North of 60 Engineering Ltd.

Granular Resource Demand Forecast Model for the Western Arctic Region

A Final Report
presented to
Indian & Northern Affairs, Canada

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Granular Resource Demand Forecast Model for the Western Arctic Region

1. Introduction

The purpose of this final report is to briefly describe the development of a Granular Resource Demand Forecast Model for the Western Arctic Region.

The report is subdivided into eleven sections. They are:

- Section 1, this introduction,
- Sections 2 & 3 which provides the background and objectives for the project,
- Sections 4 & 5, which discuss the forecasting process and framework for the model,
- Sections 6 & 7 & 8, which discuss the specifics of the model,
- Section 9, which outlines the hardware and software requirements, and
- Sections 10 & 11, which provide sources for additional information.

This project was carried out for DIAND, under DSS Contract No. 038ST.A7134-2-0071, as part of the Inuvialuit Final Agreement Implementation Program - Task 7: Sand and Gravel Inventory Management.

2. Background for Project

Granular resources are an important construction material in the North. Historically, granular material has been used in the construction of roadways, airfield runways, embankments to support buildings and other physical structures, and in the construction of drilling pads and temporary offshore exploration structures in the shallow waters of the Beaufort Sea.

Granular resources in the Mackenzie Delta region of the Northwest Territories are limited in supply. Much work has been done during the past quarter century to quantify the volumes and quality of the various eskers located in the region.

Historically, management of granular resources was the responsibility of the Department of Indian and Northern Affairs, Canada. As part of the Inuvialuit Land settlement in 1984, however, much of the granular resources in the Mackenzie Delta region is now owned by the Inuvialuit. Thus, management of the resource is now divided between the Department and the Inuvialuit Land Administration.

One of the key variables in managing the resource is the ability to forecast potential demands on an ongoing basis. Currently, future demands are forecasted by hand every five years.

The purpose of this study was to develop a computer model to assist in forecasting future granular requirements. The model would be used by both Indian and Northern Affairs Canada and the Inuvialuit Land Administration. The model would not only simplify the forecasting process but also provide additional benefits. Some of the benefits that are envisioned are: more frequent and accurate forecasting of granular demands, a better understanding of potential impact that the demand may have on the resource and supporting infrastructure, the ability to forecast potential business opportunities and ultimately better management of the resource.

3. Objective of the Project

The primary objective of the project was to develop a tool that will allow DIAND and the Inuvialuit Land Administration to forecast granular resource requirements in the Western Arctic Region.

Some of the specific goals of the project were that the model:

- provide a simple user interface,
- operate under existing platforms (such as Microsoft Excel),
- provide capability for sensitivity analysis,
- generate the necessary reports, and
- provide flexibility to modify correlations based on historic data.

Generally speaking, these goals have been achieved.

4. Forecasting Models

It is important to forecast aggregate demand to assess the sufficiency of the resource supply to meet the expected demand. Forecasting also helps identify areas with potential resource deficiencies thus providing lead time to identify new sources.

There are three primary methodologies that have been used to forecast aggregate demand. They are the direct approach; an input output approach; and an econometric approach. The direct approach is the simplest and assumes that future demand for aggregate will grow at some constant rate. The input/output approach assumes that demand for aggregate is derived from the demand for development in an area, and that prices of inputs (including aggregate) have little impact on demand. The econometric approach is to estimate statistically the relationship between aggregate demand and historical levels of economic activity in a region and to then use this relationship to estimate future aggregate demand.

