

Version 2.0

User Manual

Standardized Reclamation Cost Estimator

December 2017

Prepared with the generous support of:



Disclaimer: Use of the Standardized Reclamation Cost Estimator (the Model) is conditioned upon your acceptance of the terms and conditions set forth in the Model, as they may be amended from time to time. By opening and using the Model, the user accepts these terms and conditions without limitation.

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Chapter 1

Introduction

The Model was developed to provide a useful reclamation and closure cost estimating tool that standardizes user input requirements, productivity calculations, volume and area calculations in a consistent format while allowing enough flexibility to incorporate site-specific conditions.

This chapter could be subtitled “Why did we do it?”. The answer to that question is fairly simple: we did it to provide a tool to facilitate accuracy, completeness and consistency in the calculation of costs for mine site reclamation. The process to achieve that goal wasn’t so simple.



The Standardized Reclamation Cost Estimator (SRCE) model (the Model) was originally developed with guidance developed during the implementation of the Nevada Standardized Unit Cost (NSUC) Project, a cooperative effort between the Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation (NDEP), the U.S. Department of Interior, Bureau of Land Management (BLM) and the Nevada Mining Association (NvMA) to facilitate accuracy, completeness and consistency in the calculation of costs for mine sites reclamation.

Purpose

The purpose of the Model is to provide a tool to assist mining professionals improve the consistency and accuracy of reclamation and closure cost estimates. Although the Model was developed to provide standardized approaches to reclamation and closure cost calculations, the need to account for diverse approaches to mine closure, and differences between mining operations and regulatory requirements required that the Model also provide a reasonable amount of flexibility. To that end, the Model requires fairly limited user input to perform the cost calculations yet allows the user to combine or subdivide the input data in a number of different ways to account for site specific conditions and reclamation methods.

Background



In late 2002 a group of mining professionals representing the mining industry, and state and federal regulatory agencies in the State of Nevada (USA) met to discuss the concept of developing a standardized cost estimating approach to improve the consistency of closure cost estimates for surety bonding purposes. This initial meeting led to the formation of the NSUCP, which ultimately provided guidance used in developing the Model.

The NSUC Project was implemented largely on a voluntary basis with initial funding provided the NvMA for the development of the original guidelines. The Model continues to be developed and supported primarily on a voluntary basis, and several versions of the Model are publicly available free of charge. For more information on the NSUC Project please see the About SRCE page at the www.nvbond.org website.

The Model was originally developed primarily for use in the State of Nevada, and as such the original version tended to focus on the types of facilities and approaches commonly used for mine reclamation and closure in Nevada. The format of the Data Files was also the result of the origins of the Model. Because the initial focus of the Model was to calculate reclamation and closure bond costs, the Data Files needed to be formatted to incorporate certain data and standards required by US and Nevada regulations.

However, even during the initial development, a number of the NSUC Project participants saw the potential to use the Model for other purposes. Among those possible uses were mine closure cost planning, due diligence, feasibility studies, budget tracking and financial reporting requirements. As a result the initial versions and subsequent derivative versions of the Model have been, and are being developed to expand the capabilities to include these other uses. Nonetheless, a Nevada-specific version of the Model does, and may always exist to meet the needs of the industry and regulators in Nevada.

The original version (v. 1.0) of the Model was released for a six-month trial period in March 2006 after about three years of development and beta testing. This version and two subsequent versions (versions 1.1.1 and 1.1.2) were specifically developed to prepare financial assurance (bond) cost estimates in the State of Nevada, USA. As such, these original versions utilized imperial measurement units and included a number of Nevada-specific elements.

In September, 2009 we released the first public domain version of the model designed for use outside of Nevada. This version (1.3) included a number of enhancements and additions, and provided the user with the option to use metric units. Since that time minor improvements and extensions of the model have been added to Version 1.4.1, which was released in both Nevada and public domain versions.

After several years of development, SRCE 2.0 is finally ready for release as a beta version. Although our beta test team has been testing this extensively version for the last few months, we are releasing this as a beta version and users should be aware that there may still be issues with this version.

This new version of SRCE includes new features, updated equipment fleets and numerous enhancements. The key new features include:

- Detailed scheduling at the activity level
- User defined general chart of accounts (facility/activity type)
- Automatic filtering by cost estimate type Life-of-Mine (LOM), Asset Retirement Obligation (ARO) and Financial Assurance (FA).
- Filtering by facility/activity type and three user-defined filter categories
- Greater control over productivity calculations
- User overrides for haul cycle times
- Addition of a second cover layer in all major worksheets and the ability to crush, screen and/or compact all cover layers
- A worksheet to calculate the total number of hours by year for most equipment used in a model
- A mobilization/demobilization worksheet
- The ability to schedule multiple water/soil/rock/vegetation/air sampling categories
- A number of graphs suitable for presentations
- User selected currency symbols (not currency conversions)
- Changeable User Worksheet names
- Multi-line delete function
- Easy to use form-based Table of Contents
- Ability to hide unused worksheets
- A form-based multi-sheet print utility
- User overrides for fuel use
- Updated equipment specifications and productivity curves based on the 2017 Caterpillar Performance Handbook (CPH) (ed. 47)
- Improved performance of most worksheets and macro functions



This version only works in Excel 2013 or later and will not import models from previous versions. However, based on our experience during testing with some very large models, a manual import effort from Version 1.4 typically does not take more than an hour.

Model Validation

Initially, the Model was validated in the State of Nevada (U.S.A.) through an extensive alpha and beta testing process that lasted approximately 18 months. This beta testing process was conducted by representatives from the mining industry, and federal and state regulatory agencies. Beta testers validated the accuracy of the majority of the Model calculations using manual methods, civil CAD software, GIS and other cost estimating tools. The volumetric calculations were found to be very accurate in comparison to other methods, providing the project data was properly entered. Productivity calculations were largely derived from published sources such as the Caterpillar® Performance Handbook (ed. 35) and were compared against actual field conditions.



Although productivity calculations for specific tasks can be highly variable, the beta testing period indicated that the overall time required to perform most tasks was within the range of data from actual projects, or slightly conservative.

During the six-month trial period following the beta testing process, additional modifications were implemented as well as comparisons with actual field data from ongoing reclamation and closure projects. Version 1.1 (later revised to version 1.1.2), released in early 2007 incorporated a number of changes and enhancements based on input from the trial period, including new productivity formulae for exploration drill road reclamation.

During the period July 2006 through August 2009, a number of enhancements and additions were made to the international (metric) version of the model. These changes were based on feedback provided by a number of users on six continents. Although not every change or new feature requested by the users was incorporated into the current version of the model, many enhancements were made.

During the development of Version 2.0 a small group of beta testers were selected to validate the model. This included general testing, comparison of results with previous versions using actual site data, manual calculations to validate the algorithms used in the model. The beta test team comprised qualified closure/closure cost specialists from industry consultants and several mining companies. As of the end of 2017, Version 2.0 has not been validated by any third-party or government reviewers.

The Future

The author of the Model and many of the active supporters of the NSUC Project always envisioned that it would evolve through use, change, improvement and expansion. Several revisions of the Model have already been released since the original trial period ended, including a version that is capable of using either imperial or metric units. Other improvements and additions have already been added to the original version, some of which have been incorporated into the Nevada version of the Model. Others have yet to undergo the testing and approval process required for inclusion in the Nevada version. Many additional capabilities have already been added to the international version of the model, some of which may be added to the Nevada version at some time in the future.

Things to Remember

In order for any model to provide useful results, the user must understand not only the Model but also the system that the Model is intended to simulate. The best results will be obtained from the Model when used by a qualified mine closure professional with an understanding of closure planning, construction techniques used for mine reclamation and closure, and standard cost estimating practices. However, by creating a tool that can be used by less experienced people we recognize that it will be used by people with a broad range of skills and experience. With that in mind, we offer the following cautions and caveats that one should consider before embarking on the process.

- **The Model is only a tool.** It cannot do your work for you and will only provide results based on your input. It may not be the correct tool for your project. Don't blame the tool if you don't like the results. As the old saying goes "A poor workman blames his tools".
- **The Model results are only an estimate.** It is always tempting to believe the numbers that come out of a computer model without question. However, for a number of reasons, it is important to remember that the Model results are only an estimate. A number of factors that will affect the accuracy of the estimate, but it is nonetheless only an estimate. Issues such as numerical rounding, the reliance of the calculations on other estimates for components such as productivities and volume calculations, and the accuracy of the input data will all affect the level of accuracy. It is important to understand both the limitations of the estimate and the areas of uncertainty in the data used and the calculation methods.
- **Know the intended use of the estimate.** What you plan to do with the estimate will dictate the amount of effort required to gather the information needed to provide the accuracy required from that data.
- **There is more than one way to prepare a cost estimate.** Although the Model provides a fairly simple method for estimating reclamation and closure costs, it is not the only way to do so. There are other tools and approaches to preparing closure cost estimates and some of these may be more suitable for a particular use, or may be appropriate for use in combination with the Model.

- **Results from Model are only as good as the plan and data used as a basis for the cost estimate.** There is nothing in the Model that can make up for an incomplete reclamation and closure plan. It will not add things you left out. It will not correct your input data. That being said, if used properly, it can assist the user in finding gaps in their closure planning process and in certain circumstances may highlight data errors. It can also be used in evaluating the relative costs of different reclamation and closure approaches to assist in the planning process.
- **There is no such thing as perfect software.** Although the process of beta testing, the trial period and subsequent use by mine closure specialists has resulted in rigorous testing of typical uses for the Model, it also identified a number of needed changes including bug fixes. Testing for any model only includes scenarios contemplated by the testing team, because the Model was developed to be as flexible as possible, there are undoubtedly many possible scenarios that have yet to be tested. As users attempt to use the Model in ways unforeseen by the testing team, new issues are likely to arise. On the other hand, as the Model continues to be used by different people on different mine sites it will improve, provided the users continue to provide feedback. The best way to do that is to submit suggestions and bug reports through the www.nvbond.org web site.

Conventions Used in this Manual

In order to make this manual readable and useful as a functional user guide, standardized text formatting conventions have been used. These formats are intended to highlight different components of the Model and model input requirements.

Icons have also been used to highlight important information included in the manual. Notes and tips are shown in grey boxes with the icons along the other edge of the page

Text Conventions

$A_1 \times 1.2 = A_2$	Formula or algorithm
------------------------	-------------------------

Property Information	Worksheet or Table Name
---------------------------------	----------------------------

<i>Regrade Volume</i>	Cell Name
------------------------------	-----------

Delete	Button Name
---------------	-------------

Icon Key



Important Note



Tip

¹Caterpillar® Performance Handbook, Edition 35, a CAT® publication by Caterpillar Inc., Peoria, Illinois, U.S.A., October 2004

Chapter 2

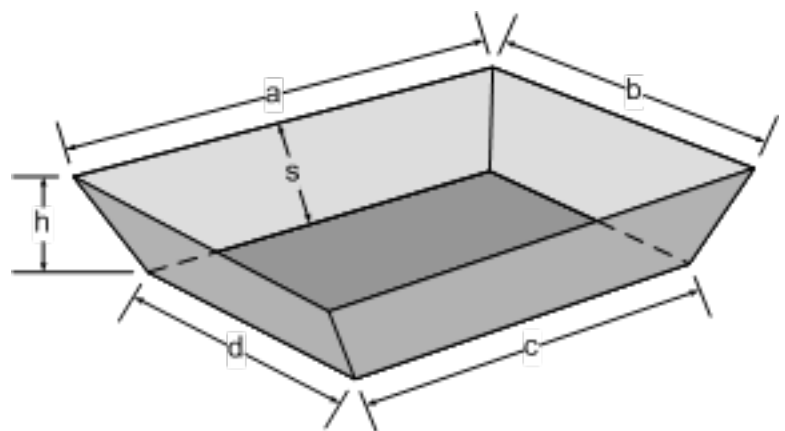
How it Works

The Model was developed to utilize a first-principles approach to reclamation cost estimating, to the best degree possible. A basic understanding of the principles employed to calculate areas, volumes, productivities and time should help the user effectively use the Model.

The methods of calculation used in the Model are based on first-principle approaches for volume and distance calculations, and productivity estimation. In some instances, new approaches and software code were developed to implement and combine these standard methods into a single model that allows both consistency and flexibility.

Volume Calculations

Where possible, the Model uses the simplest methods for volumetric estimation. For example, pond volumes are calculated based on the formula for the frustum of a regular pyramid to determine pond volumes for backfilling calculations and surface areas for liner installation (**Figure 2-1**). Where simple calculations are inadequate to fulfill the goals of simplicity of use and flexibility for site specific conditions, the Model uses combinations of basic formulae or Visual Basic (VBA) code to estimate volumes.



Area and Volume of the Frustum of a Pyramid

$$\text{Surface Area} = ab + cd + (a+b+c+d) \times \frac{s}{2}$$

$$\text{Volume} = \frac{h(ab + cd + \sqrt{abcd})}{3}$$

Figure 2-1: Frustum of a Pyramid

In the case of the calculation of slope regrading volumes creation of a new VBA code was necessitated because the Model needed to calculate volumes for situations where the fill material would be pushed downhill at the toe of the dump (**Figure 2-2 (a)**) and situations where the material would be pushed into an opposing hillside (**Figure 2-2 (b)**). In both instances, the Model uses a VBA routine to calculate a series of cross-sectional cut and fill areas designated by A_1 and A_2 , respectively, using the parameters shown on **Figure 2-3** until $A_1 = A_2$. By using this VBA routine the Model determines the exact dimensions necessary for a balanced cut-to-fill.

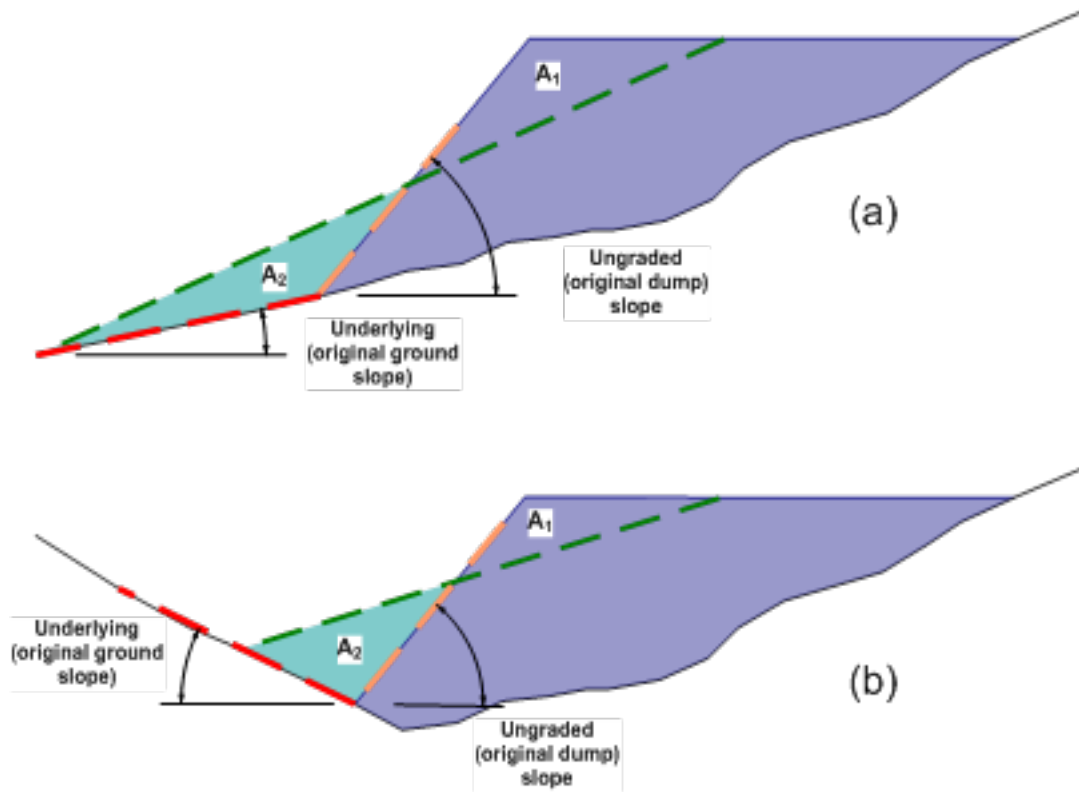
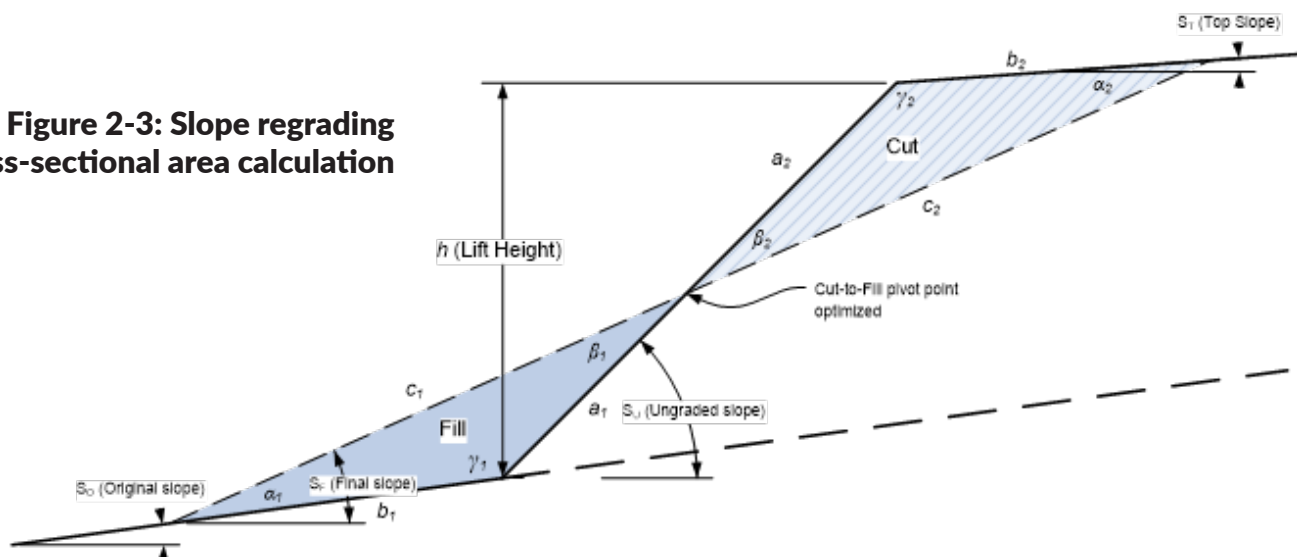


Figure 2-2: Regrading volume (a) uphill and (b) downhill

Figure 2-3: Slope regrading cross-sectional area calculation



Once the cross-sectional cut and fill areas are determined, the Model estimates the cut-to-fill volume by the formula $A_1 \times \text{mid-bench length}$. The mid bench length is a user input representing the distance of a line along the contour of the slope approximately $\frac{1}{2}$ the way up the slope. This slope regrading volume estimation method is used in the Waste Rock Dumps, Heap Leach and Tailing Impoundment worksheets.

