Granular Resource Demand Estimating Methods

A Report Submitted to
Natural Resources & Environment
Department of Indian Affairs and Northern Development

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INTRODUCTION

The internet has become a convenient medium for publishing information and researching new ideas. Internet users are becoming more expectant of the services and content provided on the WEB. Providing tools on the internet that do more than publish information but offer applications that users apply as solutions can satisfy this need.

The granular resources estimating tool has been implemented as a web application, allowing users to estimate granular resource requirements for their projects. This is the first step in developing a tool that can provide information on the selection of source materials and aid in managing granular resources.

STUDY OBJECTIVES & DELIVERABLES

The purpose of this study was to research and develop a web application that allows users to set up a user account, define simple projects and estimate granular resource requirements for those projects. The projects are defined by a combination of simple items or object, such as pads, roads, runways, etc. A series of tasks were performed to create the web application:

Task 1 - Develop a framework for the database that will store the information required and the framework for the web application. This includes a definition of the data to collect from the users, the structure of the database tables, and a flowchart diagram describing the main elements of the application.

Task 2 - Develop the web application using ASP server-side scripting and an Access database. Server-side scripting is browser independent because the scripting is run on the server. Most of the time was spent on developing and testing this configuration.

Task 3 - Publish the web application on the internet at the URL http://www.grancalc.ca. Implementing a dynamic web site that uses a database requires a web server that allows server side scripting and ODBC database access. The web application will not work without such a web server and will not work as a stand-alone application. It must be hosted on a web server.

The study produced the following deliverables:

- The web application, as a set of web pages and a Microsoft Access database.
- A hosting solution to test the web application, set-up in working condition on a web server.
- This report, which includes a brief description of application use, a description of the work process, and a detailed description of the application logic.

APPLICATION IMPLEMENTATION

The application consists of a website that allows users to define hypothetical and real projects and calculate theoretical granular requirements. Users set up an account on the website so that they can save their projects. The data defining the projects and estimates are stored in a database, and the estimates are calculated by querying the database.

The web pages and associated database are hosted using the service provider CyberWAVE Technologies. The URL of the website is http://www.grancalc.ca.

The website essentially acts as a user interface for editing and displaying the data stored in the database. A diagram showing the basic implementation of the application follows:

