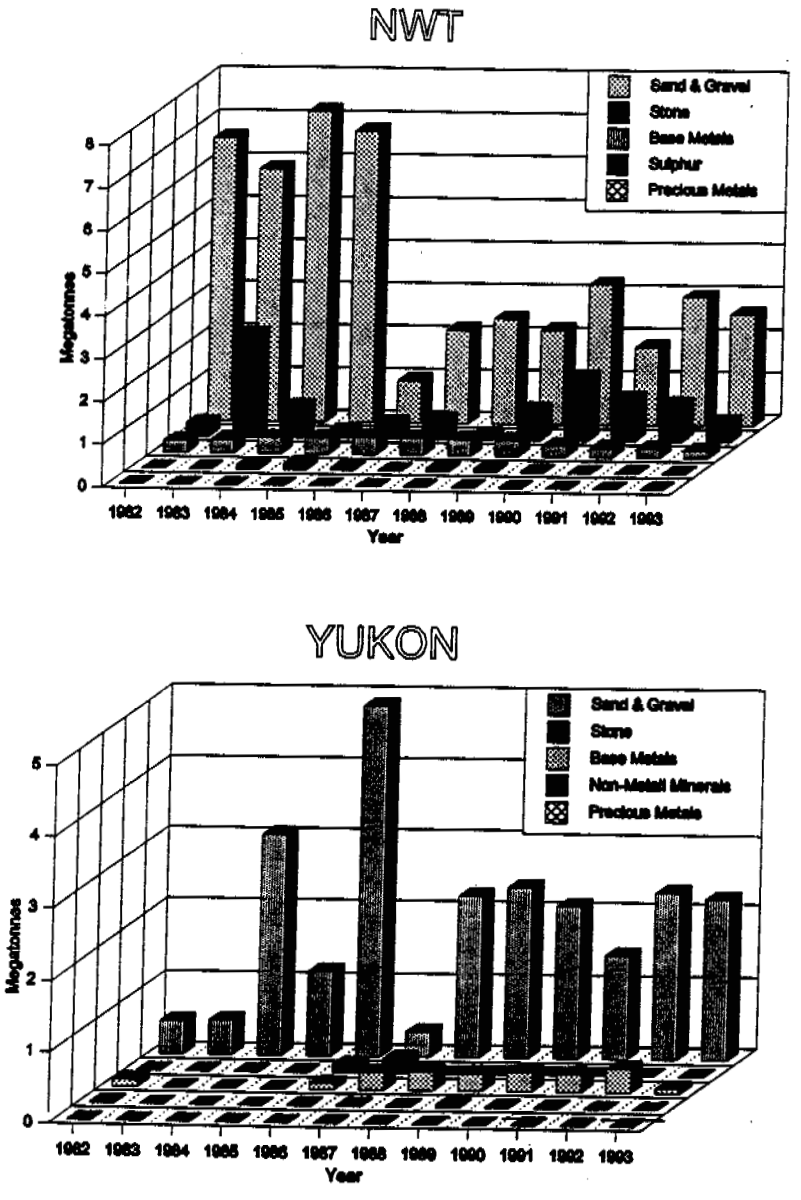

Figure 9: Annual Production of Selected Materials - NWT and Yukon

illustrates the enormous demands placed on sand and gravel production in the territories in the boom years. These demands will fluctuate over short periods of time as the economic viability of development changes. Despite the fluctuations, this graph and other statistics can provide basic information on usage patterns needed to predict and evaluate future demands. Before any demand predictions are made for a planning area, the historic usage pattern should be reviewed.

3.7.3 Forecast Models

Public demands for granular materials include requirements for routine maintenance and upgrading of infrastructure, such as roads and new capital projects. The maintenance and upgrading demands can be predicted with some accuracy in most communities based on historical usage and projected minor capital projects, forecast over a 5-year period. The forecasting of major northern development projects whether public or private, such as pipelines, remains difficult to assess, as political and economic uncertainty play a key role in their development. However, attempts should always be made to include such forecasts. Changes in technology and engineering design introduce further difficulties in forecasting. In most major projects requiring large amounts of granular materials, the demands for each type of material will not be known with accuracy until engineering design is complete.

Due to the above uncertainties, the forecasting of 20-year demand should be undertaken at least every five years as part of the preparation and monitoring of granular resource management plans. The success of demand forecasting relies on the co-operation of the territorial governments and industry. There also needs to be an annual comparison of forecast demands and permitted usage of granular materials. This comparison will help in deciding the need for updated forecasts and in analyzing the accuracy of current forecasts.