The Model also uses a similar method to estimate cut-to-fill volumes for road recontouring, but recognizes that the fill volume requiring placement back in the cut will have expanded during excavation. To account for this the Model applies a 20% swell factor to the cut volume by the formula: $A_1 \times 1.2 = A_2$.

Surface Area Calculations

All calculations in the Model used to determine the quantity of seeded area and the volume of cover material are based on true **surface** areas rather than **footprint** areas. The surface area on non-planar facilities (e.g. waste rock dumps, heap leach pads, etc.) is estimated from the results of the cut-to-fill volume VBA routines as follows:

$$\text{Final Slope Length} = \text{Final Slope of Fill } (c_1) + \text{Final Slope of Cut } (c_2)$$

Final Disturbance Area = user input (footprint of resloped facility)

Final Slope Surface Area = Mid-Bench Length \times Final Slope Length

Final Slope Footprint Area = Horizontal Distance between Final Crest and Final Toe \times Mid-Bench Length

Final Flat Area = Total Final Disturbance Area – Final Slope Footprint Area

Final Surface Area = Final Slope Area + Final Flat (Footprint) Area (**Figure 2-4**)

Where facilities are assumed to be flat (e.g. yards, tailings impoundment surfaces, landfill surfaces, building foundations, the Model assumes that **surface area = footprint area**.

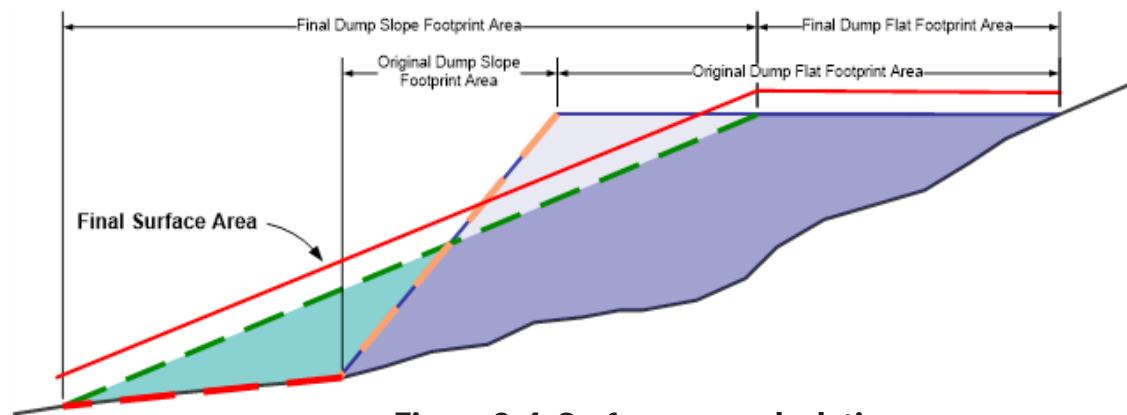


Figure 2-4: Surface area calculations

Equipment Productivities

The Model uses several different sources and methods for calculating equipment productivities. The primary source is the Caterpillar® Performance Handbook (CAT Handbook). Other sources include the Means Heavy Construction Cost Data 2006, equipment and material suppliers, and local contractors. In some instances, such as exploration roads, and drill hole and well abandonment, productivity data was collated from actual work performed in the field and used to adjust the calculated numbers to reflect actual data.

Where the CAT® Handbook was used, several different approaches were used. If productivity curves were included in the Handbook, tables in the Model (Table 1) were created based on those curves and then converted back to curves using the graphing functions in MS Excel. From those graphs, a trendline was fitted to each curve using built-in Excel functions (**Figure 2-5**). The formula for each curve is then used in the calculation of equipment productivity for each situation where that equipment is specified by the user. For example, if a D9T dozer is used to push material 91 meters the formula used to calculate the productivity will be:

$$\text{Productivity} = 49152 \times 91^{-0.833}$$

Table 1 - Dozer Productivity vs. Grading Distance

Dozer Productivity vs. Grading Distance						
Average Dozing Distance (m)	Production (LCM/hr)					
	D6T	D7E	D8T	D9T	D10T2	D11T
15	421	726	803	1,338	1,950	2,752
30	268	443	474	841	1,208	1,682
61	157	260	291	482	688	971
91	115	176	214	329	482	688
122		138	161	252	367	535
152		115	138	214	291	436
183		92	115	176	252	352
Source: Caterpillar Performance Handbook Edition 47						
dozer productivity = k x Dozing Distance ^p						
(see graph)						
k =	9623.7	26451	23933	49152	74681	101567

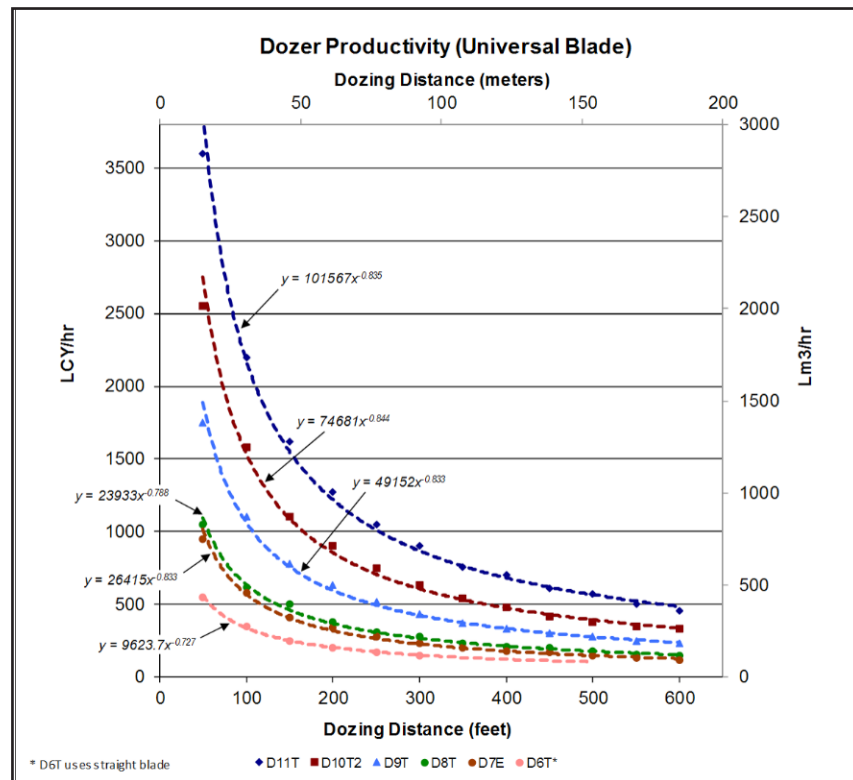


Figure 2-5: Dozer productivity vs. distance

Examples of equipment that utilize tables from the CAT® Handbook include the uphill and downhill travel times for scrapers and trucks.

Productivities for equipment such as loaders and excavators were calculated from cycle time tables and graphs in the CAT® Handbook assuming average bucket capacity and bucket sizes matched to the equipment and task. Average capacity was estimated by the formula:

$$\text{Average Capacity} = \text{Struck Capacity} + \frac{1}{2} (\text{Heaped Capacity} - \text{Struck Capacity})$$

As appropriate, correction factors for equipment are added to the productivity calculations for each facility. Some of the correction factors included in the Model for some or all of the equipment include Job Efficiency, Slope Grading, Rolling Resistance, Operator Efficiency, Density Correction, Material Type, Visibility and Slot Dozing. These correction factors are based on information provided in the CAT® Handbook and applied based on industry standards or site-specific conditions. Job Efficiency and Operator Efficiency correction factors can be adjusted by the user in the International version at the top of the **Productivity** worksheet in the Model.

The Model combines the information input by the user for each facility with the productivity formulae, tables and correction factors created from published data and industry data to calculate the individual productivity. As an example, if a user adds a 30 meter high dump

facility that will require grading from angle-of-repose to a 3H:1V slope, the Model will follow the following steps to estimate the cost to regrade the slope:

1. Calculate volume of cut material to push
2. Calculate the push distance
3. Apply the Dozing Distance vs. Productivity Curve Formulae to estimate uncorrected productivity.
4. Apply correction factors based on user input and standard values to calculation corrected dozer productivity
5. Divide dozing volume by corrected productivity to calculate work hours
6. Multiply equipment and labor rates to work hours to calculate cost.

Miscellaneous Productivity Calculations

Where published equipment data is not available to calculate productivities, other sources including published cost databases, contractor data and field data were used to determine productivity information for other types of equipment and crews.

Bore plugging and well abandonment productivities are based on data from approximately 65 exploration drillholes and 30 monitor and production wells. These data, taken from daily drillers logs were compiled to determine the production rates for casing removal, casing perforation and grouting.

Productivities for demolition and other miscellaneous tasks are estimated from information contained in and used by permission from Means Heavy Construction Cost Data 2006 (Means). As an example, wall demolition productivities (and crews) from Means are combined with the equipment and labor cost data imported into the Model to calculate a unit cost for each wall type (**Figure 2-6**).

Daily									
Means Number	Unit	Crew	Output	Materials	Labor	Equipment	Premium	Total	Notes
Wall Demolition									
Block 4" thick	CUY20-130-2000	SF	1 Cdb	180		\$1.54	20%	\$1.84	assumes vertical reinforcing rods included (20% premium)
Block 8" thick	CUY20-130-2040	SF	1 Cdb	170		\$1.54	20%	\$1.84	assumes vertical reinforcing rods included (20% premium)
Block 8" thick	CUY20-130-2080	SF	1 Cdb	150		\$1.54	20%	\$1.84	assumes vertical reinforcing rods included (20% premium)
Block 12" thick	CUY20-130-2100	SF	1 Cdb	150		\$1.54	20%	\$1.84	assumes vertical reinforcing rods included (20% premium)
Conc 8" thick	CUY20-130-2400	SF	8 S	180		\$6.30	10%	\$6.93	assumes average reinforcing (10% premium)
Conc 8" thick	CUY20-130-2420	SF	8 S	140		\$7.56	10%	\$8.28	assumes average reinforcing (10% premium)
Conc 10" thick	CUY20-130-2440	SF	8 S	140		\$9.24	10%	\$10.16	assumes average reinforcing (10% premium)
Conc 12" thick	CUY20-130-2500	SF	8 S	100		\$11.00	10%	\$12.10	assumes average reinforcing (10% premium)

EQUIPMENT FLEET S			
A CTIVITY AND FLEET	EQUIPMENT UNIT CO ST (Hourly)	LABOR UNIT CO ST (Hourly)	TOTAL CO ST (Hourly)
B-9 - Concrete Wall Demolition			
General Laborer	\$0.00	\$35.73	\$35.73
General Laborer	\$0.00	\$35.73	\$35.73
General Laborer	\$0.00	\$35.73	\$35.73
General Laborer	\$0.00	\$35.73	\$35.73
Foreman	\$13.03	\$52.01	\$65.04
Air Compressor, 4' Hoists	\$15.46	\$0.00	\$15.46
Total	\$28.49	\$194.93	\$223.42

Figure 2-6: Use of Means crews and productivities

Dozing Distance Calculations

During development of the model, several contractors who were part of the working group we advised that the model use a centroid-to-centroid dozing distance. The centroids are defined as the intersection of the lines from each vertex of the two triangles that make up the cut and fill areas to the center of the opposite side (**Figure 2-7**). The point where these lines intersect are exactly two-thirds of the distance from each vertex. Added together, they represent the centroid-to-centroid distance.

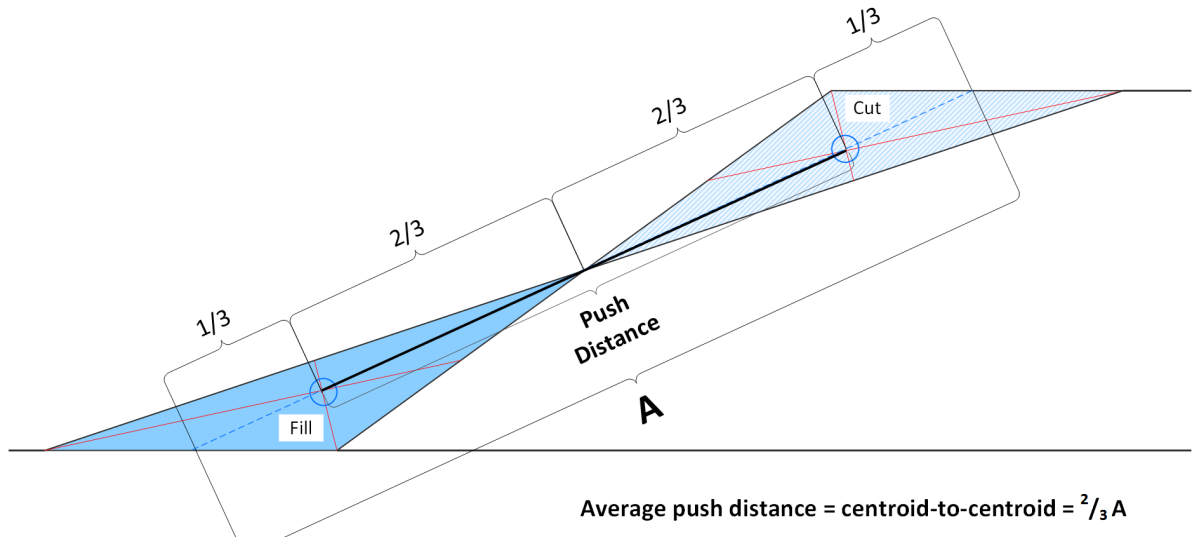


Figure 2-7: Dozing distance calculation

Cycle Times for Material Hauling Fleets

Cycle times for material hauling fleets are estimated by combining the uphill travel time curves and the downhill travel speed tables with the project data provided by the user. Loaded vehicle weights for use with the travel speed tables are based on standard materials included in the CAT® Handbook. The Rolling Resistance factor used (2.5%) assumes a regularly maintained dirt road will be used. The equipment cycle time is then calculated as follows:

$$\text{Cycle Time} = \text{Maneuver to Load Time} + \text{Loading time} + \text{Loaded Haul} + \text{Dumping Time} + \text{Empty Haul Time}$$

The loading time is based on the cycle time for the loading equipment (e.g. loader or shovel). The loaded and empty haul times are based on either the travel time curves or travel speed tables depending on whether the equipment is performing an uphill or downhill loaded haul. Appendix A provides additional detail on the algorithms used to estimate cycle times and productivities for various fleets and closure activities.

Fleet Productivities

Fleet productivities are the compilation of the individual equipment productivity of all of the equipment in the fleet. The fleets are assumed to be limited by the cycle time of the loading equipment (i.e. loader limited) and the number of hauling units is determined by the loading cycle. This means that a truck fleet size is determined cycle time of the loader and the loader is assumed to never be idle. For example, if the time required by a truck to make a round trip is slightly more than twice the loader cycle time, then the Model will assume that three trucks are required with two traveling and one being loaded at all times. The overall fleet productivity and work hours are therefore based on the loader productivity. In SRCE 2.0, the user can override the number of trucks for each fleet and create a truck-limited fleet. The user can also override the cycle time for each haul if on-site cycle time data is available.

The total cost for hauling is calculated by multiplying labor and equipment rates by the number pieces of equipment in the fleet including the loader, trucks and spreading dozer.

Dozer loaded scraper fleets are assumed to be dozer limited, and the cycle times and fleet sizes are determined on that basis.

Solution Management

The solution pumping, forced evaporation and decontamination tables included in the Solution Management worksheet include cost calculations for pumping water from one location to another using Manning's Equation and other standard hydraulic formulae. This worksheet uses these formulae to estimate the energy (kW) required to pump solution a defined distance with a hydraulic head through a pipe of a known diameter and material. Once the energy required is known, the cost of pumping that water can be calculated by applying the total pumping time and unit cost of the energy.

The forced evaporation option also includes an option for the user to define a required pressure at the end of the pipe.

¹ Ibid.

² Means Heavy Construction Cost Data 2017. Reed Construction Data, RSMeans, Kingston, MA., Copyright © 2006

³ Ibid.

Chapter 3

Gathering Your Data

The Model was designed to allow a variety of input methods while ensuring that the simplest methods would still produce accurate results.

The data required to perform a reclamation cost estimate using the Model is determined by two primary factors; the minimum data required by the Model to calculate costs, and the intended purpose of the cost estimate. The Model requirements dictate the minimum data necessary to produce a usable cost estimate. The intended purpose will define the level of detail of the input data.

The Model requires the user to provide two types of data; **cost data** and **project data**. Cost data include the equipment, labor and material rates required to perform the reclamation and closure activities. Project data are the dimensions, methods, and design criteria used to define the closure plan for the facilities.