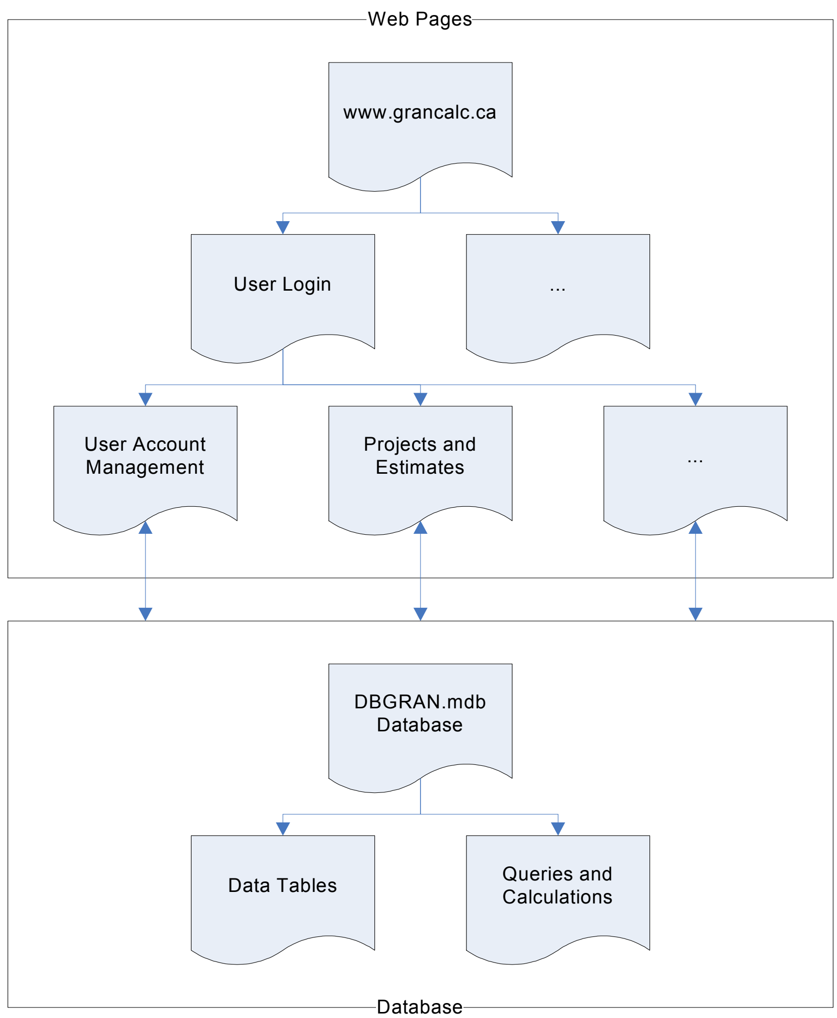

Figure 1 – Application Implementation

Specific attention was made to keep the data and calculations separate from the web pages and user interface. This allows the application to be reused if the user interface is redesigned or integrated with another website or application.

Website

The website was designed using Microsoft Frontpage and consists of a basic website layout using a built-in template or theme for the toolbars, fonts, buttons, etc. This allows the look and feel of the website to be changed easily, and the navigation toolbars are managed automatically.

Underlying the web pages are scripts for connecting to the database. The web forms allow adding and editing the data necessary to define projects and estimates. The web pages also query the database to calculate the granular requirements for each estimate and display that information to the user as a summary table.

The web application uses Active Server Pages, or ASP, as the script technology. Access to the script pages and web pages is through the ftp site: ftp://www.grancalc.ca/website, username: grancalc. This URL can be entered directly in Microsoft Frontpage to export the website to a workstation for future design and editing. The web page design follows a basic hierarchical layout, letting users navigate deeper into the site as needed.

Database

The Microsoft Access database is stored on the server with the web pages. It is a stand-alone database that can be downloaded from the server for later use in creating summary reports or importing data into the Granular Forecast model. When a user displays the projects summary this database performs all the calculations for the estimates. In essence, the website is only a user interface for editing and displaying the data. The database acts as a component that can be reused in the future, such as integrating with another website or integrating with Microsoft Excel. The contents of the database are described in the Database Framework section of this report.

Access to the database is through the ftp site: ftp://www.grancalc.ca/database/, username: grancalc. The specific URL of the database file is ftp://www.grancalc.ca/database/DBGRAN.mdb, which can be downloaded directly at any time.

DATABASE FRAMEWORK

The Microsoft Access database used by the web application contains the following tables and queries:

USERS Table

All the data in the database is associated with a user account. This table lists each user's ID, login name, password, name and company name. This table also stores the token information used to manage the user's session while he or she is logged into the website. The ID is the key that all other tables use to identify data associated with a user.

PROJECTS Table

Estimates are grouped into projects. The project table lists the project names, descriptions, locations, coordinates, start and end dates, and the projects' completion confidence.

LOCATIONS Table

This contains the list of known locations that users can select when defining a project.

BLOCKS Table

This contains the list of blocks – geographical regions used to categorize granular estimates.

OBJECTS Table

An estimate is represented as an object in the database. This table lists common information for objects, such as its name, category, type, and the project with which it is associated.

OBJ_* Tables

These tables contain the detailed input parameters required to calculate the volume of granular materials for each object. Information such as embankment thickness, road lengths, terrain type, etc. is listed in each table.

Some estimates have parameters that can be calculated or overridden. For these parameters, there is an associated field in the OBJ_ table with the suffix text "OR" to indicate if a value is calculated or overridden.

TERRAIN Table

Each estimate requires a terrain type that is used to adjust the volume estimates to accommodate extra material due to difficult terrain. The terrain types and their factors are listed in the TERRAIN table.

CALC_* Queries

The volume calculations are performed by these queries. Intermediate values for some calculations are also available in these queries. A summary of the equations can be found in the next section, Estimate Algorithm Equations.

ORPUSH_* Queries

These queries are used to force the calculated parameters into the OBJ_* tables if they are calculated. This allows the user to view the calculated values on the web forms when editing an estimate.

PROJ_SUMMARY Query

This query lists a summary of each project, each project's estimates and their estimated volumes. It is used primarily to create the summary tables for the web application.