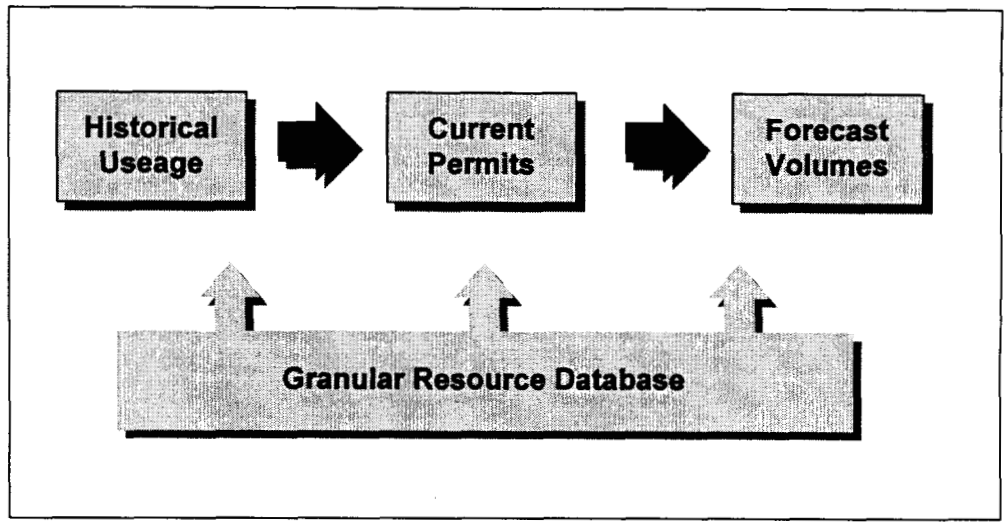
Aggregate demand in the Western Arctic Region has historically followed the level of hydrocarbon exploration activity. Aggregate demands were high in the 1970's when Industry focused exploration activity on the onshore and near offshore areas of the Mackenzie Delta. Recent aggregate demand has dropped significantly with the curtailment of exploration activity. Past studies have shown that future demand is very dependent on development activity, whether it be from industry, or the public sector. An input/output approach was therefore, selected as the basis for the forecast model.

5. Overview of the Forecast Model

Based on discussions with potential users within DIAND and the ILA, it appeared both organizations would benefit from a model that not only forecast future requirements, but tracked current and historical usage.

The broad framework for the model is shown in Figure 1. As identified above, the model can focus on the past, present, and future. It draws this information from one central data base that contains information pertinent to granular resource usage.

The intent in following this approach was to provide a tool that would help the various groups forecast granular resource usage, as was the intent of the project, plus help in the management of current granular usage.



Model Overview
Figure 1

6. Program Structure

The Granular Resource Forecast Model© is a database of historic, present day and future granular requirements. The application has been divided into two major components. The first half of the application is devoted to adding and maintaining information within the database. The details of the database will be discussed in the next section of the User's Guide.

The second half of the application is devoted to analyzing the information within the database, both from historic and future perspectives. You can, for example, compare actual granular usage to historic forecasts, or usage by area, source or quality. The analysis section also allows, with limitations, users to define their own criteria to study the data. Additional information on data analysis and reporting capabilities of the model is contained in Section 8 of this report.

7. Granular Resource Usage Database

The granular usage database contains 22 fields of information for each record. These fields are summarized in Table 1 and discussed in the following pages. They are presented in the order in which they are presented in the table view of the database.

FIELD	NAME	DESCRIPTION
Record Number	REC#	
Date of Permit / Estimate	DATE	Date of Permit or Estimate
Quarry Permit #	QUARRY	Actual Permit Number
Land use Permit #	LAND	Actual Number or Estimate Number
Permit / Estimate Status	STATUS	Estimate, Active, Closed
Block / District	BLOCK	General Area i.e. ILA Block, or DIAND District
Source	SOURCE	Source Code Identification
Source Location	LOCATION	Source Location
Permit Holder	PERMITTEE	Company responsible for permits
Contractor	CONTRACTOR	Company that is extracting gravel
Low Estimate	EST_LOW	Low estimate of requirements
Mean Estimate	EST_MEAN	Likely estimate of requirements
High Estimate	EST_HIGH	High estimate of requirements
Estimate Classification	EST_CLASS	Estimated material classifications
Requested Requirements	REQUESTED	Requested requirements
Requested Class	REQ_CLASS	Requested class of material
Actual Requirements	ACTUAL	Actual amount extracted
Actual Class	ACT_CLASS	Actual classification
Year of Usage	EST_YEAR	Year of extraction and placement
Sponsor	SPONSOR	Company Sponsoring the Project
Category	CATEGORY	End user classification e.g. Private, Government, Military, Municipal
Project Description	PROJ_DESCRIP	Description of the project
Location	PROJ_LOC	Actual Location

Granular Resource Data Base
Table 1

Record Number: This is the number of the record. It is automatically generated by the program. Record numbers can change from time to time, if for example an old record is deleted. It is therefore not recommended that they be used to identify land use or quarry permit numbers.