Further improvement in demand forecasting may be achieved with demand models. These may include the direct approach, assuming that changes in demand will continue at the same rate as they have historically; the supply/demand approach, which predicts that demands will change in response to the known proven supplies; and the econometric approach, which calculates future demands based on broader economic growth forecasts. The need for periodic updating of demands for several critical areas and the desirability

of improving forecasting methods means that there is an ongoing requirement for demand forecasting. An example of a 20 year demand forecast (North of 60 Engineering, 1995) developed from a computerized granular resources demand model for the Inuvialuit Settlement Region is presented as Figure 10.

3.7 DEVELOPMENT SCENARIOS

The development scenarios section is a key component to a granular resource management plan. In this final component, the plans authors must compare the available supply and demand forecasts with future development scenarios. These scenarios should consider, for example, the impacts of speculative projects (i.e., new airport runway) or anticipated changes in management/ownership of lands (i.e., land claims settlements). This comparison should be assessed with a determination of all potential impacts and the potential demand for granular resources (i.e., high/ likely/ low). Through the exercise of evaluating the impacts of different development scenarios, a resource management plan reaches its fullest and most effective potential as a process which recognizes the sustainable development of a non-renewable resources.

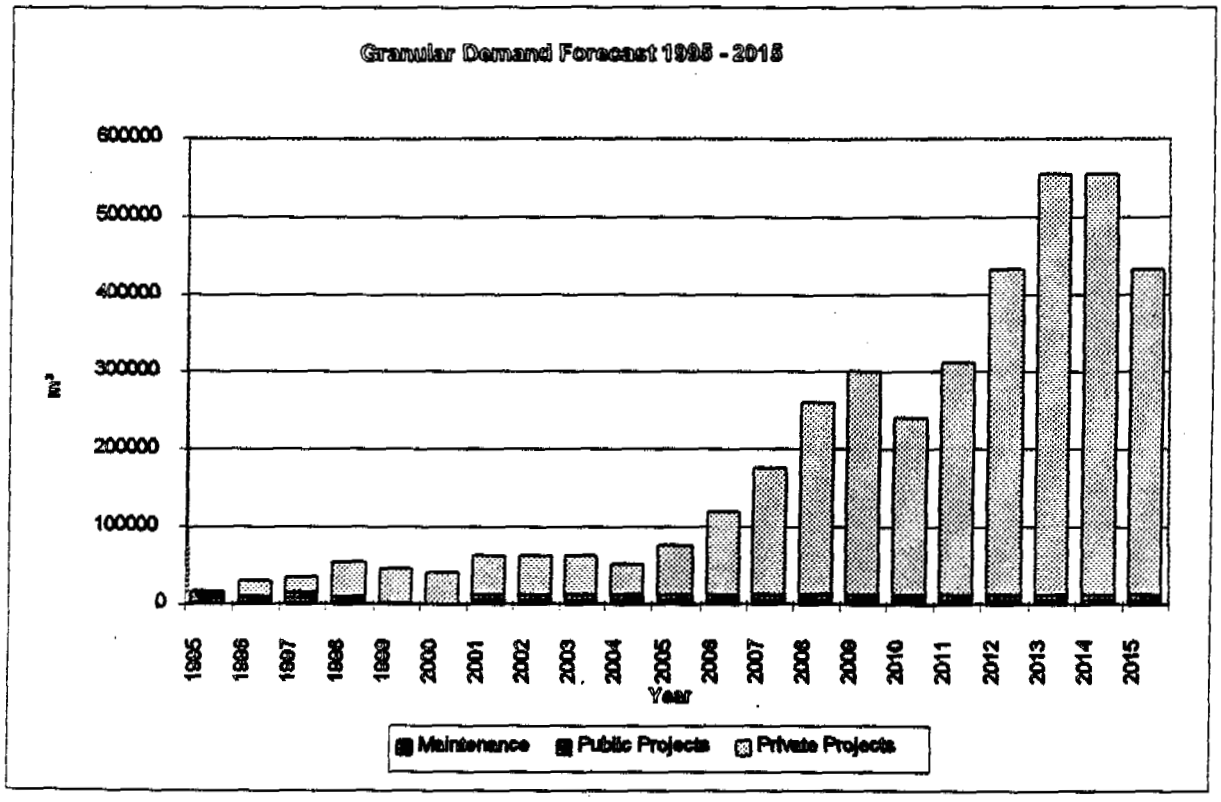

Figure 10: Predicted Granular Resources Demands - Inuvialuit Settlement Region *(Source: North of 60 Engineering, 1995)*

4.0 SUMMARY

Granular resources are essential to the north and it's growth in the future. To effectively manage these future demands, resource management plans should be put into place to ensure the sustainable development of this limited resource. The responsibility for managing the granular resources on Crown lands rests with DIAND as administered by the land resource managers. It is hoped that through the preparation of management plans, the land resource mangers will be better prepared to deal with current and future requirements.