Cost Data

The cost data required as input to the Model can be obtained from a number of sources and comprise the underlying rate assumptions used in the cost estimation process. The particular cost data required for any estimate will be dependent on the available information and the purpose for which the cost estimate is being prepared. Reclamation cost estimates for the purpose of providing a surety estimate for regulatory purposes typically require the use of government-approved rates. Financial reporting requirements usually dictate the use of third-party contractor rates as a base for equipment, labor and material rates. If the purpose of the cost estimate is for mine



planning costs, then actual mine costs, or costs from an analogue mine could provide the most appropriate rate basis.



Important Note

Some regulatory jurisdictions, such as the State of Nevada, require the use of a jurisdiction specific version of the model and/or approved cost data.

Regardless of the purpose of the cost estimate, experience shows that most cost estimates require the use of data from a number of sources, rather than a single one. Some of the most common sources of rate data include:

- **Government Publications** – Many governments publish cost data as part of government contracting procedures. Often these comprise the data required for reclamation and closure cost estimates used for the purpose of determining the amount of regulatory surety required for a project.

In some jurisdictions, government funded institutes also compile cost data from government contracts and the private sector. These databases can be substantial and have the advantage of tracking costs over time, allowing the analysis of trends. Commonly, the final output from these institutional cost databases is a unit cost for each particular activity. Because the Model does not generally use activity unit costs, much of the data in these databases may not be usable as input to the Model. However, in many instances, these data used to derive these costs including equipment and labor rates, material costs, fleets and productivities are also recorded or can be derived from the published information.

- **Published Cost Databases** – There are a number of commercial cost databases compiled from public and private sources available for purchase. These databases may provide rate data for labor, equipment and materials or unit cost data by activity. If unit costs by activity are provided, the resources (labor, equipment and materials) required for each activity are often provided along with an estimate of the productivity of the assigned resources.

The resources (crews) and crew productivities from one of these databases (Means Heavy Construction Cost Estimating Guide, ©2017) was used in the Model for some of the miscellaneous unit costs. The Model then combines the crews and productivities with rate data to calculate a Model unit cost for each activity.

- **Third-Party Contractors** – One of the most accurate sources of cost data is a contractor's estimate. Most financial reporting standards require the use of third-party costs. Although contractor's estimates rarely include detailed equipment and labor rates, they may be willing to provide those data upon request. However, when supplying rate data, the contractor may intentionally provide an inflated rate to protect a competitive advantage.

Equipment costs provided by contractors may be inclusive of preventative maintenance, consumables and wear costs. If so, this should be noted and the Data File imported into the Model modified to reflect this (see Chapter 4 – Setting Up Cost Data Files). However, the hourly rate for equipment should not include the cost of fuel as this is automatically calculated by the Model based on the fuel cost and published data on fuel consumption for different types of equipment.

When requesting labor rate data from a contractor, the basis for that data should be defined (e.g. government vs. union vs. non-union rates) and upon receiving contractor data, the user should confirm whether the labor rates provided include all indirect costs including fringe benefits, tax withholding, retirement funding, insurance and contractor's profit. If the indirect costs are not available from the contractor, they may be available through government published data.

- **Suppliers** – Material suppliers and vendors are generally the best source of data on reclamation and closure materials. For materials with highly variable rates such as fuel, electricity and seeds, use of data averaged over a period of time such as a year or two may provide a more defensible rate. For costs with demonstrated trends, the addition of an inflation/deflation factor may be appropriate if the term of the cost estimate is long enough to be affected by those trends.
- **Mine Data** – For cost estimates intended for planning and budgeting purposes, the best source of data is generally the mine for which the cost estimate is being calculated, or a similar mine in the general region. Where these data are available, care must be taken to ensure that the reported data includes all indirect costs applicable to the intended purpose of the cost estimate.

Project Data



The Model was designed to allow a broad range of methods for gathering the project data required to estimate a reclamation and closure cost. However, the accuracy of the maps and project data available will have a direct impact on the accuracy of any cost estimate prepared using the Model. At a minimum, accurate topographic maps showing all project facilities at the time of closure and after reclamation is complete are critical to provide user input data required by Model.

- **Maps** - At the most basic level, most of the required project data can be gathered using a topographic map and an engineer's scale. Facility heights can be obtained from the contour elevations. Most distances and areas can be measured approximately with an engineer's scale, and slopes can be calculated from scale measurements and contour elevations printed on the map. A planimeter can be used to improve the accuracy of the distance and area measurements.

- **Electronic CAD Drawings** – Obtaining measurements from drawings created in a CAD package such as AutoCAD is a very effective method of collecting project data required for the different worksheets of the Model. Two-dimensional measurements such as lengths and areas of project facilities can be obtained directly from CAD drawings. Three-dimensional parameters such as heights, slopes and volumes can often be directly obtained from CAD drawings or, if necessary, calculated from two dimensional measurements.
- **Mine Planning Software** – Like CAD, mine planning software can provide all of the physical dimensions needed by the Model to calculate the cost estimate. These software packages can also estimate volumes, and often can calculate cycle times, volumes and reshaped slope dimensions, which can be used to check the Model calculations. When using the Model to schedule costs, a mine planning package can also provide useful information on how it will take a given fleet to perform an activity and also assist in the sequencing of the reclamation and closure activities.
- **GIS** – Geographical Information Systems software combine the use of vector and image data into a geographical database. GIS can combine the functionality of data collection from maps, digital design drawings and survey data. Two-dimensional measurements such as lengths and areas can be obtained directly from the tables. Three-dimensional data can also be incorporated into the attribute tables using built-in formula calculations. Utilizing aerial photography and survey data travel distances and slopes can also be calculated. GIS also provides the ability to document measurements made into tables as a visual auditing trail.
- **Air Photos** – Current aerial photos over a site can provide the basis of the physical dimensions needed by the Model to calculate the cost estimate. Aerial Photos once registered in geographical space allow you to visually see the footprint of features and can be combined into a GIS database, Vector tables can be created from visually tracing features and then geometrical information can be obtained directly from the GIS.
- **Internet Tools** - other tools such as Google Earth are available via the internet. Google Earth provides aerial photography on a geographical platform where you can draw, measure and obtain physical dimensions for the Model using the tools provided. This method can be extremely helpful in areas where site data is not available and there is current public access to aerial photography at a usable resolution.

Chapter 4

Setting Up Cost Data Files

The cost data used by the Model must first be loaded into a specially formatted cost data file.

There are two types of data files that can be used to load cost data into the Model; Standardized Data Files and User Data Files. Standardized Data Files contain data that can only be modified with a password. The data in User Data Files can be changed by anyone.

- **Standardized Data Files** may be used by regulatory jurisdictions or corporate accounting departments to ensure that the Model uses a particular set of data dictated by regulatory or corporate standards.
- **User Data Files** allow the user to input their own data.



Important Note

Some regulatory jurisdictions, such as the State of Nevada (USA), require the use of approved (standardized) cost data when the Model is used to calculate bond cost estimates required by regulations. Links to these data files can be found at www.nvbond.org.



This user can input up to 15 different bases of cost in a single file, which in turn allows the user to import a single data file into the Model, but switch between bases/regions.

For example, if a single data file is constructed to contain all of the data for different regions of a country or state, then the user would only need a single User Data File to load cost data for any operation within that

country or state. Switching between regions within the country or state would only require the user to select a different region on the **Property Information** worksheet in the Model.

Source Data

The Source Data worksheet is intended to capture basic information about the source of the data used to create the file. Some of these cells are automatically filled in by Excel. Others require user input.

Format Version: This is an automatic field that is used by the Model to determine if a Data File is in the proper format for the Model version. Because of changes in the Model, different versions of the Model may require different versions of the Data File to load properly. The Data File version is checked by the Model during the Import Data process.

File Name: This is an automatic field that contains the name of the file. It will change if you use the Save As command to change the name. The next time you open the file, the saved name will appear in this field.

Date: This is a user input field that documents the date for which the cost data was valid. This is a user input field because the valid date of the data may not be the same as the date that the file was saved.

Cost Type: This is an automatic field that tells the Model if the data imported is standardized or user data. This information is set by Excel and cannot be changed.

Author/Source: This is a user input field that is used to document the source of the data contained in the file.

Units of Measure: This is a user drop-down field that selects whether the data contained in the file is in metric (meters, hectares, etc.) or Imperial (feet, acres cubic yards, etc.) units. It is critical that only one type of measurement be used in the Data File and that the units of measure used in the Data File match the units of measure that will be used in the Model.

No. of Bases/Regions: This is an automatic field that determines how many different cost bases are contained in this Data File. Excel determines how many different Basis/Region Names the user enters in the Basis/Region section at the bottom of this worksheet.

Basis/Region Table

This table contains three columns and fifteen rows used to define different cost bases for the data contained in this file. The data in this table provides the descriptions for one to fifteen different cost bases or regions contained in the Data File.

Basis/Region: This is an **automatic** field that simply labels each basis or region used in the Data File. A cost basis could be unique to a region (e.g. a county) or could be based on rates provided by a contractor or the mine site mining department.

Basis/Region Name: This is a **user input** field containing the user's description of each cost basis or region. This field might contain a description of the costs such as "Third-party contractor" or "Mine Costs", or it could contain a description of the geographical area for which the data is valid such as "Northern Nevada" or "Western Australia".

Basis/Region Description: This is a **user input** field containing a longer description of the cost basis or region. Because this field allows for word wrapping, there is no programming restriction on how long a description can be input in this field.

Equipment Costs



The **Equipment Costs** worksheet contains the different cost components required by the Model to calculate an hourly equipment rate for each type of equipment used in the Model. There are fifteen columns for each type of data required corresponding to the different cost bases or regions the user defined in the **Source Data** worksheet. Each section contains rows to document the source of the data and or additional user comments.

There are five sections to the **Equipment Costs** worksheet requiring user input. These are:

Monthly Rental Basis: This is a user input field that defines the number of hours used to calculate the cost. Correct data in this field is critical as it will be used by the Model to determine the hourly costs by dividing the Monthly Equipment Rental Rate (cost) by the Monthly Rental Basis (hours) to determine the hourly rental cost.

Wet Rate? (Version 2.0): This is a user input

NOTE:

The **Equipment Costs** worksheet may contain equipment that is not currently used in the Model. Check the **Fleets** worksheet in the Model to determine what equipment is currently being used. The user only needs to input cost data in the **Equipment Costs** worksheet for those pieces of equipment currently used in the Model.

field (Yes or No) that indicates if the rental rates include fuel. The default is “No” and the model generally performs better if this convention is followed, because fuel is calculated based on the equipment hours that are calculated by the model. If the user chooses to use “wet” rates (i.e. including fuel), then this option should be set to “Yes”).

Monthly Equipment Rate Table: This table contains the monthly rental cost for different equipment and different cost bases or regions. These costs could be rental rates, mine ownership costs or any other basis, but typically exclude the equipment costs documented in the other tables in this worksheet.

Preventative Maintenance Cost: This table contains hourly costs for mechanic labor and consumables (excluding fuel, G.E.T. and Tires) used in preventative maintenance of the equipment.



Important Note

When using the default of “dry” rates (i.e. fuel excluded) the data loaded into the Model must not include fuel cost. Fuel costs will be added in the Model from published fuel consumption data and the fuel cost in the Cost Data File imported into the Model.

G.E.T. Consumption: This table contains the hourly cost for wear of Ground Engaging Tools for applicable equipment. G.E.T. costs might include the wear costs associated with bulldozer blades, ripper shanks and hydraulic hammers.

Tire Cost Table: This table contains the total cost per tire for equipment with tires. For backhoes or other equipment that use different size tires on the front and back axles calculate the average cost per tire (i.e. (cost of front tire + cost of back tire) ÷ 2).

Assembly/Disassembly [Total Cost] Table: This table contains the total cost of assembling and disassembling the equipment when mobilized to site and demobilized from site, respectively.

Labor Rates

The **Labor Rates** worksheet contains hourly rates for the different types of labor used in the Model. These labor costs are categorized by job task, such as Equipment Operators, Truck Drivers, Laborers and Project Management and Technical Labor.

There are columns in the **Labor Rates** worksheet for each labor type corresponding to the different cost bases or regions the user defined in the **Source Data** worksheet. Each basis contains two columns. The first column is used for descriptions, where applicable, and the second column contains the rate.

Equipment Operator and Truck Driver rates are categorized by the type of equipment. Although the same rate may apply to all equipment models in an equipment category (e.g. bulldozers), the data file allows for different rates to be entered for each model. Also, the first column for each basis can be used to define a category or group of labor.

Laborers and Project Management and Technical Labor rates are based on the specific job duties of the individual. Laborers are assumed to be hourly employees with fringe benefit and zone adjustments similar to those for equipment operators and truck drivers. Project management and technical labor employees are assumed to be professional employees and their labor rates should include all fringe benefits and zone adjustments as part of the hourly rate.

Each section also contains rows to document **Fringe Benefit** rates, zone adjustments and the source of the data and or additional user comments. Fringe Benefits include any additional employment costs such as medical and retirement plans and are input as an hourly cost.

Zone and Area Adjustments allow the user to define additional costs associated with different areas or zones. For example, if there is an additional premium added to labor rates scaled by distance from a particular location (e.g. a major city), up to seven different hourly zone adjustments can be added. The zone and area adjustments can also be used to account for lodging and meals on projects where laborers will be housed in a camp. Additional adjustments to labor rates can be entered as a cost per hour or a percent of the hourly base rate in the **Labor Rates** worksheet in the Model.

Each section also includes some rows where notes on data sources, zone adjustments or other notes can be entered. In order to ensure the Model results can be audited, the user should take the time to input the source of their labor cost data and any adjustments made thereto.

Indirect Costs such as Social Security, Workman's Compensation, Unemployment Costs or other costs added to the hourly rates in the form of a percentage can be added at the bottom of this worksheet. In the U.S. and other jurisdictions some or all of these indirect costs are mandated by law or regulation. In other jurisdictions, these costs may be defined by corporate policy or labor contracts. Three additional rows are available for other labor rate-specific indirect costs.

Reclamation Material Costs

The Reclamation Material Costs worksheet contains unit costs for various materials required for reclamation and closure. There are four major categories in this worksheet including Revegetation Materials, Well Abandonment Materials, Monitoring Costs and Fuel, Etc. The units for each depend on the specific material and the Units of Measure

selected on the **Source Data** worksheet.

There are fifteen columns included for each type of data required corresponding to the different cost bases or regions the user defined in the **Source Data** worksheet. Each section contains rows to document the source of the data and or additional user comments.

NOTE:

The user can also add additional materials directly into some user input cells in the Materials worksheet in the Model.

This worksheet contains some standard material types as well as providing additional rows in most of the sections for the user to add additional material types. The units are generally automatic fields because the Model requires these data to be input in specific units, although some rows allow the user to input units for these materials. Generally, data with user defined units would only be used for calculations done in the **User Worksheets** in the Model.

There are rows for notes and data sources in each section of this worksheet.

Miscellaneous Unit Costs



This worksheet contains a number of miscellaneous unit costs that are used in the Model. It also contains some unit costs that are not used by the Model, but could be useful as inputs performed by the user in the **User Worksheets** in the Model.

Many of these miscellaneous unit costs are used in the Model in conjunction with crews and productivities defined in Means Heavy Construction Cost Estimating Guide© to estimate costs for non-earthwork activities.

There are columns in the **Miscellaneous Unit Cost** worksheet for each unit cost corresponding to the different cost bases or regions the user defined in the **Source Data** worksheet. Each basis contains two columns. The contents of the two different columns for each basis vary by the type of unit cost being entered. In other cases, only one of the cells may be a user input cell.

For some rows, the columns may be user input cells for labor, equipment or material rates. In other sections, the columns may be user input cells for premiums expressed as a percent, daily productivity in number of units completed during an 8-hour shift, or a total cost per unit.

Chapter 5

Entering Data into the Model

Once the data has been collected, the process of entering data into the Model is fairly straightforward.

Because the Model was designed to be simple to use, the process of entering the basic data required to create a cost estimate for simple projects, little additional effort is necessary to produce a viable cost estimate with the Model. However, many projects have unique requirements that necessitate the need for careful planning to properly setup the Model for the intended use. External calculations using other tools or methods may also be required to estimate costs for non-standard or site-specific costs. Most of the worksheets in the Model allow the user to implement different approaches to calculating the reclamation costs. The most appropriate method utilized in each instance will depend on the configuration of the facility and the requirements for reclamation and closure.

Basic Data Entry

The Model workbook is divided into different worksheets (sheets). Each contains information related to a particular type of facility or activity. Generally, the first few tables on each worksheet are for user input while the other tables contain the results of the Model calculations.

Cells formatted for user input are colored green, cyan and yellow. All other cells are

Waste Rock Dumps - User Input					
Facility Description					
	Description (required)	ID Code	Construction Year	Facility/Activity Type	
1	Ore Stockpile			Waste Rock Dumps	Ph
2	WRD A	WA	2008	Waste Rock Dumps	Ph
3	WRD B - Segment 1	WB.1	2009	Waste Rock Dumps	Ph
4	WRD B - Segment 2	WB.2	2009	Waste Rock Dumps	Ph
Notes:					
1. All Physical parameters must be input even if manual overrides for volume or area are used.					
2. Input distance from crusher to placement location if material to be crushed and/or screened.					
3. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and					
Waste Rock Dumps - User Input (Cont.)					
Facility Description					
	Description (required)	Crush Material (select)	Screen Material (select)	Loss to Crushing/ Screening %	Hi to
1	Ore Stockpile				
2	WRD A				
3	WRD B - Segment 1				
4	WRD B - Segment 2				

locked and cannot be accessed by the user. The only exception to this are the **User Worksheets**, which are unlocked to allow user control of all cells in those worksheets including input and formatting.

Green cells are formatted for direct input. These cells are unlocked and can accept any type of input (text, numbers, etc.) However, the data entered will affect the resulting calculations and entry of an inappropriate data type, (e.g. text vs. number) will cause errors in the calculations dependent on these cells.