Date of Record: This represents the date the record was first entered or last updated. It is entered by the user.

Quarry Permit #: Is the quarry permit number.

Land use Permit #: Is the land use permit number.

Status: This is the status of the specific project. The user should enter one of the following depending on the stage of development.

- Estimate
- Active
- Inactive
- Closed

Block: The land block from which the granular material is being extracted.

Source #: The gravel source number within the block.

Source Location: The location of the gravel source. Generally speaking, this would be the UTM co-ordinates of the source; however, latitude and longitudes or other descriptors are also allowed.

Permit Holder: The person or company that is requesting the permits. This would generally be the person responsible for the payment of royalties and meeting the conditions of the permit.

Contractor: The person or company actually undertaking the quarry operations. In many cases, this would be the same as the permit holder.

Low Estimate: A low side estimate of the amount of material to be required, expressed in cubic meters.

Mean Estimate: A likely estimate of the amount of material to be required, expressed in cubic meters.

High Estimate: A high side estimate of the amount of material to be required, expressed in cubic meters.

Estimated Class: An estimate of the required class of material (1-5). The specific classes are defined in Appendix C of the User's Guide.

Requested Amount: The amount of material requested at the time of quarry permit application.

Requested Class: The class of material requested at the time of quarry permit application.

Actual Amount: The actual amount of material used. Generally speaking this would be based on trip tickets or an actual survey of the quarry site at the end of the project.

Actual Class: The actual class of the material used.

Year of Use: The year that the material was used. Initially this would be an estimate, but would change to reflect actual year of use.

Sponsor: The name of the individual company or municipality that is sponsoring the project.

Sponsor Category: A descriptive category for the sponsor. NORTH OF 60 ENGINEERING LTD. recommends that a limited number of categories be used. Possible examples are:

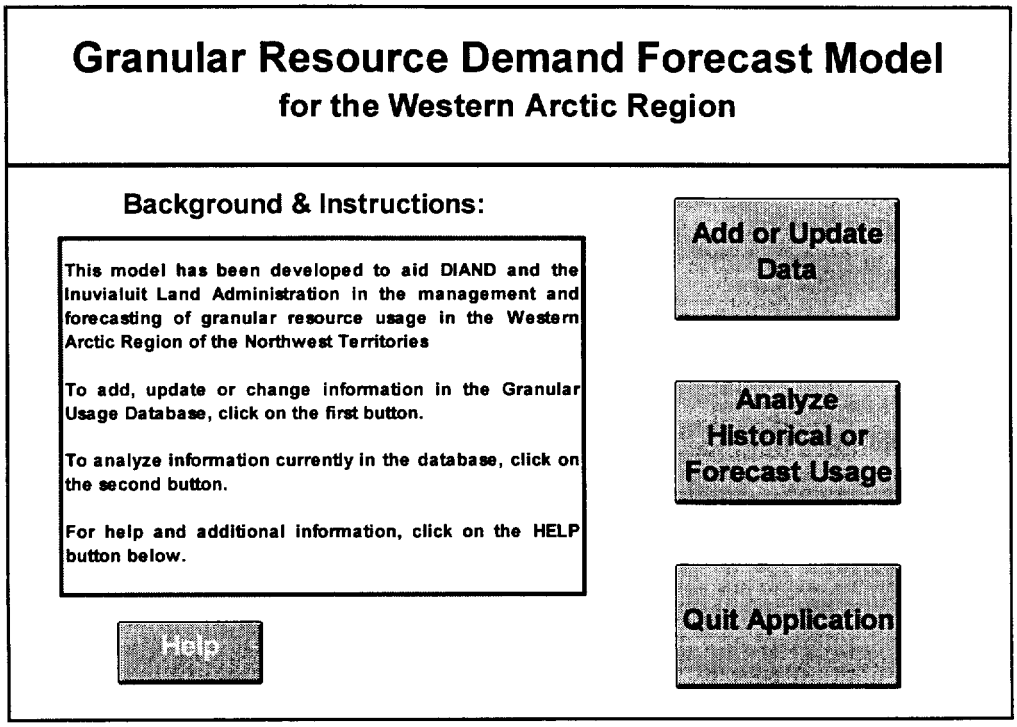
- Public
- Private
- Defence

Project Description: A brief description of the project.

Project Location: The location of the project. Generally speaking this would be the UTM co-ordinates of the source; however, latitude and longitudes or other descriptors are also allowed.

8. User Interface

A simple to use interface has been developed for the model. It consists of a Main Menu (Figure 2) and two sub-menus; the Data Management Menu (Figure 3) and the Data Analysis and Graphs Menu (Figure 6).



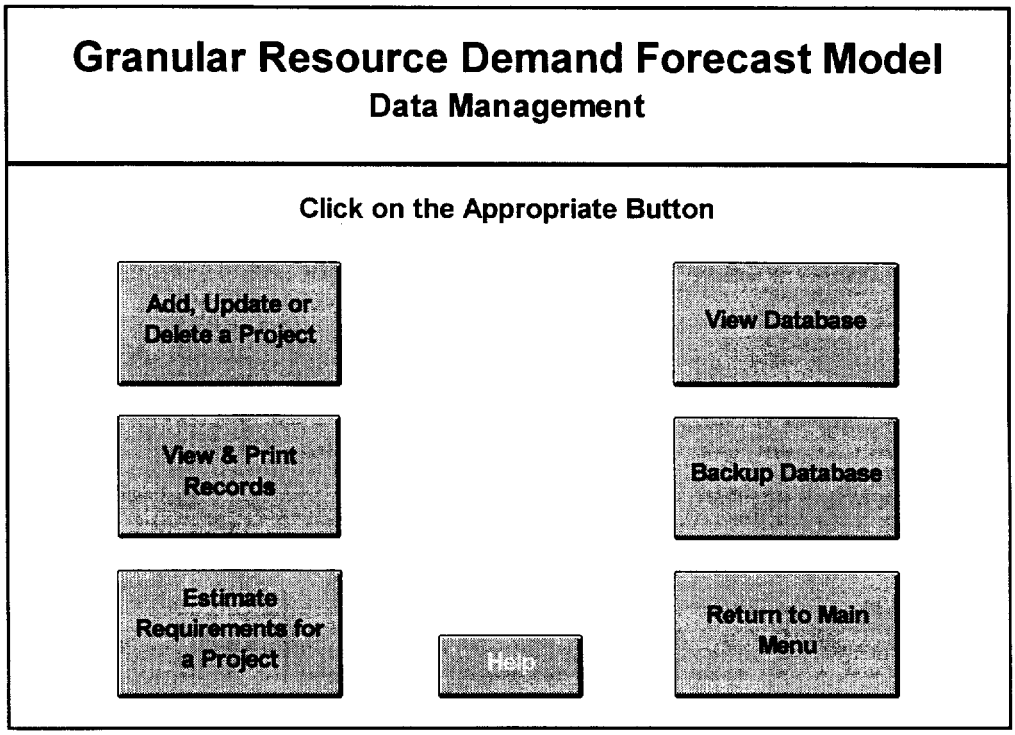
Main Menu
Figure 2

The following sections briefly describe the data management and analysis capabilities of the model.