ESTIMATE ALGORITHM EQUATIONS

The calculations for the estimate types are performed by the queries in the database. Equations implemented in these queries are listed here. All uncalculated variables are obtained from the user on the estimate forms. Some of these calculations can be overridden by the user, in which case the calculations are ignored. Additional steps such as rounding, unit conversions and determining the values overridden by the user are not shown here. The purpose of listing these equations is to aid in the inspection of the queries by showing the general logic behind the calculations and showing the equations in a format that is easy to read.

Roads

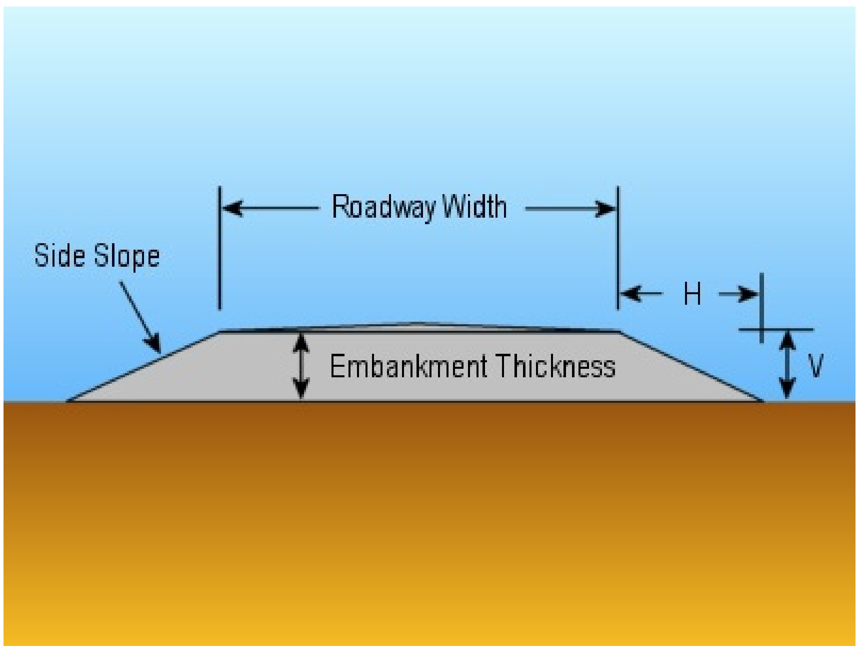

Figure 2 - Road Diagram

$$Volume_1 = \frac{0.15(Width)}{2} + (Width)(Thickness) + (SideSlope)(Thickness)^2$$

$$Volume = (Volume_1)(Length)(TerrainFactor)(BulkFactor)$$

$$BulkFactor = 1.33$$

Runways

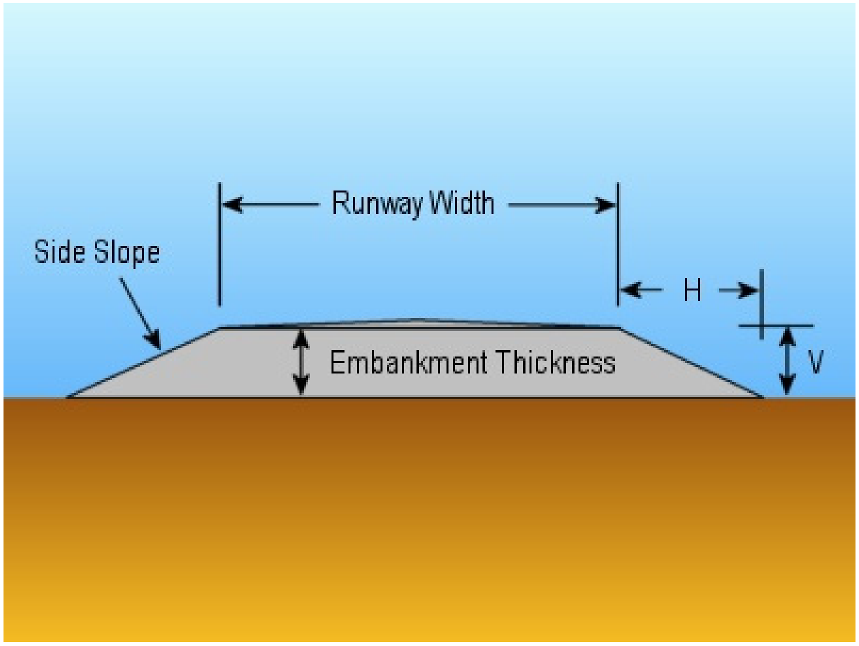

Figure 3 - Runway Diagram

$$Volume_1 = \frac{0.3(Width)}{2} + (Width)(Thickness) + (SideSlope)(Thickness)^2$$