	Description (required)
1	Ore Stockpile
2	Waste A

Slot/Side-by-Side (select)	Material Type (select)	Placement Equipment Fleet (select)
No		Small Truck
Yes		Med Truck
Yes	Alluvium	Med Truck
Yes	Basalt	Med Truck
Yes	Clay - Dry	Med Truck
	Granite - broken	
	Gravel	
	Limestone - broken	
	Limestone - crushed	

Cyan cells contain drop-down lists that allow the user to select from a list of valid options. Input of data other than the options presented in the drop-down lists is not allowed in these cells.

Yellow cells are used for direct user input that overrides calculated values for earthwork volumes or areas (i.e. regrade volumes or areas for revegetation). These override cells allow the user to input volumes or areas manually within the various worksheets, allowing control over a few limitations of some of the volume calculations (see Waste Rock Dumps and Heap Leach Pads)

	Regrade Volume (1) (if calculated elsewhere) m3	Cover Thickness Slope mm
2.00		500.0
3.00		500.0
4.00		500.0
5.00		500.0

Distance to Placement on (2)	Slope to Placement Location % grade	Slope Growth Media Thickness mm

positive value = downhill loaded
 negative value = uphill loaded

Where appropriate, data entry tips are provided when a cell is selected. When the user selects a cell containing a data entry tip with the mouse or by pressing the Tab key, a small text box will appear with useful information regarding what is expected or providing additional information on the form of the data expected. As shown here, the data entry tip indicates that by entering a positive value in this cell, the Model will assume that the slope will be graded down the underlying slope. The Model will assume that the slope will be regraded into an opposing slope if a negative value is entered in this cell.

Basic Model Commands

The Model has been designed to use a consistent set of commands for similar actions regardless of the type of facility being modeled. Where applicable, buttons to add facilities, clear the user data and delete a facility are included at the top or along the right side of a spreadsheet. Each of these buttons performs the same function on each worksheet where it is found.

Adding Facilities

The Model is distributed without any rows (facilities) in any of the worksheets. To add new facilities to a worksheet, press the Add button at the top of the worksheet. After selecting the Add function, a dialogue box will appear asking how many facilities you wish to add (**Figure 5-1**).

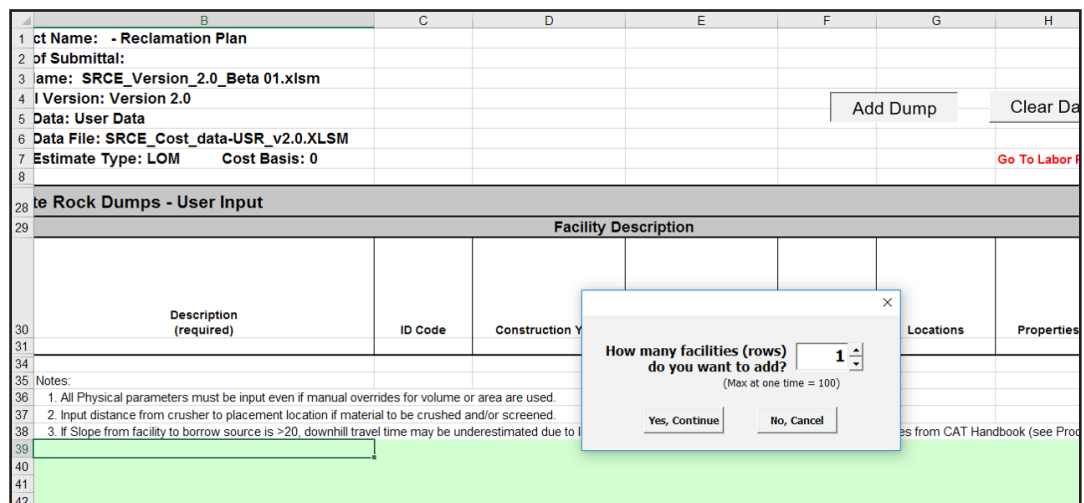


Figure 5-1: Adding facilities

If there are already facilities on the worksheet, then a second dialogue box will appear asking the user to select the row above which the new facilities should be added (**Figure 5 2**). If the user selects “**add to end**”, then the new facilities will be added to the bottom of the table(s). After the user selects “**Yes, Continue**”, the Model will add the requested rows to all of the tables in the work worksheet. Selecting “**No, Cancel**” on any dialogue box will cancel the action without adding any new facilities.

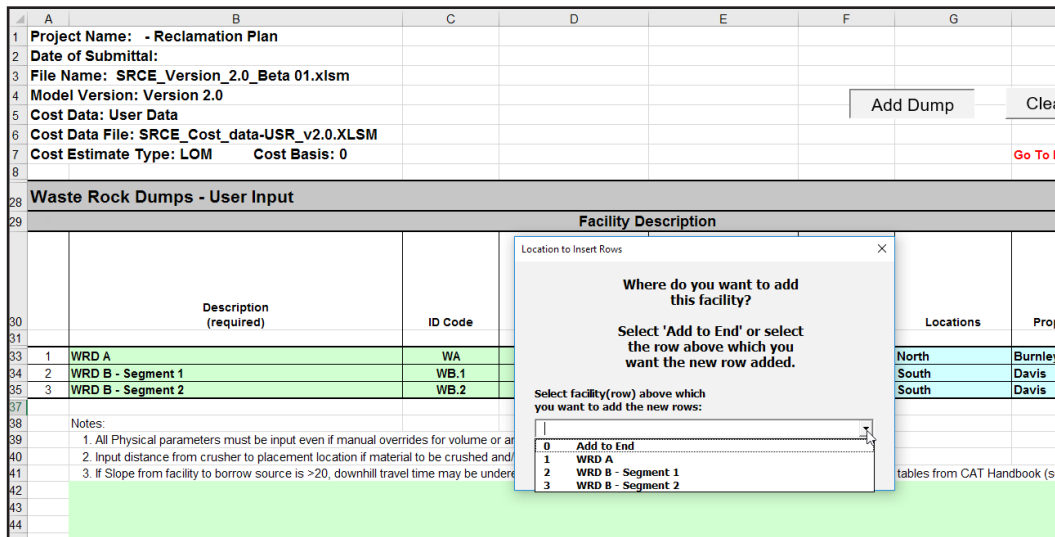


Figure 5-2: Location of added facilities

Deleting Facilities

Selecting the Delete button at the top (or side) of a worksheet will delete facilities (rows) from a model. In all current Model versions the user can only delete one facility at a time. A dialogue box will prompt the user to select the facility or facilities to be deleted and after the user confirms the deletion, the corresponding row(s) will be deleted from each of the tables on the worksheet, and the **Schedule** worksheet if there is a corresponding entry in that worksheet.

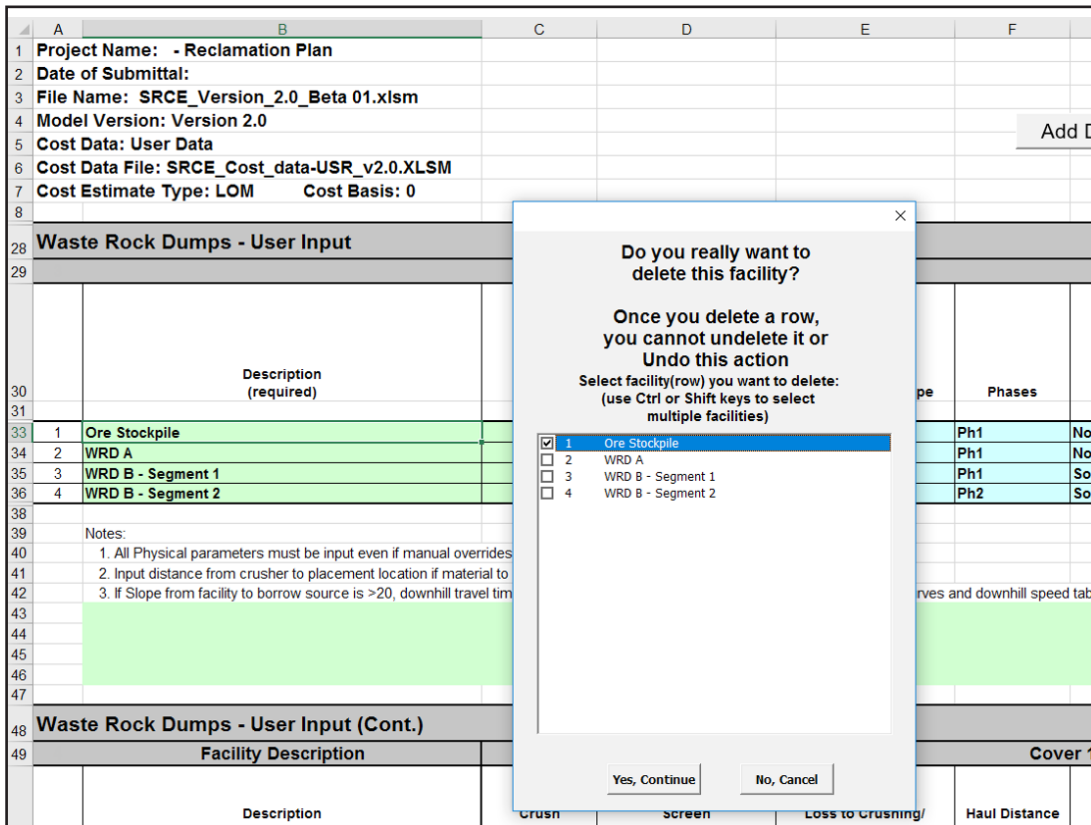


Figure 5-3: Deleting facilities

In SRCE 2.0, multi-line deletes are possible. To delete a continuous range of facilities, select the first facility in the range and then hold the Shift key down while selecting the last facility in the range. Multiple, non-contiguous facilities can be selected by selecting the Ctrl key while selecting the facilities to delete.



Important Note

Once facilities have been deleted from the Model they cannot be recovered using Excel's Undo function. into the Model.

Clearing User Data from a Worksheet

By selecting the Clear Worksheet button from the top (or side) of a worksheet, all user input information will be deleted from a worksheet, but all of the rows will remain in the tables. Use this option to empty the data from a worksheet without removing the lines for the facilities. This action cannot be undone.

NOTE:

If the version of the Model is not approved for use in the State of Nevada (USA), then a message will appear at the top of the Property Information (see Figure 5-3).

Entering Data into Worksheets

The procedure for entering data into each of the worksheets has been standardized in the Model to the highest degree possible. However, the Model requires slightly different user input for each of the facility types to calculate closure costs and allows a great deal of flexibility in how the cost estimate for each facility is approached.

Property Information

The **Property Information** worksheet contains information describing the property, the cost data basis, and the units of measure (**Figure 5-3**). This worksheet has a combination of direct user entry, option buttons and drop-down user selections. It also contains information on the last data file imported into the Model. The *File Name*, *Date*, *Cost Data Type* (Standardized or User), *Units of Measure* and *Author/Source* of the last *Data File* imported into the Model are shown at the top of the page. The bottom of the page contains information on the project and the cost estimate including the *Project Name* and *Date*, *Elevation*, *Units of Measure*, *Currency Symbol*, *Project Type* (small exploration, large exploration or mine operation), *Land Status* (Private, Public or Public/Private), and the selected *Cost Basis* (see **Chapter 4 – Setting Up Cost Data Files**).

PropertyName

Enter Data Below in Green and Blue Spaces

STANDARDIZED RECLAMATION COST ESTIMATOR

Version 2.0
Build - Beta 01

COST DATA FILE INFORMATION	
File Name:	SRCE_Version_2.0_Beta 01.xlsm
Cost Data File:	SRCE_2.0_CostDataFile_USR_Example.xlsm
Cost Data Date:	September 29, 2008
Cost Data Basis:	User Data
Author/Source:	AB Consulting
Data Cost Units:	Metric

PROJECT INFORMATION	
Property/Mine Name:	Property Code:
Project Name:	
Date of Submittal:	Average Elevation m
Units of Measure:	<input checked="" type="radio"/> Metric (m, km, ha, etc.) <input type="radio"/> Imperial (ft, mi, acres, etc.)
Currency Symbol:	Dollar (US)
Project Type:	Mine Operations Plan
Land Type:	Private Land
Cost Basis Category:	WA ARO
Cost Basis Description:	Western AUS Contractor Rates

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Figure 5-4: Property Information

Exploration Data

Because the scale of exploration disturbances is generally smaller than that for mine operations, the Model utilizes different equipment and labor fleets (crews), and productivities for exploration activities. Therefore, data for exploration projects or exploration activities at mining operations is entered into two exploration worksheets in the Model. The first worksheet, **Exploration**, is used to estimate the cost of exploration drillhole abandonment and reclaiming exploration trenches. The **Expl. Roads & Pads** worksheet contains information on the reclamation of exploration roads and drill pads.

Exploration Drillholes

The exploration drillhole abandonment worksheet on the **Exploration** worksheet allows users to estimate the cost of plug exploration drillholes using a number of methods including top plugs, grouting, grout + backfilling and cementing. If no method is selected, then no cost

is calculated. If the water depth is above the bottom of the hole and grout + backfilling is selected as the *Hole Plug Method*, then the Model calculates the amount of grout required to fill the hole from the bottom to the distance above the water table defined in the *Minimum Seal Above Groundwater Table* distance entered in at the top of the worksheet.

An option is included to allow for removal of casing for situations where casing is set in pre-drilled holes or for navigational drilling.

Multiple holes can be added on a single line using an average depth and limiting the number of lines required to estimate all drillhole abandonment costs.

Exploration Trenches

Backfilling and seeding of exploration trenches assumes that the trenches were created using a bulldozer to push material to the ends of the trench, and then backfilled using a bulldozer to push the material back into the trench. The volume of the trench is calculated based on the information provided by the user according to the diagrams and information shown on the worksheet. Although the trench may be on a slope, the Model assumes that the dozer push is on level ground because $\frac{1}{2}$ of the volume would be pushed uphill and $\frac{1}{2}$ would be pushed down hill.

Exploration Roads and Pads

The Model can calculate the cost for reclaiming exploration drill roads on flat surfaces or slopes. On flat areas (*Underlying Ground Slope* = 0%) the Model will assume that no road regrading is required, unless the user enters a volume in the *Regrade Volume* override cell. On slopes, the Model handles the regrade volume calculations for both exploration roads and pads using the same basic formulae. Essentially, the Model considers an exploration road to be a cut-to-fill road (**Figure 5-4** and **Figure 5-5**) and a drill pad to be wide section of the road. The basic formula for exploration road volume calculation is as follows:

$$\text{Regrade Volume of Pads} = (\text{Cross-sectional area of pad} \times 1.2 \text{ (swell)}) \times \text{Length of each Pad} \times \text{No. of Pads}$$

$$\text{Regrade Volume of Road} = [(\text{Cross-sectional area of road} \times 1.2 \text{ (swell)}) \times (\text{Length of Road} - \text{Length of each Pad} \times \text{No. of Pads})]$$

$$\text{Total Regrade Volume} = \text{Regrade Volume of Pads} + \text{Regrade Volume of Road}$$

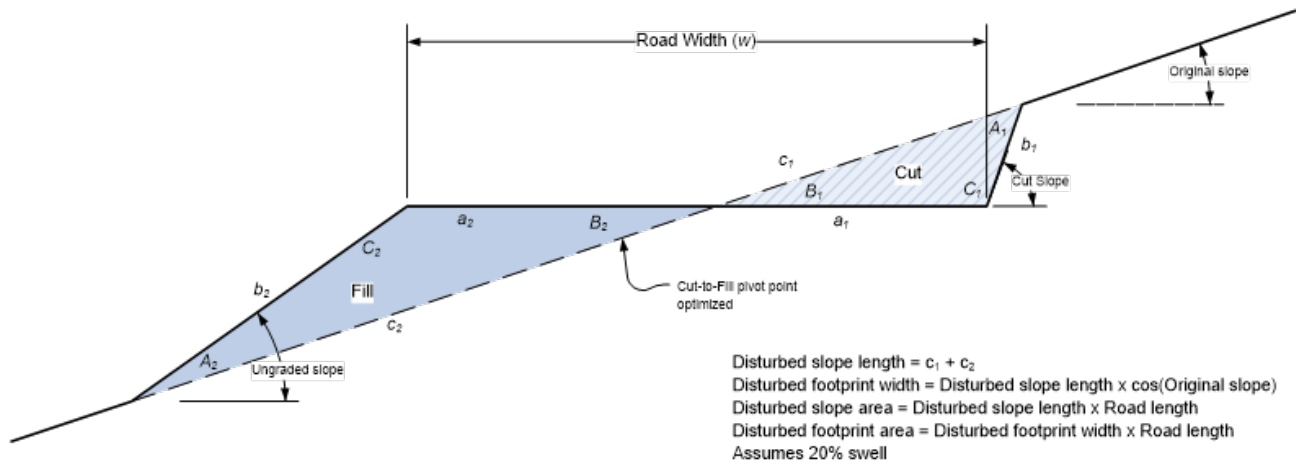


Figure 5-5: Road recountouring calculation

This greatly simplifies the input requirements to estimate the cost of reclaiming a large number of exploration roads and drill pads. **Figure 5-4** and **Figure 5-5** show the basic input requirements to estimate reclamation costs for exploration roads on a sideslope.