Data Management

The data management menu allows the user to:

- Add, Update or Delete Projects
- View the Database
- View and Print Specific Records in the Database
- Create Backup Copies of the Database
- Estimate Granular Requirements for typical projects



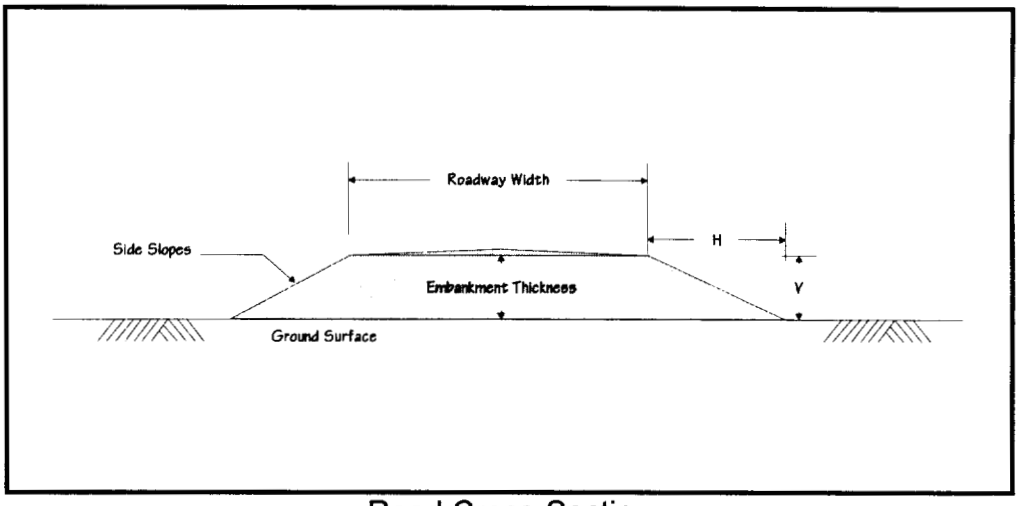
Data Management Menu
Figure 3

The project estimating capabilities represents one of the unique features that have been incorporated into the model. It helps the user estimate granular requirements for:

- Roads
- Runways
- Pads / Building Foundations
- Staging Areas
- Exploration Drill Site
- Oil or Gas Development
- Pipeline Right-of-Ways

In each case, a number of variables or parameters are used to define the geometry or development scenario under consideration. Figure 4 is a representative view of the Road geometry, and Figure 5 identifies the key parameters. The program provides default assumptions for each of the parameters, but it also allows the user to override the assumptions to reflect the specific project under consideration. In this case, for example, the embankment thickness has been decreased

from two metres to 1.5 metres, and the length of the road has been increased from one kilometre to 3.5 km. Any changes are entered into the override column and these are then automatically reflected in the Actual column.



Road Cross-Section
Figure 4

Granular Resource Demand Forecast Model

Menu **Roadway Embankment** Add

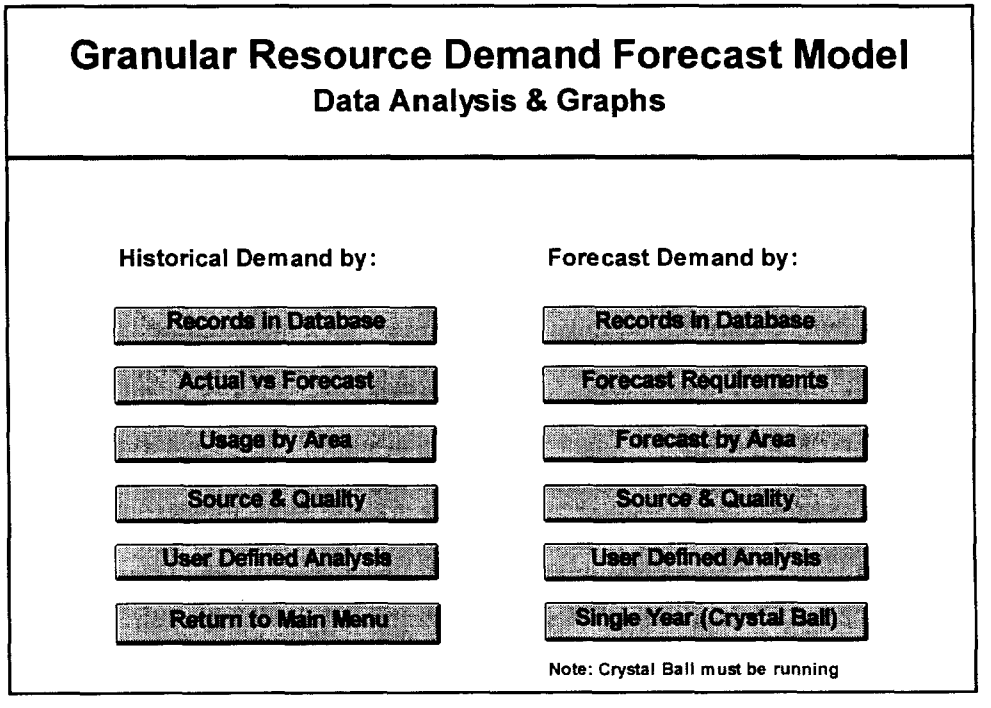
Parameter	Units	Default	Override	Actual
Width of Driving Surface	m	8.0		8.0
Embankment Thickness	m	2.0	1.5	1.5
Slopes	H/V	3.0		3.0
Length	km	1.0	3.5	3.5
Terrain Factor	1 - 5	2		2
Material Class	1 - 5	3		3
Calculated Volume	m^3	41,842		99,082