$$Volume = (Volume_1)(Length)(TerrainFactor)(BulkFactor)$$

$$BulkFactor = 1.33$$

Pads

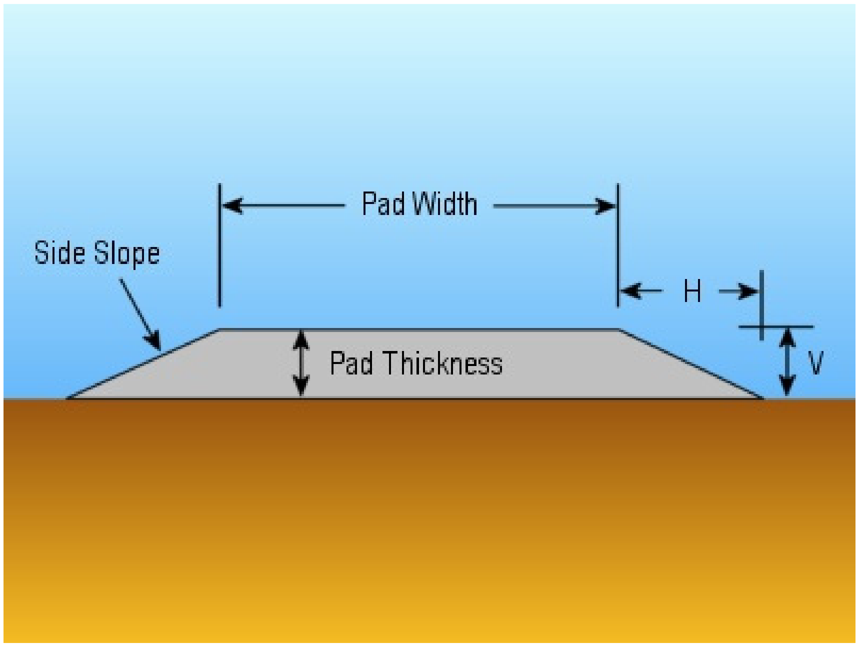

Figure 4 - Pads Diagram

$$Volume_1 = (Width)(Length)(Thickness) + \left[(Slope)(Thickness)^2\right](Width + Length)$$