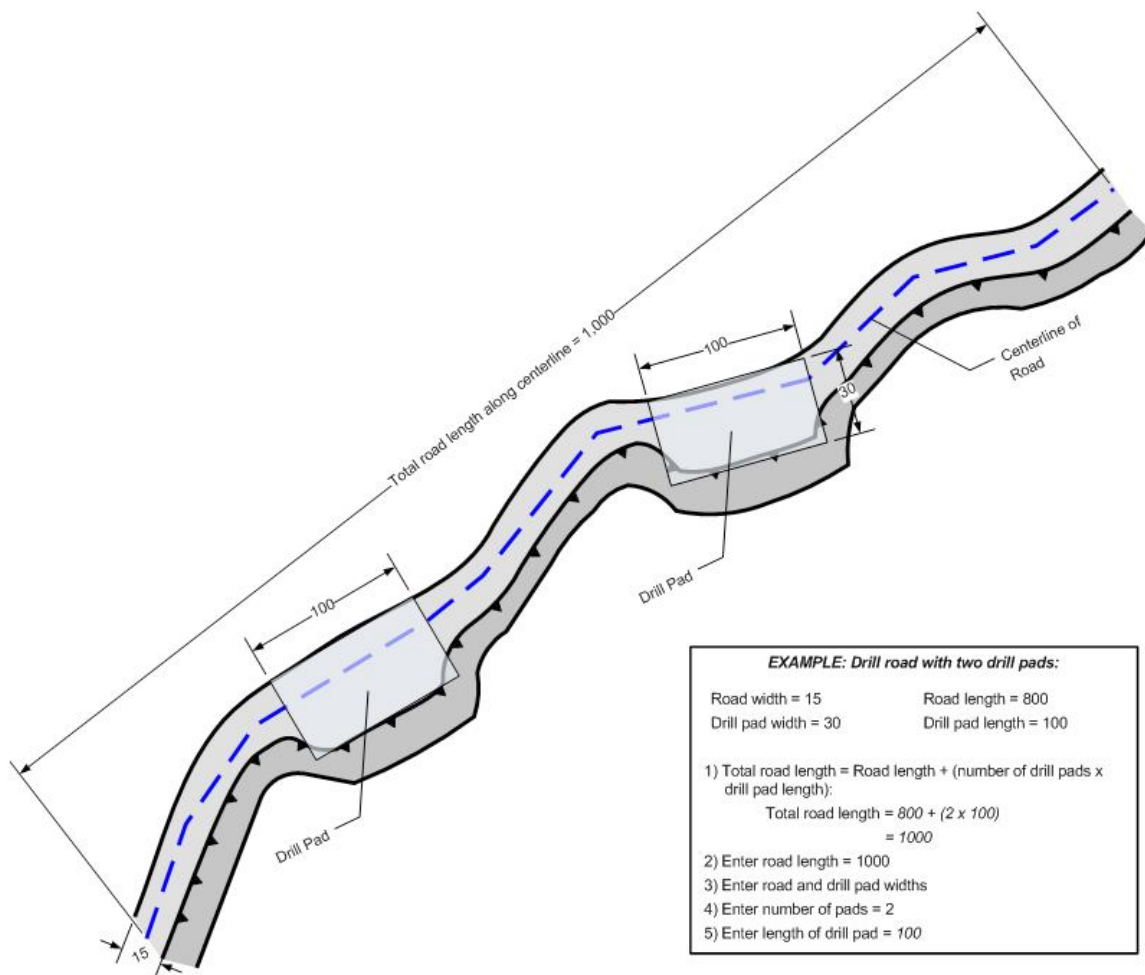


Figure 5-6: Exploration road inputs

The surface area disturbed for use in the calculation of cover and seeding quantities is the surface area as defined by: $area = (slope\ length\ disturbed\ by\ cut + fill) \times total\ length$

On flat areas, the roads may still require some regrading and/or scarifying.

On slopes of greater than 30% grade, the Model assumes that the volume of any sumps needed for drilling fluids is included in the pad regrading volumes. On slopes of less than 30% grade the Model uses input from the user in the Individual Sump Volume cell to estimate the total volume of sumps requiring backfilling.



Tip

Minimize the required data input for exploration road reclamation by creating exploration zones of similar slope.

When entering data for a large number of exploration drill roads and pads first subdivide the exploration into zones of similar slope (**Figure 5-6**). Then enter the average slope for that zone, the average road width, the total length of drill roads + pads, the total number of pads and the dimensions of the pads as a single row in the worksheet. Include any pads not on roads or on roads to remain after reclamation in the number of pads and include the total length of these pads in the total length of drill roads + pads.

This can greatly reduce the total amount of lines required to estimate the total exploration road and pad reclamation cost without significantly sacrificing the accuracy.

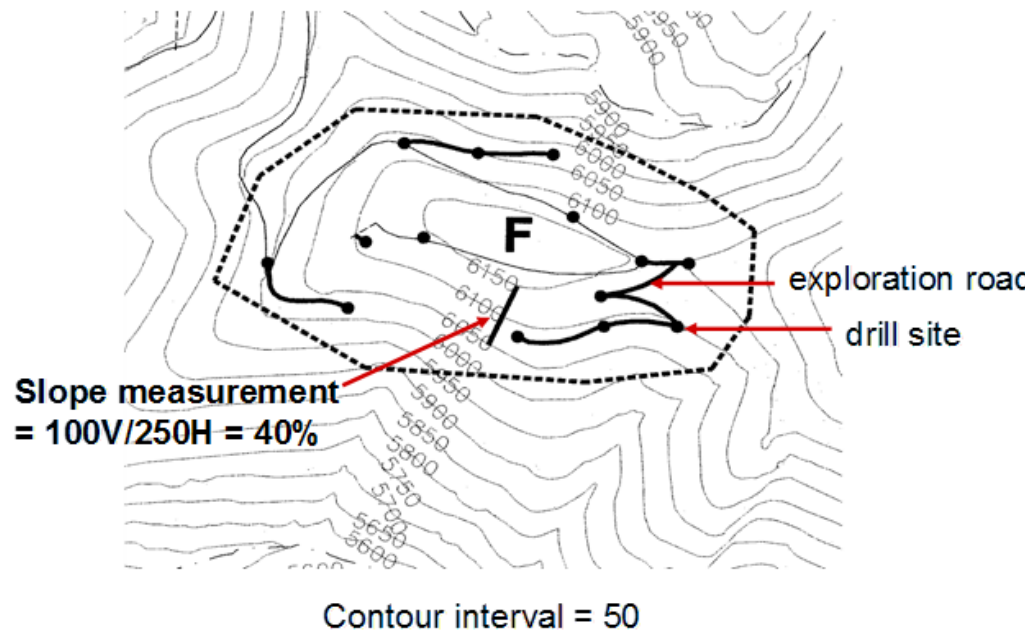


Figure 5-7: Exploration road zones

Mine Facilities

In general, mine facilities are larger and require larger equipment and different crews to perform reclamation and closure. Therefore, the Model uses different crews and methods than for exploration project to calculate the reclamation and closure of mine facilities.

Although there are a number of different types of facilities included in the Model, the Model estimates the closure and reclamation costs of each using similar or identical calculation methods, to the best degree possible. For example, the method for calculating the loading, hauling and placing of cover on all facilities uses exactly the same formulae.

Waste Rock Dumps and Heap Leach Pads

The Model uses nearly identical formulas and subroutines to estimate costs for waste rock dumps and heaps. Therefore, they are discussed together in this section.

The only difference between the **Waste Rock Dump** and **Heap Leach** worksheets are the additional tables in the **Heap Leach** worksheet used to calculate the cost of placing drainage pipe and drain rock in the solution channels surrounding the heap before regrading.

Heap and dumps are typically constructed as side hill, valley fill or valley floor configurations. With limited input data from the user the Model can estimate reclamation and closure costs for all of these configurations.

First, the Model calculates the volume of material requiring regrading and the final surface area of the facility by using the basic geometry of the facility and the methods described in **Chapter 2**. The input required to perform these calculations are shown on **Figure 5-7** and **Figure 5-8** and includes the height, underlying (original ground) slope, ungraded slope, the mid-bench length and the final facility footprint. The Model also allows the user to input a final grade for the top of the facility, but typically this will only slightly affect the regrading volume calculations.

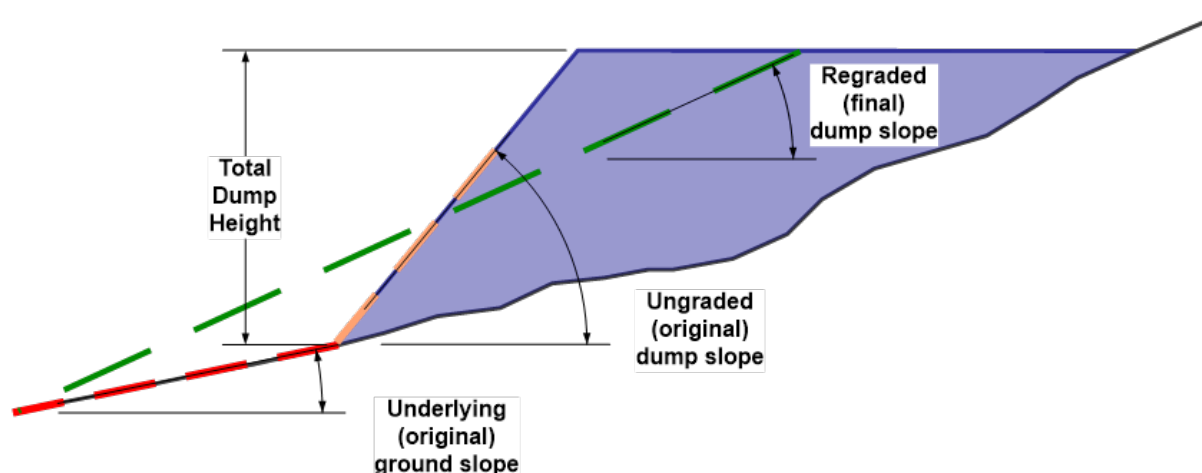


Figure 5-8: Waste rock dump or heap slope inputs

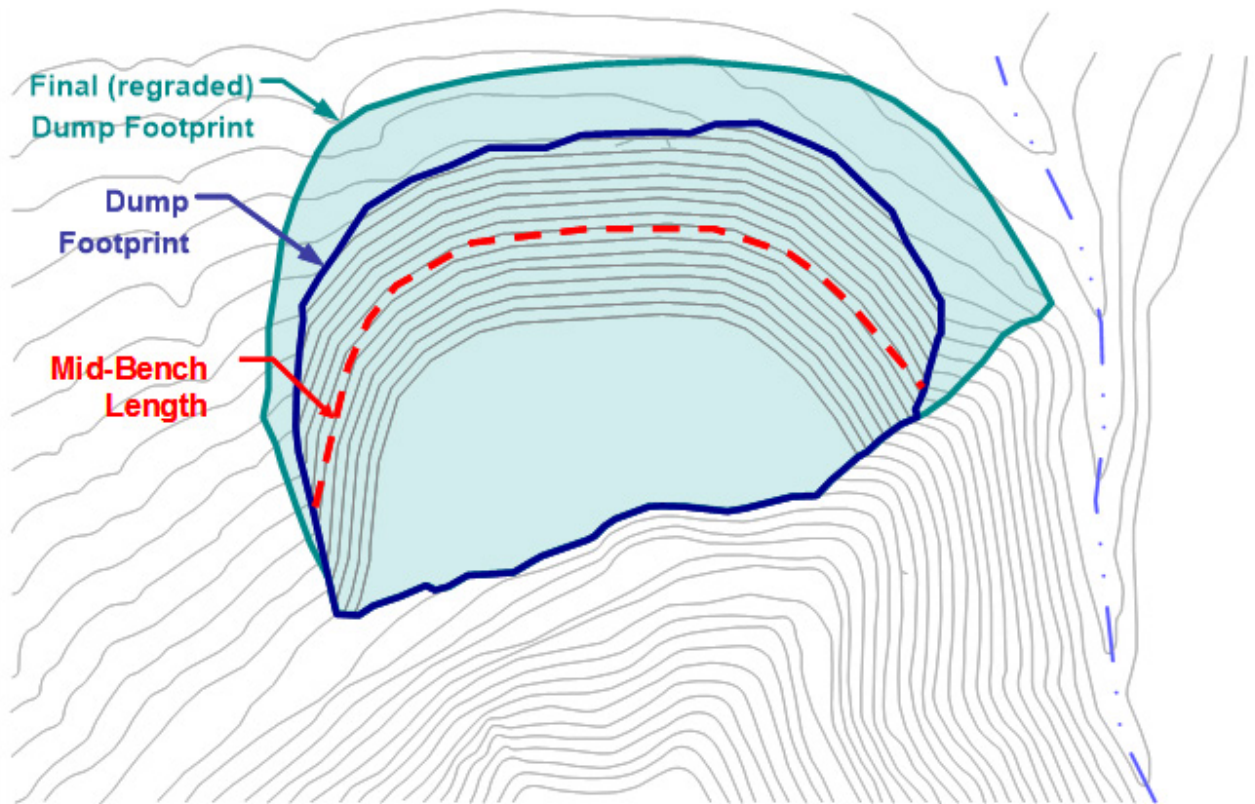


Figure 5-9: Regrading volume inputs

In the simplest configuration, the data required to calculate waste rock dump and heap leach closure costs is fairly straightforward. However, the configuration of a waste rock dump or heap leach facility can affect the accuracy of the cost calculation the minimum data required is all that the user enters. Because the Model does not limit the user to using a single line item for each waste rock dump and heap leach, a complex dump can be subdivided into sections to increase the overall accuracy of the Model calculations for the facility.

An example waste rock dump is shown in **Figure 5-9**. This dump comprises two separate lifts with an irregular footprint and varying lift heights. It has also been partially reclaimed and the current slope angles on the bottom lift are at their final configuration. After reviewing the current dump configuration, the user can see that the dump can be better represented in the Model if it is divided into four areas based on the height of the lifts and the underlying ground slope (the upper lift has an underlying slope of zero because it is located on top of the lower lift). Areas 1 and 2 represent the upper lift and are separated primarily because of the different height of the lift in those two areas. Areas 3 and 4 have different lift heights as well, but also have different existing slope angles with the entire slope of Area 4 having been regraded to the final slope. Using these divisions, the dump can now be broken into four sections, each input into separate line in the **Waste Rock Dump** worksheet (**Figure 5-10**).

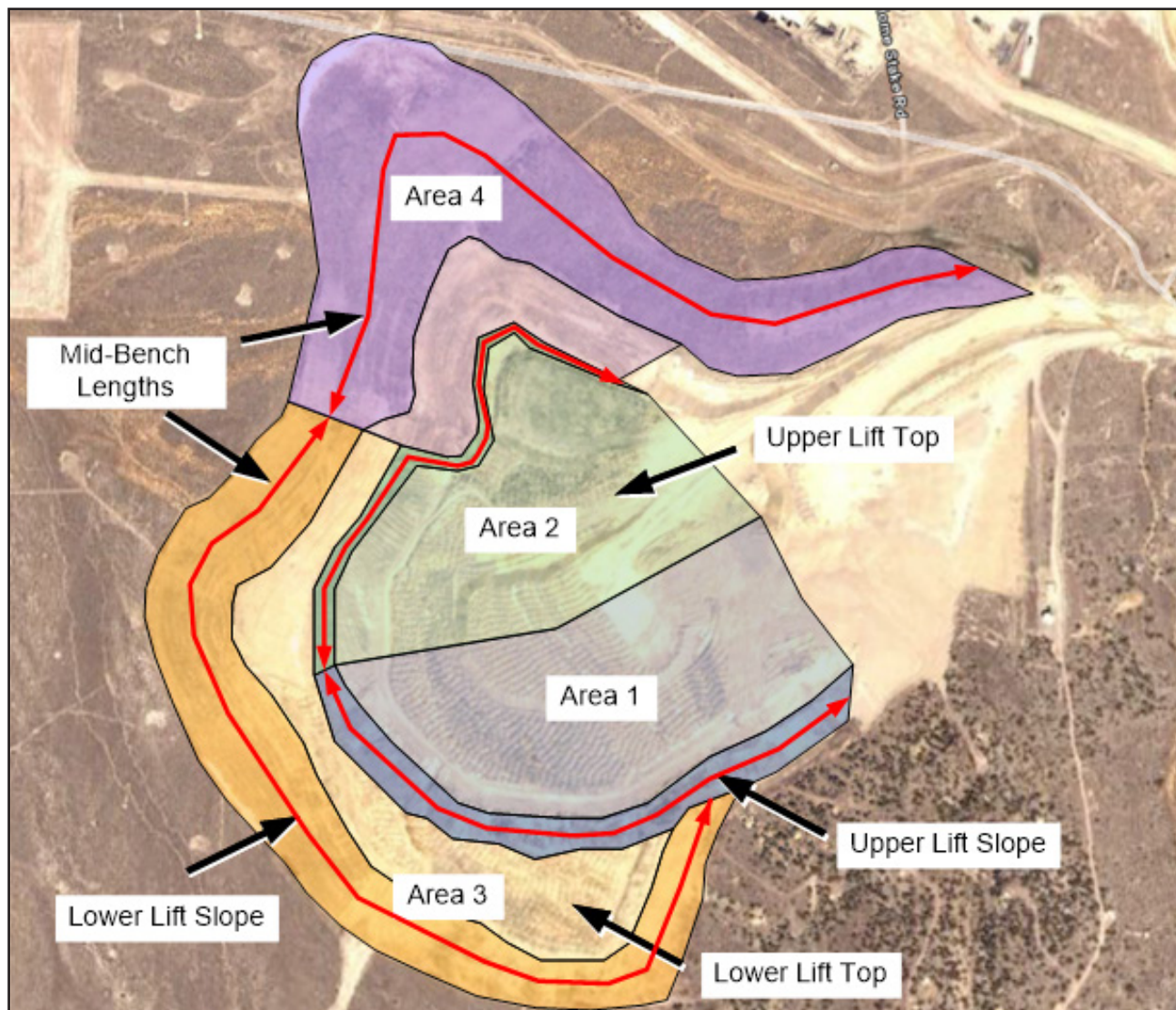


Figure 5-10: Example Waste Rock Dump

The **Final Footprint Area (figure 5-11)** for the upper lift areas must be estimated based on the approximate location of the regraded toe. The **Final Footprint Area** for the lower lift areas should reflect the area of the lower lift that will not be covered by the upper lift in its final configuration.