This document serves as a guide to the process of developing resource management plans. While providing a process that allows for public participation, this process has the flexibility to adapt to any proposed area and its unique characteristics. The guide outlines the planning process and briefly explains the type of information which will be needed at each step towards the preparation of a granular resource management plan. This guide is designed to provide a starting point to practice better long-term resource management of granular resources.

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5.2 DIAND OPERATIONAL GUIDELINES PUBLICATIONS

(1) Natural Resource Development in the Northwest Territories /Yukon: Requirements, Procedures and Legislation

(2) A Guide to Territorial Land Use Regulations

(3) Environmental Guidelines - Pits and Quarries

(4) Information and Procedures - Developing the Inuvialuit Settlement Region

APPENDIX A:

GRANULAR RESOURCES -

QUALITY AND QUANTITY

APPENDIX A: GRANULAR RESOURCES - QUALITY AND QUANTITY

Quality

Granular products and their appropriate uses vary depending upon the type and quality of the source material. Unconsolidated material, sand and gravel, are categorized according to their predominant particle size fraction (sand or gravel) and also the percentage of fines (%< No. 200 sieve). For example, building pads, staging sites, and air strips require well-graded sand and gravel with less than 5% fines. Lower quality sand and gravel, such as poorly-graded fine sand, can be used as general fill. Consolidated material, bedrock, provides material for erosion protection (rip-rap), building stone, general fill, or as "granular material" depending on the processing. These typical uses of granular materials are described and illustrated in the DIAND publication: Environmental Guidelines - Pits and Quarries.

Generally, major granular resource consuming organizations have established their own quality classifications systems for granular resources. These classifications are usually based on their requirements for the material and their capability for processing to achieve a specific end-product. For example, the Government of the Northwest Territories divides granular resources into five material groups based on their end use, including:

- concrete aggregate [CA],
- surfacing material [SM],
- base [B],
- sub-base [SB]/embankment [E], and
- rip-rap.

These five groups are similar to those described in the previous paragraph.

The types of raw materials produced in the northern granular resource industry include natural sand and gravel, "pit run," crushed gravels, bedrock for aggregates, general fill, and armour stone.

To describe and evaluate these varied granular materials, DIAND adopted a classification system in 1983 that considers both the engineering classification of the material and the most suitable end use. As the main manager of the resource in its natural state, DIAND generally considers the quality of the material (in-situ) and what it may eventually be used for, without regard for the variety of user-specifications. DIAND documents divide granular resources into one of five classes (Figure 11):

Class 1	excellent quality material,
Class 2	good quality material,
Class 3	fair quality material,
Class 4	poor quality material, and
Class 5	bedrock, felsenmeer and talus.

Figure 11 compares the DIAND material class descriptions which classifies supply resources based on their material composition with the Northwest Territorial government system which classifies resources based on their end use. By combining the two classification systems, the resulting chart provides an overview of the various types of granular material and their end uses.

MATERIAL DESCRIPTION	CLASS	POTENTIAL APPLICATIONS
Excellent quality material consisting of clean, well-graded structurally sound sands and gravel suitable for use as high-quality (e.g. runway) surfacing material, or as asphalt or concrete aggregate with a minimum of processing.	1	Concrete Aggregate (CA) Surfacing Material (SM)
Good quality material generally consisting of well-graded sand gravels with limited quantities of silt. This material will provide aggregates of structure-supporting fill. Production of concrete aggregates may be possible with extensive processing, except where deleterious materials are present.	2	Concrete Aggregate (CA) Surface Material (SM)
Fair quality material consisting generally of poorly-graded sands and gravel with or without substantial silt content. This material will provide fair quality general fill for roads, flexible foundation pads, or lay-down yards.	3	Base (B) Subbase (SB) Embankment (E)
Poor quality material generally consisting of silty, poorly-graded, fine-grained sand, with minor gravel. May also contain weak particles and deleterious materials and are considered suitable only for marginal, general (non-structural) fills.	4	Subbase (SB) Embankment (E)
Bedrock of fair to good quality, felsenmeer, or talus. Potentially excellent sources of construction material, ranging form general fill to concrete aggregate or building stone if quarried and processed. Also includes erosion control material such a rip-rap or armour stone.	5	Rip-rap, or if processed properly, equivalent to Class 1 or any other class of material.