$$Volume_2 = Volume_1 + \frac{(Thickness)[2(Slope)(Thickness)]^2}{3}$$

$$Volume = (Volume_2)(TerrainFactor)(BulkFactor)$$

$$BulkFactor = 1.33$$

Oil and Gas Development

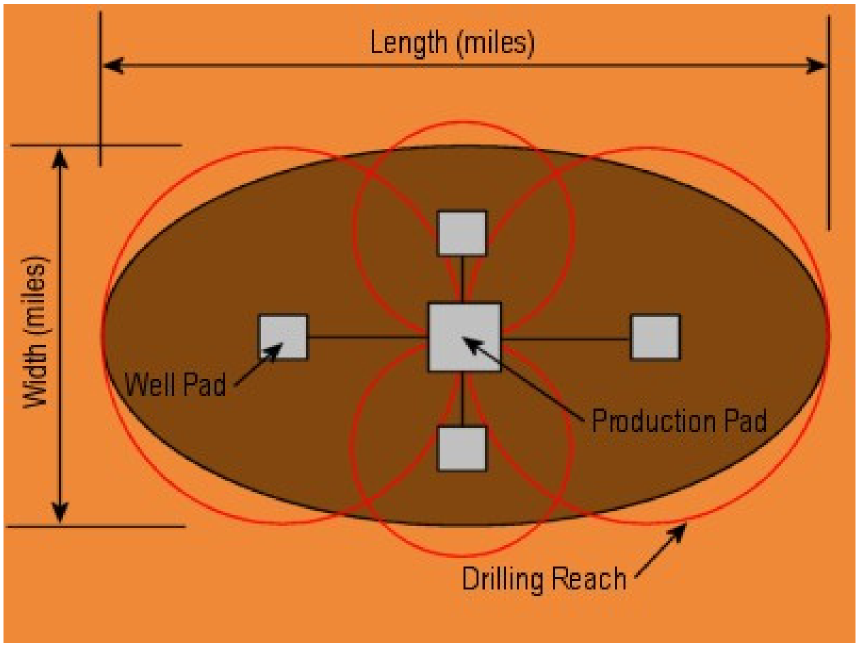

Figure 5 - Oil and Gas Development Diagram

Note: The calculations for Oil and Gas Development are designed for imperial units. The web application accepts only metric units, therefore these equations contain unit conversion factors.

$$ReservoirArea = \frac{(ReservoirArea)}{(2.59)}$$

$$Depth = (3.28)(Depth)$$

If $Product = "Oil"$ **then**

$$WellSpacing = (65)(2.47)$$

Else

$$WellSpacing = (260)(2.47)$$

End if

$$KickDepth = 800$$

$$DeviationAngle = 45$$

$$BuildAngle = 0.03$$

$$Drainage = \frac{[(WellSpacing)(43560)]^{0.5}}{(2)}$$

$$Dev_1 = (BuildAngle)[(Depth) - (KickDepth)]$$

If $DeviationAngle < Dev_1$ **then**

$$MaxDev = DeviationAngle$$

Else

$$MaxDev = Dev_1$$

End if

$$Horizontal = \frac{-\log\left(\cos\left((MaxDev)\left(\frac{\pi}{180}\right)\right)\right)}{(BuildAngle)\left(\frac{\pi}{180}\right)}$$

If $MaxDev = DeviationAngle$ **then**

$$TangDist = \tan\left((DeviationAngle)\left(\frac{\pi}{180}\right)\right)$$

$$\times\left[(Depth) - (KickDepth) - \frac{(DeviationAngle)}{(BuildAngle)}\right]$$

Else

$$TangDist = 0$$

End if

$$TotalKick = (Drainage) + (Horizontal) + (TangDist)$$

$$Height_{Ellipse} = (2)\left[\frac{(ReservoirArea)(5280)^2}{\pi(AspectRatio)}\right]^{0.5}$$

$$Width_{Ellipse} = (Heigth_{Ellipse})(AspectRatio)$$

$$DrillPads = \underbrace{\left(\frac{(Height_{Ellipse})}{(2)(TotalKick)}\right)}_{\text{Round Up}}\underbrace{\left(\frac{(Width_{Ellipse})}{(2)(TotalKick)}\right)}_{\text{Round Up}}$$

If $DrillPads = 1$ **then**

$$AverageDistance = 0.5$$

Then

$$AverageDistance = \frac{(2)(DrillPads - 1)(TotalKick)}{(5280)(DrillPads)}$$

End if

$$NumWells = \frac{(ReservoirArea)(640)(1.3)}{(WellSpacing)}$$

If $Product = \text{"Oil"}$ **then**

$$Rate = (6289)\left(\frac{(Reserves)(0.1)(1.2)}{(365)}\right)$$

Else

$$Rate = (35.5)\left(\frac{(Reserves)(0.1)(1.2)}{(365)}\right)$$

End if

If $Product = \text{"Oil"}$ **then**

If $NumWells > 100$ **then**

$$Length_{Runway} = (1875)(3.2)$$

Else

$$Length_{Runway} = (1000)(3.2)$$

End if

Else

If $NumWells > 500$ **then**

$$Length_{Runway} = (1875)(3.2)$$

Else

$$Length_{Runway} = (1000)(3.2)$$

End if

End if

If $Length_{Runway} > 3200$ **then**

$$Width_{Runway} = 300$$

Else

$$Width_{Runway} = 150$$

End if

$$Volume_{Runway} = \left[(Width_{Runway})(Thickness)(3.2) + (2)(Thickness)^2 \right](Length_{Runway})$$