24	Waste Rock Dumps - User Input			You must fill in ALL green cells in this section for each dump, lift or dump category							
25				Physical							
	Description (required)		GIS Code (optional)	Underlying Ground Slope	Ungraded Slope	Final Slope	Final Top Slope	Lift (dump) Height	Mid-Bench Length	Average Flat Area Long Dimension (ripping distance)	Final (Regraded) Dump Footprint
26				% Grade	= H:V	= H:V	% Grade	m	m	m	ha
27											
29	1	Area 1	SWRD-1	0.0	1.3	3.0	0	10.0	1000.0	1000.0	12.00
30	2	Area 2	SWRD-2	0.0	1.3	3.0	0	15.0	1500.0	1000.0	14.00
31	3	Area 3	SWRD-3	15.0	3.0	3.0	0	20.0	1850.0	1700.0	22.00
32	4	Area 4	SWRD-4	10.0	4.0	4.0	0	25.0	2350.0	2000.0	17.00
34											
35		(1) All Physical parameters must be input even if manual overrides for volume is used.									
36											

Figure 5-11: User input example for Waste Rock Dump

In this example, the accuracy of the calculations could be increased by further subdividing the lower lift areas. Area 4 could be divided into two areas to delineate the northeast slope that has already been covered by topsoil (see darker area). This would allow the user to the Area 3 could be further subdivided to separate the portion of the slope that has been partially regraded and the portion of the slope that has not yet been regraded (southeast corner).

The decision on how much detail is appropriate is a function of the information available, the purpose of the cost estimate and the required level of accuracy required for that purpose.



Important Note

When working with narrow waste rock dumps or heap leach pads, the Model may overestimate the total volume of regrading required if the cross-sectional cut areas overlap from one side of the dump to the other.

Tailings Impoundments

The **Tailings** worksheet addresses the two main components of a tailings impoundment separately (**Figure 5-11**). The embankment is treated in a manner similar to that of waste rock dump and heap leach slopes. The tailings surface is addressed separately as a near horizontal, irregular surface. The Model has options for regrading, cover and revegetation for both areas of an impoundment.

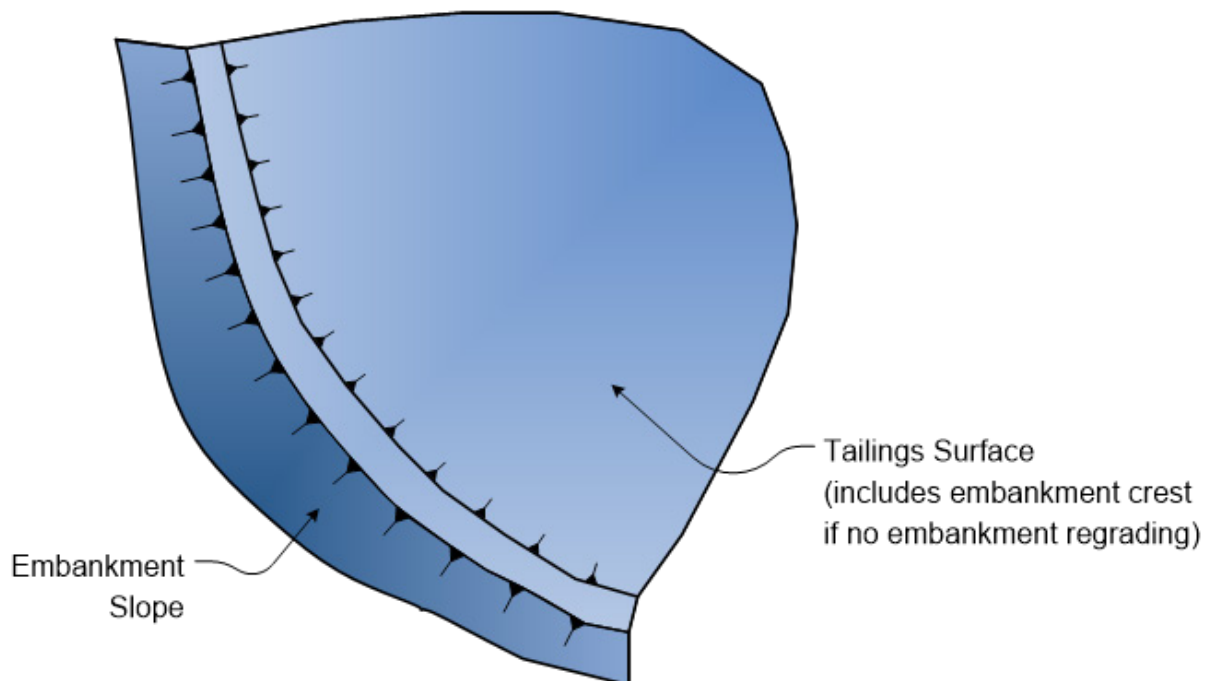


Figure 5-12: Tailings Impoundments



Tip

In estimating the closure costs for tailings impoundments, the Model uses some of the calculations used to calculate the costs for waste rock dumps and heap leach pads. In particular, the inputs required and calculations performed to estimate the cost to regrade a tailings embankment are the same as needed to estimate the cost to regrade a waste rock dump or heap leach pad (see Figure 5-12). As with waste rock dumps, if the embankment has been constructed in a manner that facilitates regraded by raises, then the cost to reclaim each raise can be estimated separately.

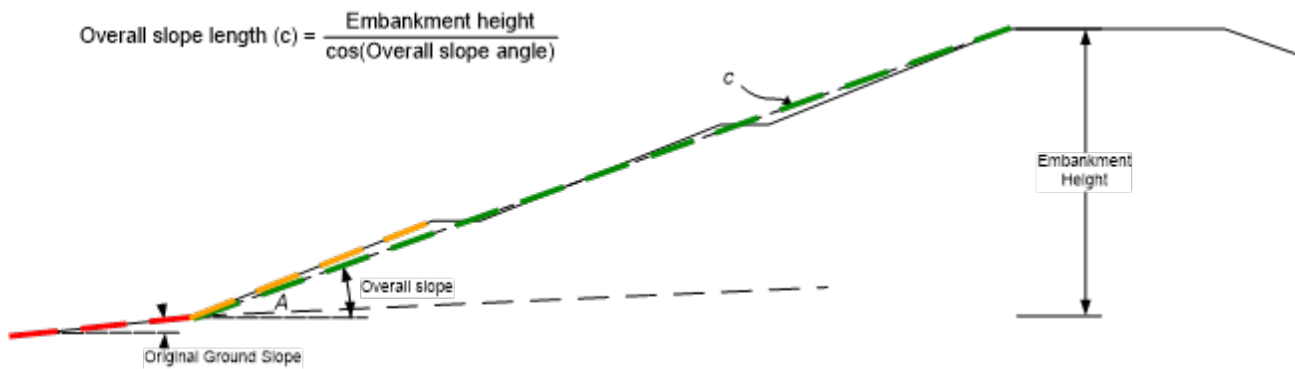


Figure 5-13: Tailings embankment parameters

Many tailings embankments are constructed at their final configuration and may only require final cover placement and revegetation. As noted in **Chapter 2**, in order for the Model to calculate the surface area of a facility such as a tailings embankment, the same geometric dimensions needed to calculate a regrade volume will still be needed as user input.

The surface of a tailings impoundment may also require regrading as part of closure. However, because the final configuration of the tailings will vary greatly depending on the deposition of tailings in the final years of production, there is no simple method for calculating the volume of material that will require regrading at closure. Therefore, the user must calculate this volume separately and input it directly into the Model.

Roads

The **Roads** worksheet uses nearly identical calculations to those used by the **Exploration Roads and Pads** worksheet to calculate the cost of regrading of other roads. The only significant difference between these two worksheets is the types of equipment used and the addition of safety berms to the regrade volume calculation in the **Roads** worksheet.

The *Haul Road Safety Berms* table allows the user to account for the volume of safety berms constructed along the side(s) of a road. The Model will use the berm dimensions input by the user to calculate the berm volumes for each road entered. Because the berm length is separate from the road length, the user can enter the same length as the entire road or a shorter length if the berm only extends along a portion of the road. Depending on the

situation and regulatory requirements, berms may be required on one or both sides of the road, and the Model allows the user to indicate if there are berms on one or both sides of the road.

Where roads cross drainages requiring significant regrading, the user should calculate the volume of regrade separately. This volume can then be entered directly in to the *Regrade Volume* override column.

In situations where only ripping is the only required reclamation treatment, the user should enter 0 into the *Regrade Volume* override column and then enter the ripping parameters as needed.



Tip

Where roads are located on flat or nearly flat ground, either enter the regrade volume directly or use a very low underlying (original) slope angle to estimate a minimal regrade.

Pits

The Pits worksheet contains options for placing and revegetating a pit perimeter berm or pit ramp berms to preclude access into a pit. If pit backfilling is required, use the Haul Material worksheet (see **Chapter 6 – How Do I Calculate Pit Backfilling**).



Tip

Three options exist for the berm construction method; Haul & Place, Excavate and Dozer.

Option	Description
Haul & Place	Assumes a truck and loader operation to haul material to the berm location. The material is end dumped and shaped with a small dozer.
Excavate	Assumes that an excavator will excavate a trench and place the excavated material along the edge of the trench closest to the pit to create a berm.
Dozer	Assumes a dozer will push material along a berm in a direction perpendicular to the pit rim (and berm) to create a berm from the pushed material. The average push length assumed to be approximately 33m/100ft.



Tip

Revegetation of the berms uses the same options as all other facility types. Ripping the berm is not included as an option.

Underground Openings

The **Underground Openings** worksheet includes options for closing both vertical (shaft) and horizontal (adit)/subhorizontal (decline) openings to underground workings. Generally, closure methods allowed involve construction of barriers or backfilling.

Productivities for adit plugs, barricades and bat gates are calculated from actual work recorded in the western U.S. Backfill productivities are based on material hauling costs with special (small) fleets and have been generally validated with actual work in the western U.S. The productivity and material costs for construction of a reinforced concrete shaft cap were adopted from Means¹.

Adits

Closure of adits assumes that a barricade, gate or backfill is required. Barricades are assumed to be concrete walls, with or without rock backfill from the barricade to the opening. Gates, designed to allow egress and ingress of bats may be appropriate for certain situations. Backfill may be the primary closure method or used in conjunction with a barricade. Options for backfill include rock backfill or expanding foam.

The volume of a barricade or backfill is computed from the user input parameters. If a combination of a cement barricade and rock backfill is selected, the Model assumes that the adit opening will be filled with backfill from the opening to the cement wall. Similarly, if expanding foam is used, the Model assumes that a minimum of 5m/15ft of backfill is required to protect the foam plug.

Shafts

The two basic options for closing shafts are the construction of a concrete reinforced cap. If a cap is selected, it is assumed to be an elevated 1-way beam and reinforced concrete slab 45cm/18in thick. A minimum of 3m/10ft of backfill is assumed as cover on top of the cap. Backfill is assumed to be performed by trucks and loaders, with a small dozer to push the material into the shaft.

Haul Material

The **Haul Material** worksheet is a worksheet that calculates the cost of hauling any type of material from one location to another using trucks or scrapers. The fleets used for these calculations include loading equipment and a small dozer to spread the material moved. This worksheet uses the same basic formulae as the routines used to calculate the cost for hauling cover and growth material materials in many of the other worksheets. However,

it also includes options for crushing and screening the material prior to placement, and compaction of the placed material.

If screening or crushing are selected, an option is also provided to define the amount of volume loss occurs during the process. The Model then increased the total material hauled to account for this loss prior to placement.

The **Haul Material** worksheet that can be used for a number of purposes, including but not limited to:

- **Pit backfilling,**
- **Multi-layer covers** with compacted and/or crushed or screened layers,
- **Hauling construction materials** for various uses, or
- **Transport of mine waste** to new location.

For use in calculating pit backfilling costs, this worksheet allows the placement of additional cover and topsoil after backfilling. If infiltration reduction is required, then compaction of the backfill can be included by selecting “Yes” in the *Compact After Placement?* cell.

This worksheet has options to include costs for crushing, screening and/or compacting the primary material hauled. If crushing or screening options are selected, the user must also input the additional distance that the material will be hauled from the crushing/screening plant. Another option lets the user define the quantity of material delivered to the crusher/screen that is lost due because it is either too small or too large for the intended use. If compaction is selected, the Model assumes that a vibratory roller will be used for compaction. Costs for crushing, screening and compaction are based on per volume costs included in the Misc. Unit Cost worksheet. Up to two additional layers can be added by using the cover and growth material options in the same manner included in many of the other worksheets.

For all of the hauling fleets, this worksheet also has an option to limit the maximum size of the hauling fleet. This can be useful if a small fleet is available to haul a large volume of material. If the user enters a non-zero, positive integer in the Maximum Fleet Size cell for any of the materials (primary material, cover, growth material), the Model will use this input value to override the standard formulae that calculate a loader limited or dozer limited fleet size for truck/loader or dozer/scrapper fleet, respectively.

Foundations and Buildings

The **Foundations & Buildings** worksheet provides a simple method to estimate the cost to demolish buildings, foundation slabs and foundation walls. It also provides options to place cover and/or growth media, and scarify and revegetate building areas. There is no option to perform regrading in this worksheet, so if regrading is required, use the Yards worksheet to estimate that cost.

The **Foundations & Buildings** worksheet uses basic cost/volume and cost/area calculations to estimate building, and wall and slab demolition costs. The source of the demolition productivities and crews is Means Heavy Construction² (used by permission). The cost data imported into the Model from a cost data file are combined with the productivities to produce the cost/volume cost/area rates for demolition. These productivities, crews and rates are shown on the **Misc. Unit Costs** worksheet.

The user input required by this worksheet includes: the dimensions of the buildings, the type of building construction, the heights and thicknesses of the walls, concrete slab demolition method, the building area (including surrounding areas such as parking lots associated with the buildings, and the thickness of cover and topsoil for the areas. Input such as dimensions, wall thicknesses, and cover and topsoil parameters are input as number directly in to the first user data table in the worksheet. Information such as the type of building and wall construction and slab demolition method are selected from a list of available options. The building types are based on the building types included in the demolition section of Means Heavy Construction.

When entering the Building Area Footprint, areas surrounding and associated with the buildings can be included (**Figure 5-14**). The Model uses this footprint area when calculating the cost of placing cover and growth media, scarifying and revegetation for the building. However, a more realistic closure sequence for areas with a number of buildings and structures is to decommission and demolish all of the buildings in that area and then perform all earthworks needed for the entire area at one time (**Figure 5-14**). To model this approach enter zero (0) for the Building Area Footprint in the **Foundations & Buildings** worksheet and include the earthworks (grading, cover, topsoil) and revegetation for the entire area in the **Yards** worksheet.

If the Break and Bury option is selected as the slab demolition method, the Model assumes that an excavator equipped with a hydraulic hammer will be used to break the slab before burying.



Tip

The Buildings and Foundations worksheet can be used to estimate the cost of tank demolition. Enter the tank diameter in both the length and width columns and select a steel building type. This will slightly overestimate the volume, but not significantly.

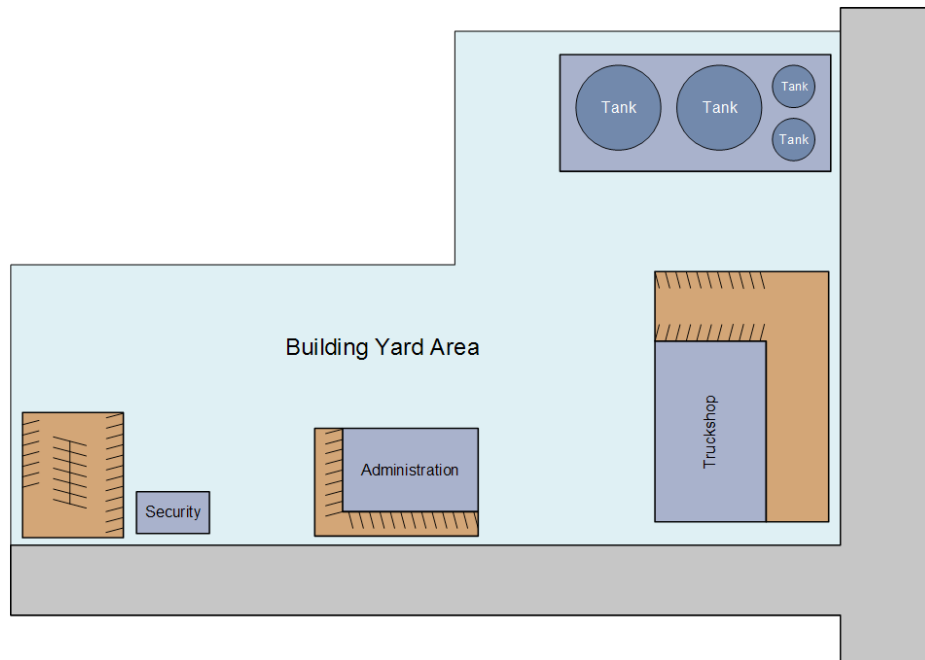


Figure 5-14: Buildings and foundations

Other Demolition and Equipment Removal

The **Other Demo & Equipment Removal** worksheet provides another option for the user to include the cost of demolition and removal of buildings, structures, and equipment that does not require the input of building or area dimensions. This worksheet is intended to be used with external calculations or experience regarding the cost of or time required for demolition or equipment removal activities. The user must enter data into the *Location*, *Quantity* and various unit cost fields on each line for the Model to estimate costs for these activities.



Tip

By entering formulae in the labor and equipment unit cost cells linking these cells to fleet unit (hourly) costs for an appropriate fleet in the Fleets worksheet these costs will be automatically updated as new equipment and labor rates become available.

Diversion Ditches and Sediment Ponds

The **Sediment & Drainage Control** worksheet is intended to calculate the cost of installing diversion ditches and installing or removing sediment ponds. Diversion ditches are assumed to have a trapezoidal cross-section and be constructed using an excavator. The excavation volume is either calculated based on dimensions input by the user or a volume input by the user in the *Excavate Volume* override cell (**Figure 5-15**). There is a new option to add rip-rap in diversion channels include in the **Diversion Ditch** worksheet in SRCE 2.0.