Figure 11: Granular Material Types

Quantity

There is no precise method of determining the quantity of materials in its natural state. However, there are many ways of estimating quantity, all of which have some inherent level of confidence. To provide coherent detail between inventory and available resources, DIAND initiated a "degree of certainty" classification to insert confidence into the class descriptions. This certainty level provides to resource managers a broad standard for comparison of granular reserves in an inventoried area. These levels are defined as follows:

a) Proven:
A 'proven' volume is one whose occurrence, distribution, thickness and quality is supported by ground truth information, such as geotechnical drilling, test pitting and/or exposed stratigraphic sections. The thickness of material encountered in a borehole is extrapolated to a radius usually not exceeding fifty metres around the hole, with adjustments for the type of landform, general stratigraphy, etc..

b) Probable:
A 'probable' volume is one whose existence and extent is inferred from more than one method of direct or indirect evidence. These methods include topographic analysis, landform characteristics, airphoto interpretation, extrapolation of known stratigraphy, geophysical data and/or limited sampling.

c) Prospective:
A 'prospective' volume is one whose existence is suspected based on limited direct evidence, such as airphoto interpretation, geophysical data, and/or general geological considerations.

By convention, probable quantities include proven and prospective includes probable.

All inventory reports prepared through the DIAND Granular Program will have one or more of the above certainty levels associated with each class of granular material being described. The certainty levels are based on the information and the level of detail available at the time of study. Detailed site investigations can "firm-up" the actual volume, or occasionally, find it non-existent. Additional site investigation work allows for the re-assessment of the quantity (usually a reduction); however, it also upgrades the certainty of the estimate.

APPENDIX B:

Granular Resources -

Diversity of Source

APPENDIX B: GRANULAR RESOURCES - DIVERSITY OF SOURCE

Physiographic Regions

The Yukon and Northwest Territories can be divided into four basic physiographic regions, Cordillera, Interior Plains, Canadian Shield and Queen Elizabeth Islands. A brief summary of these regions and the types of potential granular sources in each region follows. A more complete discussion has been prepared for DIAND by GVM Geological Consultants (1995).

The Cordillera, an elevated platform rimmed by mountain ranges, forms the western boundary of Canada. In the Yukon, the St. Elias Mountains forms the western boundary and the Arctic, Mackenzie, and Franklin Mountains delineate the eastern boundary. Between the western and eastern systems, are the Yukon Plateau and the Olgilvie, Selwyn and Kaska Mountains.

The Interior Plains stretch from the Canada/United States border to the Beaufort Sea with the section north of the 60th Parallel termed the Northern Interior Plains. The Plains are generally flat and low lying with mountains delineating the boundary on either side. The underlying geology consists of flat to gently-sloping sedimentary rocks of Paleozoic and Mesozoic age.

The Canadian Shield extends east from the Mackenzie River valley across the Northwest Territories. This geologic region consists of Precambrian rock with a variable mantle of Quaternary deposits.

Deposit Descriptions and Associated Landforms

Morainic Deposits

Since most of the North has been glaciated, much of its surface is covered by morainic deposits, commonly referred to as till, that were laid down directly by glaciers. Till is composed of a variable mixture of gravel, sand, silt, and clay-sized materials (often poorly-sorted and stony), dependant on what the glacier encountered along its path.

Common landforms:

a) End, Interlobate, and Recessional Moraines - End moraines form at the margin of glaciers and suggest the furthest limit a glacier has advanced into an area. Interlobate moraines form between two opposing lobes of a glacier. Recessional moraines mark temporary or intermediate end moraines or margins.

(b) Ground Moraine - Ground moraine is a variable mantle of till covering the surface. Outwash deposits often bury or erode this material, however, it commonly covers plateaus in the southern Yukon.

Glaciofluvial Deposits

Glaciofluvial sediments are deposited by glacial meltwaters and consist of sand and gravel. These deposits exhibit a variable degree of sorting and stratification. Glaciofluvial sediments are widely distributed except for areas of high rugged alpine terrain. Common landforms on the Yukon Plateau and in the Northwest Territories associated with this type of deposit are eskers, kames, and outwash.