If $Product = "\text{Oil}"$ **then**

$$Area_{Plant} = \underbrace{\left[\frac{(Rate)}{(30)} \right]}_{\text{Round Up}} (75)^2 (10.764)$$

Else

$$Area_{Plant} = \underbrace{\left[\frac{(Rate)}{(50)} \right]}_{\text{Round Up}} (75)^2 (10.764)$$

End if

$$WellsPerPad = \frac{(NumWells)}{(DrillPads)}$$

$$Area_{Drilling} = \left[(WellsPerPad - 1)(50) + 100 \right](200)$$

$$Area_{Camp} = (Area_{Camp})(10.764)$$

$$Area_{Equivalent} = Area_{Camp} + Area_{Plant} + (Area_{Drilling})(DrillPads)$$

$$Volume_{Pad} = \left[(Area_{Equivalent})(Thickness)(3.2) \right] + \left[(4)((Thickness)(3.2))^2 (Area_{Equivalent})^{0.5} \right]$$

$$Length_{Road} = (DrillPads)(AverageDistance)(1.25)$$

$$Width_{Road} = 24$$

$$Volume_{Road} = \left[(Width_{Road})(Thickness)(3.2) \right] + \left[(2)((Thickness)(3.2))^2 (Length_{Road})(5280) \right]$$

$$Volume = (Volume_{Runway} + Volume_{Pad} + Volume_{Road})(0.0283)(BulkFactor)(TerrainFactor)$$