28	Diversion Ditches - User Input										
29			Diversions Ditches								
30	Description (required)		ID Code	Diversion Length	Diversion Depth	Ditch Bottom Width	Ditch Sideslope Angle	Excavate Volume (if calculated elsewhere)	Excavating Material	Excavating Equipment Fleet	Seed Mix
31				m	m	m	_H:1V	m3	(select)	(select)	(select)
33	1	North Diversion Ditch	DD-1	1500	3	1	3.0		1	Medium	(from Seed)
35											
36	Sediment/Evaporation Pond Construction/Removal - User Input										
37			Sediment Ponds								
38	Description (required)		ID Code	Pond Width	Pond/Berm Length	Berm Height	Crest Width	Sideslope Angle	Final Area (if calculated elsewhere)	Regrade Volume (if calculated elsewhere)	Cover Volume (if calculated elsewhere)
39				m	m	m	m	_H:1V	ha	m3	m3
41	1	North Dump Sediment Pond		20	20	3	2	2.5			
43											
44	Sediment/Evaporation Pond Construction/Removal - User Input (cont.)										
45			Sediment Ponds				Cover		Revegetation		
46	Description		Excavating Material	Material Type	Excavating Equipment Fleet	Liner Type	Cover Material Type	Cover Placement Equipment Fleet	Seed Mix	Mulch	Fertilizer
47			(select)	(select)	(select)	(select)	(select)	(select)	(select)	(select)	(select)
49	1	North Dump Sediment Pond	0.8	Granite - brok	Medium	60 mil HDPE			Mix 2	Timber Mulch	

Figure 5-15: Diversion Ditches and Sediment Ponds

Because the worksheet assumes that bulldozers would be used to either construct or remove a sediment pond, and the same basic calculations are required to estimate volumes and work hours for either option, this worksheet can be used to estimate the cost of either removing or installing a sediment pond. The Model currently assumes that sediment ponds will be constructed across a surface water drainage by pushing material with a bulldozer to create a berm. The disturbed area, dozing volume and cover volume calculations can be overridden by the user. An option to install a 60mil HDPE liner in a sediment pond is available (see **Figure 5-15**).

Process Ponds

Estimating the cost of backfilling, liner removal and revegetation of process ponds requires limited information including the dimensions of the pond, the methods and parameters for backfilling and placement of growth media, and revegetation (see **Figure 5-16**). Once the pond dimensions are entered in to the first table of the Process Pond worksheet, the volume is calculated using the formula shown on the worksheet and in **Figure 2-1**. If needed, override cells are provided for both the *Disturbed Area and Pond Volume*.

Two methods of backfilling are provided, dozers or a truck and loader fleet. The cost of hauling backfill, if a truck and loader option is selected, uses the same cycle time and productivity calculations used for other material hauling activities (e.g. cover or growth media placement. Unless otherwise specified by the user, the Model assumes that the pond will be completely backfilled.

Process Ponds - User Input										
You must fill in ALL green cells and relevant blue cells in this section for each pond										
		Pond Dimensions (1)					Backfill (1)			
Description (required)	ID Code	Pond Length m	Pond Width m	Pond Depth m	Pond Sideslope Angle H:1V	Disturbed Area (if calculated elsewhere) ha	Percent Backfill (100% if blank)	Distance from Backfill Borrow m	Slope from Facility to Borrow Area % grade	Pond Volume (if calculated elsewhere) m3
Pregnant Pond		56	36	5	2.5					
(1) All Pond Dimension and Backfill parameters must be input even if manual overrides for volume or area are used.										

Process Ponds - User Input (cont.)								
	Liner	Backfill		Growth Media		Revegetation		
Description (required)	Crew Cut & Fold Time hrs	Backfill Material Type (select)	Backfill Equipment Fleet (select)	Growth Media Material Type (select)	Media Placement Equipment Fleet (select)	Seed Mix (select)	Mulch (select)	Fertilizer (select)

Figure 5-16: Process Pond User Input

The cost of cutting and folding a pond liner is based in the *Crew Cut & Fold Time* parameter input by the user and assumes that two laborers and a small excavator with operator comprise the removal crew.

In SRCE 2.0, the Process Pond worksheet includes new options to repair and install liners and construct evaporation/evapotranspiration (E/ET) cells. These options include:

- repair, replace, or install liners (**Figure 5-17**)
- replace or install geonet and geotextile layers (**Figure 5-17**)
- E/ET cell piping installation (**Figure 5-18**)
- overflow drain field pipe installation (**Figure 5-18**)

Process Ponds - User Input (Cont.)						
	Description (required)	Add/Replace Liner (1) (select)	Liner Thickness (select)	Install Leak Detection/ Recovery System (select)	Add/Replace Geonet (select)	Number of Geotextile Layer(s)
1	Pregnant Pond	Repair single	60 mil HDPE	No	No	
2	Barren Pond	Repair single	60 mil HDPE	No	Yes	
3	Emergency Stormwater Pond	Install/add single	60 mil HDPE	Yes	Yes	2
Notes:						
1. If single liner is installed, no drainage layer is included. If liner is repaired, assumes 10% of liner surface area is replaced.						
2. Geomembrane layers are in addition to any required liner installation.						
3. Spacing between drainpipes used to distribute water in E/ET-cell						
4. Premium for misc. costs (e.g., inflow sampling port, low distribution box, drain rock and geotextile for draindown distribution system, dosing tank (where required), backfill)						

Figure 5-17: Liner & leak detection repair/installation

E/ET-Cell Construction								
Number of textile layer(s)	Drain pipe spacing in cell (3)	Pipe Size (select)	Total Length of Cell Pipe m	Additional Pipe Between Facility and Cell m	Pipe Size (select)	Length of Drainfield Pipe m	Pipe Size (select)	Mark up (4) %
	3	Drain 6in (150mm)	corrugated., perforated	50	Water 6in (150mm)	welded HDPE		10.0%
	3	Drain 6in (150mm)	corrugated., perforated	10	Water 6in (150mm)	welded HDPE		10.0%
2	3	Drain 6in (150mm)	corrugated., perforated	10	Water 6in (150mm)	500	Drain 6in (150mm) c	20.0%

Figure 5-18: E/ET Cell construction

Landfills

The **Landfills** worksheet provides a method for calculating the cost of reclaiming landfills associated with solid waste disposal, including construction debris. This worksheet is nearly identical to the **Waste Rock Dumps** worksheet except that it does not calculate a regrade volume and assumes a flat area. The user must enter a regrade volume and a disturbance area for the cost calculations to work properly.

Yards, Etc.

The **Yards, Etc.** worksheet was designed to allow the user to include reclamation costs for miscellaneous disturbance areas such as ready lines, laydown yards, disturbed areas unrelated to another facility and facilities such as parking areas not associated with a particular building. This worksheet is essentially identical to the **Landfills** worksheet and requires the same user input.

Waste Disposal

The **Waste Disposal** worksheet has three separate sections for disposal of solid, hazardous and hydrocarbon wastes. The options for each type of waste are based on typical disposal methods.

Solid Waste

Two options exist for *Solid Waste* disposal; on-site and off-site. On site disposal assumes that the waste will be loaded and hauled to an on-site landfill. The closure of the landfill should be included in the **Landfills** worksheet. If solid waste is hauled from the site, the Model assumes that roll-off containers will be used. The rental rates and haulage costs for off-site disposal are based on unit costs included in the cost data file imported by the user.

Hazardous Waste

For the purposes of the Model, hazardous waste is any waste material requiring special handling, transportation or disposal. The *Hazardous Waste* tables assume that hazardous waste will be removed from the site. The method of packaging and transporting is dependent on the type and quantity of waste. Options for both liquid and solid hazardous wastes are included. The transport and disposal costs for hazardous waste are based on unit costs included in the cost data file imported by the user. Testing of unknown materials is not

included, but can be included using the *Other Costs* option in the **Misc. Costs** worksheet.

Hydrocarbon Contaminated Soils

Methods for disposal of Hydrocarbon Contaminated Soils include off-site disposal and on-site treatment. If the material is hauled off site, the unit costs are based on data included in the cost data file imported by the user. If the materials are treated on-site, the costs include hauling to the treatment area and treatment assuming simple landfarming (biotreatment) techniques. Closure of the treatment facility is not included in this worksheet but can be added in the **Yards, Etc.** worksheet.

Well Abandonment

The **Well Abandonment** worksheet provides options for closing cased wells or borings. This worksheet has been optimized based on the assumption that when abandoned wells must not be open to the surface or have the potential to cross-connect aquifers.

Two types of wells are included based on the well construction methods. Production, dewatering and infiltration wells assume that the casing is steel and that hydraulic seals are not included in the annular space except at the very top of the well. Monitor wells may be constructed with steel or plastic casing, but are assumed to have a hydraulic seal immediately above the screened section and the annular space above the seal is filled with low permeability materials such as bentonite grout or cement.

The thickness of the surface seal for the well and the minimum seal required above groundwater when grout is used are set by the user in the cells provided at the top of the worksheet (see **Figure 5-19**).

		Well seal thickness:	5 m
		Minimum seal above groundwater table:	20 m
Production, Dewatering and Infiltration Well Closure			
	Description (required)	ID Code	Construction Year
1	Production wells 1-4		2004
2	Dewatering wells 1-10		2005
3	Dewatering wells 10-15		2009

The productivity for the different well abandonment methods are based on actual field data from the State of Nevada, USA provided by mine operators and drilling companies. The labor, equipment and material unit rates for hole plugging are included in the cost data file imported by the user.

Figure 5-19: Well Seal Thickness

The cost for abandoning both types of wells are similar with production well abandonment including options to remove a pump and perforate the well casing above the water table to when using grout to allow the grout to enter the annular space. Both well types have options for several well plugging methods including a top plug only, grout, a cement plug and nothing.

Grout volumes are calculated based on 2.0 and 1.25 times the well casing volume for production wells and monitor wells, respectively. The additional volume allows for migration of grout into the annular space and formation. Because production wells are typically larger diameter and deeper, the weight of the grout material will force more grout into the formation than a smaller, shallower monitor well.

Misc. Costs

The **Misc. Costs** worksheet includes a number of additional costs for which productivities have been calculated using published data or information available from contractors. Many of these are linear works such as fence installation and removal, culvert and pipe removal and power line removal. An option for riprap placement is also included. The last table in the worksheet, Other Costs can be used by the user to input the cost for any activity for which labor, equipment and material rates are available.

The *Fence Installation*, *Fence Removal Costs*, *Culvert Removal*, *Pipeline Removal* costs, and *Rip-Rap and Rock Lining* costs are all based on crews and crew productivities from Means Heavy Construction. The labor and equipment rates for these are based on the cost data file imported by the user. The *Powerline and Substation Removal* costs are estimated from unit costs included in the cost data file imported by the user.

Monitoring

The **Monitoring** worksheet includes options for reclamation monitoring, and ground and surface water monitoring. These costs include labor and equipment for field activities as well as labor costs for preparing annual reports.

Reclamation Monitoring

The **Reclamation Monitoring** section of the **Monitoring** worksheet allows the user to specify the cost of post-closure monitoring of the revegetation, geotechnical stability or other biophysical aspects of the site. Periodic field work and reporting options for both vegetation monitoring and monitoring by an engineer are provided. The user enters the work hours, days per year and the length of the monitoring period for a field geologist or engineer and a revegetation specialist (**Figure 5-20**).

Reclamation Monitoring							
	Description (required)	Staff	Number of Staff	Number of Trucks	Hrs/Day	Days/Year	Number of Years
1	Revegetation Monitoring	Range Scientist	2	1	8	5	5
2	Tailings dam inspections	Field Geologist/Engineer	1	1	8	3	10
3	Cover monitoring/inspections	Field Geologist/Engineer	1	1	8	3	5

Figure 5-20: Reclamation Monitoring

Geochemical Monitoring

The **Monitoring** worksheet also includes options for collecting and analyzing rock and water samples. Sampling labor, travel, analytical and reporting costs are calculated based on the time required for each event, the number of events per year and the length of the monitoring period (**Figure 5-21**). Periodic replacement of monitor well pumps can also be specified in the **Monitoring** worksheet.

Water and Rock Sample Analysis							
	Description (required)	Analysis Type	Samples #	Events/Year #	No. Years #	First Sample Year closure year	N
1	Heap leach monitoring	Water Analysis (Complete) (1)	9	12	5	1	
2	WRD sampling	ABA + S speciation	50	1	1	1	
3	Groundwater sampling	Water Analysis (Complete) (1)	15	4	10	1	
4	Truck shop/process soil sampling	TPH in soils	12	1	1	3	
5	Soil agricultural testing	Soil Fertility	20	1	1	-2	

Figure 5-21: Rock & Water Monitoring



Tip

To enter a one-time sampling event in the Water and Rock Sample Analysis section enter the number of samples and then enter a "1" in both the Events/Year and No Years cells.

Reclamation Maintenance

The **Recl Maint** worksheet includes options to maintain vegetation, covers and growth media during and after closure. Maintenance costs for reseeding and erosion of covers and topsoil are estimated based on a percent of the total surface area, and cover and topsoil volume, respectively. A table of surface areas, and cover and growth media volumes is shown by facility type for all facilities in the **Reclamation Quantities** worksheet. This worksheet also calculates the average costs for cover and growth media placement by facility type, which are used in the **Recl Maint** worksheet to calculate reclamation maintenance costs based on a user defined percent of each that will require maintenance during closure and the post-closure monitoring period.

Revegetation Maintenance

The *Total Revegetation Surface Area* is calculated as the sum of the surface areas included in all of the other worksheets and included in the **Schedule**. Because the calculation of total surface area does not differentiate areas to be seeded and areas that may not be seeded, the user may need to reduce the percentage requiring reseeding if a significant amount of the total surface area included in the Model does not require seeding, or has been successfully seeded and will not require reseeding (**Figure 5-22**).

			Revegetation Surface Area (1, 2, 3) ha							
			Information from Reclamation Quantities Sheet:	139						
Revegetation Maintenance										
Option (required)	ID Code	Construction Year	Revegetation Surface Area (user override)	% Area Requiring Reseeding	Seed Mix (select)	Area Requiring Reseeding ha	Seed \$/ha	Labor \$/ha	Equipment \$/ha	
		2006		5%	Mix 1	7.0	696.30	169.22	304.24	
		2006		8%	Mix 1	11.1	696.30	169.22	304.24	
Total Revegetation Maintenance										

Figure 5-22: Revegetation maintenance

Cover and Growth Media Maintenance

The Model tracks the total volumes of cover and growth media included in all of the other worksheets and included in the **Schedule**. These total as shown in the Recl Maint worksheet.

The Model also calculates the average cover and growth media placement costs based on the average of the those costs by facility weighted by the volume of material required by each facility. The average cover and growth media placement costs for all facilities is used in the **Monitoring** worksheet to estimate the cost of replacement of topsoil respectively (**Figure 5-23**).

			Total Cover Volume m3							
			Information from Reclamation Quantities Sheet:	1,393,414						
Cover Maintenance										
	Description (required)	ID Code	Construction Year	Total Cover Volume (1) (user override)	% Volume Requiring Maintenance	Average Placement Cost (1) (user override)	Volume Requiring Replacement m3	Labor (assume: 25%) \$/m3	Equipment (assume: 75%) \$/m3	
1	North Area WRD Covers				3%		41,802	0.65	1.95	
2	Heap Cover				5%		69,671	0.65	1.95	
3	South Area Covers				3%		41,802	0.65	1.95	
Total Cover Maintenance										

Figure 5-23: Cover maintenance

Construction Management

The **Construction Management and Road Maintenance** worksheet allows the user to add general management, construction support and maintenance costs necessary to complete the closure project. Costs included in this worksheet include the cost of project supervision, temporary power and office space and road maintenance crews. Each

section of the worksheet provides options for varying the amount of management and maintenance based on the phase of the closure work (i.e. active closure, and monitoring and maintenance).

The *Construction Management* table includes options for the number of project supervisors, temporary office space and toilets (see **Figure 5-20**). Generator power for the office is automatically added based on the number of office trailers selected.

Construction Management							
		Construction Management Staff			Construction Support		
	Description (required)	Duration mo.	Hours/ Month hrs	Number of Supervisors	Temporary Office Units	Temporary Toilet Units	First Construction Year closure year
1	Closure period	60	167	2	4	20	1
2	Post-closure monitoring period	120	40	1	1	1	6

Figure 5-24: Construction management

Road Maintenance

In the *Road Maintenance* table, the user can select the size and number of pieces of equipment used for road maintenance (**Figure 5-25**). In addition, the time required for the fleet can be entered by the phase of closure. If water for dust control must be purchased, this can also be entered in this worksheet.

Road Maintenance									
	Description (required)	Water Truck (select)	Grader (select)	Fleet Size number	Duration mo.	First Maintenance Year closure year	Hours/ Month hrs	Equipment Fleet	Fleet Hours hrs
1	Closure period		Large	2	60	1	167	24M	10,020
2	Closure period	Large		1	60	1	167	785D H2O Truck	10,020
3	Post-closure monitoring period	Medium	Medium	1	120	6	16	777G H2O Truck/16M3	1,920

Figure 5-25: Road maintenance



Tip

To estimate the Duration for which Construction Management and Road Maintenance are required for a project, review the various worksheets to determine the total time required to complete all activities. Concurrent activities and the number and types of fleets mobilized to the site should be considered. If a Reclamation and Closure Schedule is available for the project, use this.

Solution (Water) Management

The **Solution Management** worksheet provides options for calculating costs for some basic solution or water management activities. This worksheet does not provide standardized costs for water treatment, estimate draindown times or include a water balance worksheet as all of

these calculations are highly site specific. However, this worksheet does include placeholders for some typical activities associated with closure solution and water management. These include:

- Pumping;
- Forced Evaporation;
- Water Treatment; and
- Decontamination.