Roadway Parameters
Figure 5

Having estimated the quantities for a specific project, the user can then add the project to the database or simply return to the Data Management menu. This provides the capability of performing "what if" scenarios to assess the potential impact of a possible project on granular resources.

Data Analysis

The Data Analysis & Graphs component of the model helps the user analyze the data within the database to prepare reports. The menu for this portion of the model is shown in Figure 6.



Data Analysis & Graphs Menu
Figure 6

The analysis and reporting is broken into two time frames, the past and the future. Generally speaking, the analysis and reports are the same for both time frames. Users can look at, and report on:

- Historical or anticipated projects within the database
- Actual or forecast requirements
- Usage by area
- Usage by source and quality
- Usage by project category

The program provides the capability for the user to customize the data analysis and reporting. In addition, it provides the capability of looking at the statistical variability of the aggregate demand for any given year using the **Crystal Ball** Monte Carlo simulation program developed by Decisioneering Inc. of Denver, Colorado.

9. Software & Hardware Requirements

The Granular Resource Forecast Model© has been developed under Microsoft Excel which requires the Microsoft Windows 3.1 operating system. To use the model you need the following minimum hardware:

- An IBM compatible computer with an Intel 386, 486, or Pentium processor.
- A VGA screen and graphics card compatible with Microsoft Windows version 3.1.
- At least 4 megabytes (MB) of random-access memory (RAM).
- A hard disk with at least two megabytes of free space for program files and data files.
- A Microsoft Mouse or compatible pointing device.
- A Microsoft Windows-compatible printer is optional, but recommended.

The following software is required to run the model:

- MS-DOS version 3.1 or later.
- Microsoft Windows 3.1 or later.
- Microsoft Excel 4.0.

10. Forecast Model Documentation

The Granular Resource Forecast Model© includes a detailed User's Guide. The guide describes the program and its underlying basis. It provides basic instructions, procedures and tips on how to use the tool in an effective and accurate manner.

The user's guide is intended for people of all experience levels. Appendix A is a copy of the Table of Contents for the Users Guide. The information within the guide is organized into six sections. The introduction gives an overview of the contents and conventions. Section 2 defines the system requirements and provides instructions to install and use the Granular Resource Forecast Model©. It also gives an overview of the menu structure. Section 3 defines the Data Management portion of the program, Section 4 the individual parameters contained in the estimating section of the program, and Section 5 the analysis half of the program. Section 6 presents suggested procedures for managing the database and performing forecasts.

Copies of the guide may be obtained from DIAND.

Additional Information

Additional information regarding the model can be obtained from the Scientific Authority for the Project or from North of 60 Engineering Ltd. Specific contacts within both organizations are:

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Appendix A

Granular Resource Forecast Model User's Guide

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