Common landforms:

a) Esker - Eskers are long sinuous ridges of sediment deposited in subglacial channels under high pressures. Formed as continuous or discontinuous ridges, in singular or multiple form, an esker generally consists of well-sorted sands and gravels.

b) Kame - A steep-sided ridge or conical hill formed through the filling of glacier cavities by glacial meltwater. Often variable in composition, this material consists of bedded sands and gravels with occasional till inclusions.

c) Outwash - Outwash consists of well-sorted sand and gravel derived from sediments washed from a melting glacier. Outwash is common in most large valleys and lowlands in the territories. It is generally flat-lying in areas of open plain. Along valley sides it may be terraced, as a result of either changing glacier levels during its formation or recent fluvial incision during lowering of the floodplain.

Glaciolacustrine Deposits

Glaciolacustrine deposits consist of sand, silt, and clay carried by meltwater channels into glacier-dammed lakes. These deposits commonly occur in the territories, especially in large valleys of the southern Yukon and in the unglaciated northern Yukon Territory.

Common landforms:

a) Deltas - A fan-shaped form at the mouth of a river where successive periods of deposition are overlain. Component materials range in size from silt to fine sand, grading finer from the delta apex.

b) Beaches - Beaches result from the sorting action of currents and waves on margins of water bodies. The composition of beach materials varies depending on factors such as, the length of time that a lake existed at particular elevations and the nature of the material being reworked along the shoreline. This landform can be an invaluable source of granular material but it is site specific.

Glaciomarine Deposits

Glaciomarine deposits were deposited on the sea floor by meltwater streams, by flows of supraglacial debris directly from ice, and by the melting of icebergs. The sediments exhibit a wide range of types, such as till or gravel. Stratified sands and gravels of glacial marine origin are restricted to deltas, subaqueous outwash fans, and beaches.

APPENDIX C:

Glossary

APPENDIX B: GLOSSARY

Commissioner's lands - A parcel of land controlled by the Territorial government surrounding a community that is set aside for its use and protection

demand forecasting - The process of determining the future requirements for a resource over a specified period of time.

demand models - The method/model used to determine the future need of a particular resource. These models are often based on historical usage patterns such as the econometric model.

DIAND - The Department of Indian Affairs and Northern Development.

EARP - The "Environmental Assessment Review Process" is a mechanism by which environmental considerations are incorporated into the planning, design, implementation, and operation of federal projects.

fines - Fine soil particles such as clay and silt that can pass through a #200 standard mesh screen.

granular resources - Naturally-occurring deposits of sand, gravel or other unconsolidated mixtures with a major proportion of sand or gravel sized material, as well as similarly sized products produced by processing of unconsolidated materials and the crushing of consolidated bedrock.

guideline - A recommended practice.

land use planning - A generalized scheme or proposal regarding how land should logically be used and where growth and renewal should occur.

major amendments - are those which significantly affect one or more programs, affect district targets, or are likely to result in significant public reaction either locally, regionally, or territorially (Ontario Ministry of Natural Resources, 1988).

minor amendments - generally consist of 'housekeeping', corrections, or changes which do not alter the original intent of the document, affect district targets, or the ability of the district to meet or to have an affect on the public (Ontario Ministry of Natural Resources, 1988).

NEB - The "**N**ational **E**nergy **B**oard" is a regulatory body which issues certificates of public convenience and necessity for the construction and operation of interprovincial and international oil, gas, and petroleum product pipelines.

NOGAP - The "**N**orthern **O**il **A**nd **G**as **A**ction **P**rogram" was a federal government research and planning program to advance the state of federal and territorial government preparedness for major hydrocarbon development north of 60.

permafrost - A thermal condition existing in soil or rock where temperatures below 0°C persist over at least two consecutive winters and the intervening summer.

permit - A form by which the minister or native land administration authorizes one to operate a pit for a specified term, generally of not more than one year.

pit - An open excavation or a site where surface material, not including consolidated rock, is being or has been taken.

quarry - An open excavation or surface working for the extraction of stone. Commonly in the Northwest Territories and Yukon, this term includes "pit".

rehabilitation - The return of disturbed lands to productive use.

restoration - The return of land previously occupied by a pit or quarry to a stable condition which is natural looking or available for public use.

resource management planning - refers to the dynamic process of conceptualizing, developing, evaluating and implementing a series of objectives, policies, and procedures that will ensure effective use and conservation of a resource and protection of the environment during its exploitation.

sensitive areas - Areas rated as high as high value for timber, recreation, watershed, wildlife, archaeological or historical sites, and unique landforms; or areas adversely affected by disturbance such as water bodies or beaches.

TLA - The "Territorial Lands Act" provides the authority for dealing with the administration and protection of Territorial (Federal Crown) Lands, which are under the direct control of the Minister of Indian Affairs and Northern Development.