$$BulkFactor = 1.33$$

Mining Development

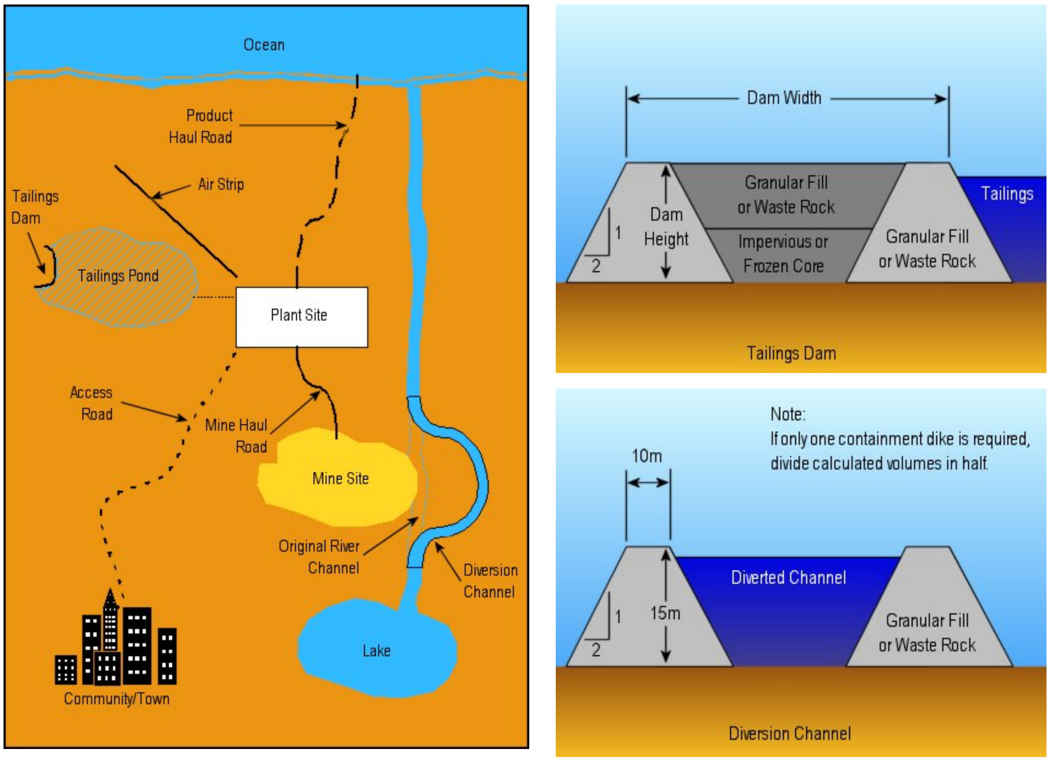

Figure 6 - Mining Development Diagram

$$AssociatedWaste = (Reserves)(2.5)$$

$$TailingWaste = (Reserves)(0.85)$$

$$DailyProduction = \frac{(Reserves)}{(15)(365)}$$

Camp

If $Infrastructure = \text{"Significant"}$ **then**

$$Area_{Camp} = 0$$

Else

$$Area_{Camp} = 12500$$

End if

$$Volume_{Camp} = (2)(Area_{Camp})$$

Plant

$$Area_{Plant} = (500)\left(\frac{(DailyProduction)}{3500}\right)^{0.6}(1000)$$

$$Volume_{Plant} = (2)(Area_{Plant})$$

Tailings Dam (TD)

If $TailingWaste > 0$ **then**

$$Length_{TD} = 1000$$

Else

$$Length_{TD} = 0$$

End if

$$Volume_{TD} = [(2)(Width_{TD}) + Height_{TD}](Height_{TD})(Length_{TD})\left(1 - \frac{(Waste_{TD})}{100}\right)$$

Air Strip (AS)

If $Infrastructure =$ "Significant" **then**

$$Length_{AS} = 0$$

Else

If $DailyProduction > 3000$ **then**

$$Length_{AS} = 1875$$

Else

$$Length_{AS} = 1000$$

End if

End if

If $Length_{AS} > 1000$ **then**

$$Width_{AS} = 100$$

Else

$$Width_{AS} = 50$$

```
End if
```

$$Volume_{AS} = [6 + (Width_{AS})](2)(Length_{AS})\left(1 - \frac{(Waste_{AS})}{100}\right)$$

Water Diversion Channel (WDC)

$$Volume_{WDC} = (20)(5)(Length_{WDC})(1000)\left(1 - \frac{(Waste_{WDC})}{100}\right)$$

Access Roads (AR)

$$Volume_{AR} = [(Width_{AR}) + 4](2)(Length_{AR})(1000)\left(1 - \frac{(Waste_{AR})}{100}\right)$$

Mineral Haul Roads (MHR)

$$Volume_{MHR} = [(Width_{MHR}) + 4](2)(Length_{MHR})(1000)\left(1 - \frac{(Waste_{MHR})}{100}\right)$$

Product Haul Roads (PHR)

$$Volume_{PHR} = [(Width_{PHR}) + 4](2)(Length_{PHR})(1000)\left(1 - \frac{(Waste_{PHR})}{100}\right)$$

$$Volume = (TerrainFactor)(BulkFactor)\sum Volume_i$$

$$BulkFactor = 1.33$$

Pipeline ROW

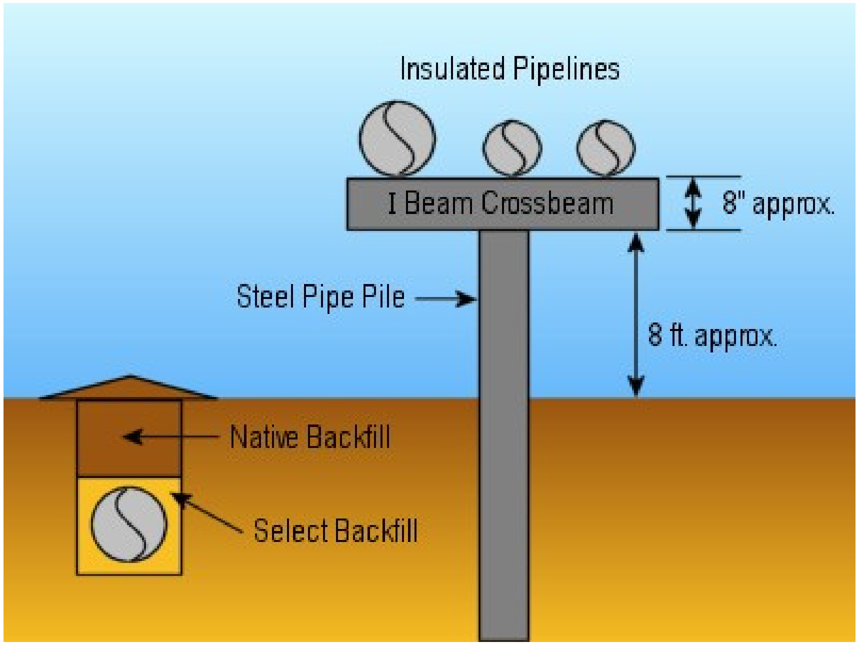

Figure 7 - Pipeline ROW Diagram

Above Ground

$$Volume_1 = \frac{(Length)}{(Spacing)}(1.2)(0.5)$$

$$Volume = (Volume_1)(TerrainFactor)(BulkFactor)$$

$$BulkFactor = 1.33$$

Buried

$$Volume_1 = \left[4(LineSize)^2 - \pi\left(\frac{LineSize}{2}\right)^2\right](Length)(1.2)$$

$$Volume = (Volume_1)(TerrainFactor)(BulkFactor)$$

$$BulkFactor = 1.33$$

Drill Site

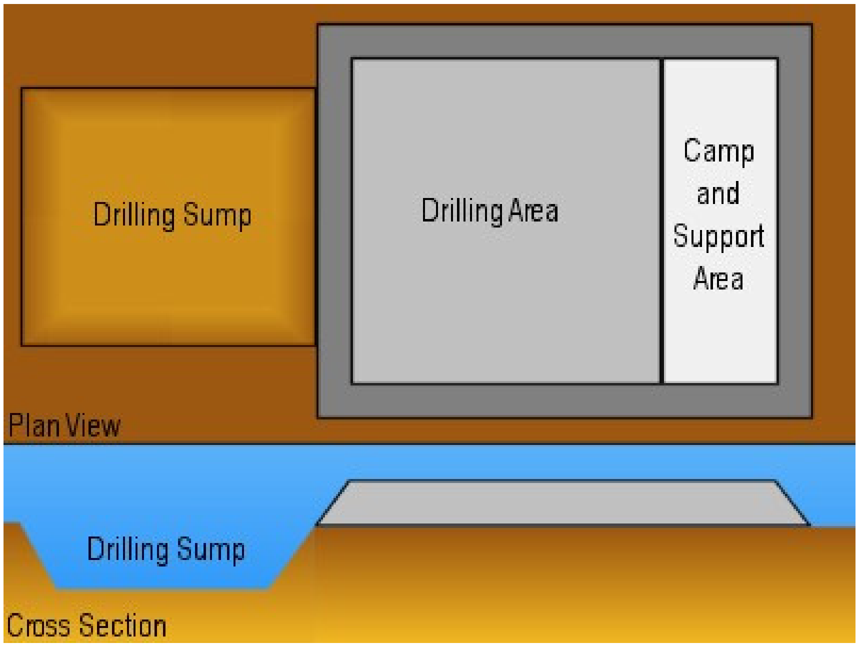

Figure 8 – Drill Site Diagram

$$Volume_{Drilling} = (Area_{Drilling})(Thickness) + 4(Thickness)(Area_{Drilling})^{0.5}$$

$$Volume_{Camp} = (Area_{Camp})(Thickness) + 4(Thickness)(Area_{Camp})^{0.5}$$

$$Volume_{Sump} = (Area_{Sump})(1\ \mathrm{m})$$

$$Volume = (Volume_{Drilling} + Volume_{Camp} + Volume_{Sump})(TerrainFactor)(BulkFactor)$$

$$BulkFactor = 1.33$$

Terrain Factors

The volumes calculated in all the estimates are adjusted by a terrain factor that adds an allowance for different terrain. The factors are arbitrary allowances for varying and difficult terrain. Values for the factors a listed in the table below:

Factor	Value
Flat	1.05
Gently Rolling	1.10
Rolling	1.15
Hilly	1.25
Rough	1.50

Table 1 - Terrain Factor Values

CONCLUSIONS

The web application was designed to take advantage of one of the simplest methods of creating a web application. The web site was created using Microsoft Frontpage, allowing easy implementation of themes and website navigation. Microsoft Access was used to create the database and the queries used to calculate the granular material needed for estimates. The separation of the database from the website will allow future use of the data collected and allow future updates to the application with little effort.

www.grancalc.ca is a dynamic web application giving users the ability to determine rough estimates for granular resources and potentially giving DIAND a database of theoretical future projects to aid in the management of granular resources.