The *Pumping*, *Forced Evaporation* and *Decontamination* tables include calculations to estimate the cost to pump water from one location to another using Manning's Equation and standard hydraulic formulae. These formulae require user input for the diameter and material type of the pipe, the static head, the required flow and other parameters needed to estimate the energy required. Combining this information with the unit cost of energy either entered in the **Reclamation Materials** worksheet or overridden by the user at the top of the worksheet, labor rates, and pumping schedule and user-entered capital costs, the **Solution Management** worksheet can estimate the total capital and operating (pumping cost) for these activities.

The *Forced Evaporation* option also allows the user to define the pressure required at the end of the pipe. This information is usually available from the manufacturer of the evaporation system or can be obtained from operation data.

The *Water Treatment* option requires the user to estimate the treatment costs externally. By applying the user supplied capital and operating costs to the treatment quantity and duration, the Model calculates a total water treatment costs (not including pumping. Because the labor required for different treatment methodologies and site-specific conditions can vary greatly, the user must enter the labor crew size for this option.



Important Note

If additional pumping is required for water treatment either to transport water to the treatment facility or discharge water from the treatment facility, the user will need to use the Pumping option to account for those costs.

The *Decontamination* option is provided as a placeholder for the management and disposal of decontamination rinse water. As required by in jurisdictions and by the Cyanide Code decontamination of process facilities may require the rinsing of containers, equipment and piping used to convey process solutions. The *Decontamination* option in this worksheet allows the user to account for the capital, labor and pumping costs associated with rinsing and disposal of the rinse water.

Closure Planning

The **Closure Planning** worksheet has options for including costs for studies, reports, engineering and permitting for closure. Activities entered into this worksheet should include any expected or required plans or studies. These costs are entered as lump sums based on quotes, estimates or existing information. Each table includes a column to document the type of activity and a column for comments.

Other User

The **Other User** worksheet provides an alternative method of including miscellaneous closure costs in the **Summary Costs** and **ARO-LOM** worksheets. The user must supply the capital labor and operating costs for each line item. The *Comments* field allows the user to provide additional information for each line item.

Although the user can use the *Other Costs* table in the *Misc. Costs* worksheet to include miscellaneous costs, the **Other User** worksheet carries each item included in this worksheet as a separate line item in the **ARO-LOM**. In addition, the *Cost Type* cell for each item in the **Other User** worksheet can be used to ensure that each of the Other User costs are included in the correct section of the **Summary Costs** worksheet.

General and Administration

The general and administration (**G & A**) worksheet includes costs that would be incurred by the operator during closure, but would not necessarily be incurred by a third-party closing the site. This distinction is important because that these costs are not included in the ARO costs (**Error! Reference source not found.**) unless the user overrides that default condition in the **ARO-LOM** worksheet.

The types of costs in the **G & A** worksheet include *Property Holding Costs*, *Security and Maintenance* and *Administration*. The options in this worksheet allow the user to input a *Type* of cost, the *Frequency* of the cost the *Cost per Payment* and the *Number of Payments*.

Human Resources

The **Human Resources** worksheet allows the user to include additional staff required during closure that may not be included automatically in the other worksheets. For example, if long-term security or caretaking is required, those costs can be included in this worksheet. The user can enter different job groups and vary the number of employees by the closure year. The closure years shown in these tables correspond to the *Closure Year 1* included in the **ARO-LOM** worksheet and are automatically scheduled into that worksheet based on the information provided in this worksheet.

User worksheets

There are thirty **User worksheets** at the end of the Model that can be used to perform any additional calculations needed to estimate closure costs. For example, these worksheets could be used to provide detailed calculations entered in the **Other User** or **Solution Mgmt** worksheets. Except for the header rows, the cells in these worksheets are unlocked and can contain enter any standard Excel data type or formula.

A standard header has been entered into each of these worksheets containing basic project data. SRCE 2.0 also includes a cell to add up to 23 characters as a user name for the worksheet. The user name will be added to the **User worksheet** number to create a custom **User worksheet** name (e.g. User 01 Spillway Construction)

¹ Means Heavy Construction Cost Data 2006. Reed Construction Data, RSMeans, Kingston, MA., Copyright © 2006

² Ibid.

³ 2006 International Cyanide Management Institute, 1200 G Street, NW, Suite 800, Washington, DC 20005, USA

Chapter 6

Scheduling Costs

The most significant enhancement in SRCE 2.0 is the ability to schedule closure costs at an activity level for each facility that you include in your model. However, creating a detailed schedule in SRCE 2.0 requires more effort to input all the information required to create the schedule than previous versions.

The primary worksheets that contribute to the detailed schedule in SRCE 2.0 are the Schedule, Acct Codes, and Filters worksheets. The Schedule worksheet contains all the detailed schedules by closure action type. The Acct Codes worksheet summarizes the detailed schedule by user-defined categories. The Filters worksheet allows the user to define three sets of filters that can be used to further categorize the costs.

Schedule Worksheet

The Schedule worksheet comprises six areas; the **Schedule Header**, **Facility Information**, the **Closure Period**, the **Detailed Schedule**, **Schedule Totals**, and a **Calculation Check** (Figure 6 1).

Project Name: "Reclamation Plan"

Date of Submission: "2017-01-01"

File Name: "SRCE_Version_2_0_BetaTest_032214a.xlsx"

Model Version: "Version 2.0"

Cost Data: "User Data"

Cost Data File: "RndMtn_2017KDL_Cost_Data_File_2_0_2017.xlsx"

Cost Estimate Type: "LOM"

Cost Basis: "Rnd Mtn 2017 KDL"

Cost Type: "LOM"

Current Year: "2017"

First Year of Operation: "2009"

Closure Year 1: "2019"

Closure Period: "5 years"

Post Closure Period: "10 years"

Engineering, Design and Construction Plan (%)

Contingency (%)

Contractor OH and Profit (%)

Contract Administration (%)

Filter

Filter Type

ID Code Filter

Facility/Activity Type

Phases

Locations

Properties

Include Complete Work in LOM Schedule? "TRUE"

Show how many years in schedule (10 to 100) "100"

Show how many operating years in schedule "8"

Calculate Model

Calculate Sheet

Note: AEO completed cost submittal completed AEO year or earlier. FA completed cost submittal > budget year or earlier and after FA release date.

Show Columns

Show Op Years

Facility Information

Closure Period

Detailed Schedule

Schedule Totals

Calculation Check

User	Facility	Cost Type	Description	ID Code	Facility/Activity Type	Phases	Locations	Properties	Total Cost	LOM Cost	Contract Year	Closure Start	Closure Period	FA Release Assurance Release	% Scheduled	Work Before/During Budget year	% Complete Before Budget year	Calendar Year	2017	2018	2019	2020
									\$	\$						\$						
									8,148,631	8,148,631												
									195,101	195,101	2007											
									178,191	178,191		2019	2019		100%		0	0	0	0	0	0
									178,191	178,191		2019	2019		100%		0	0	0	0	0	0
									103,738	103,738		2019	2019		100%		0	0	0	0	0	0
									388,119	388,119		2019	2019		100%		0	0	0	0	0	0
									4,500	4,500		2019	2019		100%		0	0	0	0	0	0
									3,379,710	3,379,710	2006											
									179,110	179,110		2019	2019		100%		0	0	0	0	0	0
									198,714	198,714		2019	2019		100%		0	0	0	0	0	0
									762,503	762,503		2019	2019		100%		0	0	0	0	0	0
									1,128,077	1,128,077		2019	2019		100%		0	0	0	0	0	0
									31,361	31,361		2019	2019		100%		0	0	0	0	0	0
									1,564,676	1,564,676	2009											
									179,610	179,610		2019	2019		100%		0	0	0	0	0	0
									264,103	264,103		2019	2019		100%		0	0	0	0	0	0
									298,159	299,129		2019	2019		100%		0	0	0	0	0	0
									8,147,819	8,148,631												

- **Current Year** – This is the year in which your cost estimate is being prepared or which year is covered by the cost estimate. This value is used by SRCE to determine the amount of work that will be completed before the end of the calendar year, based on the detailed schedule
- **First Year of Operation** – This sets the year for the first column in the detailed schedule.
- **Closure Year 1** – This is the first calendar year defined as the beginning of closure. It is possible, likely even, that some closure work will be performed during operations. However, Closure Year 1 is the first year that the final closure period begins. This value along with the Closure Period are used to set the color of the Detailed Schedule header cells to blue, denoting the Closure Period (**Figure 6-1**). This value is also used by the Water/Rock Quality Monitoring, Sampling Pump Purchase, Salary & Benefits, and Severance and Outplacement worksheets, which automatically schedule costs based on user input in those worksheets.
- **Closure Period** – This value defines the length of the closure period. This is only used, in conjunction with the Closure Year 1 value, to set the color of the Detailed Schedule header cells blue for the defined Closure Period.
- **Post-Closure Period** – This value sets the period of the Post-Closure activities that follow the Closure Period. This value is only used to set the color of the Detailed Schedule header cells to green for the defined Post-Closure Period.

The **Filters** section allows the user to set filters that will affect what costs will be included in the cost estimate. This includes the ability to filter by ID Codes and Facility/Activity Types, as well as three user-defined filters created in the **Filters** worksheet. The filters can be set to “Exact”, “Contains”, or “Not”. Using different combinations of filters and filter settings, users can produce specific cost estimates.

The **O&P** section allows the user to add several types of overhead costs by entering a percentage in the appropriate cell. These costs are added to the **Schedule Totals** at the bottom of the schedule.

The **Schedule View** section determines how the schedule will look. Users can select how many years are shown in the schedule (1-100) and how many operating years are shown. These options hide columns that may not be relevant to the project objective and limiting the number of schedule years shown makes schedule viewing and printing easier. The other option in the Schedule View section determines if work done before the current year is included in LOM calculations. The options are TRUE and FALSE. TRUE would be used if the total LOM cost was desired. If only the future LOM costs are desired, set the option to FALSE.

Facility Information

The Facility Information section of the Schedule worksheet contains information that is derived from the individual Facility/Activity worksheets. The information contained in this section provides context, but is also necessary for filtering and ensuring that costs are calculated and will be tabulated correctly in the **Acct Codes** worksheet. Column J contains all of the costs as calculated in the detailed worksheets. Column K only contains costs that match the selected Cost Type and passes all filters selected.

Only the first column (A) is user editable . It allows the user to manually remove a cost item from calculation. When this is selected, no cost for the item will be calculated and an “Override” message will appear in Column K (**Figure 6-3**).

User Override	Facility	Cost Type	Description	ID Code	Facility/Activity Type	Phases	Locations	Properties	Total Cost	LOM Cost
									\$	\$
			WASTE ROCK DUMPS						6,217,940	3,684,566
	1	ARO+LOM+FA	Ore Stockpile		Waste Rock Dumps	Ph1	North		552,131	552,131
			Regrading						0	0
			Cover 1 Placement						199,342	199,342
			Cover 2 Placement						119,269	119,269
			Growth Media Placement						227,020	227,020
			Ripping/Scarifying						6,500	6,500
			Revegetation						0	0
X	2	ARO+LOM+FA	WRD A	WA	Waste Rock Dumps	Ph1	North	Burnley	2,533,374	Override
			Regrading						170,199	0
			Cover 1 Placement						849,159	0
			Cover 2 Placement						558,856	0
			Growth Media Placement						1,132,350	0
			Ripping/Scarifying						22,810	0
			Revegetation						0	0
	3	ARO+LOM+FA	WRD B - Segment 1	WB.1	Waste Rock Dumps	Ph1	South	Davis	1,220,478	1,220,478
			Regrading						266,645	266,645
			Cover 1 Placement						289,673	289,673
			Cover 2 Placement						221,517	221,517
			Growth Media Placement						452,664	452,664
			Ripping/Scarifying						9,979	9,979
			Revegetation						0	0

Figure 6-3: User override in Schedule

Other messages will appear in Column K depending on the Cost Type selected, Filters set and Dates entered.

Closure Period

The **Closure Period** section details the periods during which the user has determined each closure activity (Column D) will be performed (**Figure 6-4**). These cells are required to properly determine if costs should be included in some of the Cost Types and determine the color of the cells in the **Detailed Schedule** section.

If ARO is the selected Cost Type or completed work is not included in a LOM

Construct Year	Closure Start	Closure Finish	Financial Assurance Release	% Scheduled
2007				
	2019	2020	2025	
	2020	2020	2025	100%
	2020	2021	2026	100%
	2021	2022	2027	100%
	2022	2022	2027	100%
2008				
	2019	2020	2025	
	2020	2020	2025	
	2020	2021	2026	

Figure 6-4: Closure Period

cost estimate, the cost for any activity with a Closure Finish date equal to or earlier than the Current Year will not be included in the cost estimate.

The Financial Assurance Release defines the year in which an operator has been released from financial obligation for each closure activity. These can be predicted dates based on anticipated monitoring periods or can be entered when actual release has been obtained. If Financial Assurance is the selected Cost Type, costs for any closure activity with a Financial Assurance Release equal to or earlier than the Current Year will not be included in the cost estimate.

Detailed Schedule

The **Detailed Schedule** section contains the schedule of costs. The Plan Year, Closure Year, and Calendar Year are all displayed at the top of each schedule year column.

For most of the Facility/Activity types the user manually enters percentages for work completed in each year. Those cells are colored grey, cyan, or green (**Figure 6-5**). The cyan and green colored cells are for visual reference only and they delineate the user selected closure and post-closure periods, respectively. For facility/activity types that are automatically scheduled (Water/Rock Quality Monitoring, Sampling Pump Purchase, Salary & Benefits, Severance and Outplacement) SRCE 2.0 assigns the costs automatically based on the information input into the respect detail sheets. These rows are identifiable because the costs are shown, not percentages, and the colors are a lighter shade.

Column P is one of the QA checks in SRCE 2.0. This column keeps track of how much of each activity has been scheduled by the user. If the user has scheduled 100%, then the cell will stay white and the font will be green. If the user has over or under scheduled an item the cell will change to blue or red, respectively (**Figure 6-5**). Columns Q and R track the work completed prior to the Current Year.

% Scheduled	Work Before/During Budget year	% Complete Before Budget year	Plan Year	9	10	11	12	13	14	15	
			Closure Year	-2	-1	1	2	3	4	5	
			Calendar Year	2017	2018	2019	2020	2021	2022	2023	
	\$										
	0			0	0	170,576	1,214,486	1,646,398	658,492	0	
	0			0	0	0	223,196	248,366	85,957	0	
100%	0	0%				75.00%	26.00%				
95%	0	0%					100.00%				
105%	0	0%					20.00%	75.00%			
100%	0	0%						70.00%	35.00%		
	0	0%							100.00%		
	0			0	0	0	0	0	0	0	
	0	0%				70.00%	30.00%				
	0	0%					100.00%				
	0	0%					40.00%	60.00%			
	0	0%						50.00%	50.00%		
	0	0%							100.00%		
	0	0%		0	0	133,323	425,147	380,431	281,577	0	
100%	0	0%				50.00%	50.00%				
100%	0	0%					100.00%				
100%	0	0%					10.00%	90.00%			
100%	0	0%						40.00%	60.00%		
100%	0	0%							100.00%		
	0	0%		0	0	37,255	566,144	1,017,601	290,958	0	
100%	0	0%				50.00%	50.00%				
100%	0	0%					100.00%				
100%	0	0%					20.00%	80.00%			
100%	0	0%						70.00%	30.00%		

Figure 6-5: Detailed Schedule

Schedule Totals

The total Direct Costs, and Overhead and Profit are shown at the bottom of the Schedule worksheet (**Figure 6-6**). These costs are show for the total of all costs (Column J), the currently selected cost type with filters (Column K) and for each year.

[illegible]

Figure 6-6: Schedule totals

Calculation Check

Below the **Schedule Totals** are several cells used as another QA check for the model (**Figure 6-7**). These cells compare the total cost for the current **Cost Type** in the Schedule sheet with the total cost in the **Acct Codes** worksheet. The difference is calculated in both costs and percent of the total cost. In theory, the difference should be zero. In practice, rounding in Excel formulas may result in slight differences.

[illegible]

Figure 6-7: Calculation check

In the **Schedule** worksheet, if the values are blue, then there are costs in the **Schedule** worksheet that are not being rolled up into the **Acct Codes** worksheet. This is most commonly caused by under scheduling the activities. The other cause of this are closure

actions that do not have a Facility/Activity Type assigned. If you have instances of this in your model, there will be an error message for those facilities/activities in Column F (**Figure 6-8**). In rare instances, this could also occur if a Facility/Activity Type defined in the **Acct Codes** worksheet is deleted or changed after the Facility/Activity Type is assigned to a facility.

le	Facility	Cost Type	Description	ID Code	Facility/Activity Type	Phases
WASTE ROCK DUMPS						
	1	ARO+LOM+FA	Ore Stockpile		Facility Type	Ph1
			Regrading			
			Cover 1 Placement			
			Cover 2 Placement			
			Growth Media Placement			
			Ripping/Scarifying			
			Revegetation			
	2	ARO+LOM+FA	WRD A	WA	Waste Rock Dumps	Ph1
			Regrading			
			Cover 1 Placement			
			Cover 2 Placement			
			Growth Media Placement			

Figure 6-8: Facility Type Error

Acct Codes Worksheet

The **Acct Codes** worksheet defines the Facility/Activity Types in the model. The **Acct Codes** worksheet has five main sections: **NPV Information**, **Account Codes**, **Schedule**, **NPV Calculations**, and **Calculation Check (Figure 6-9)**. Below the **Schedule** in this sheet are several graphs that display the closure costs in a number of formats.

Cost type:	LOM type:	
Budget Year:	2017	<div style="display: flex; justify-content: space-around;"> Add Account Delete Account </div>
First Year of Operation:	2009	
Closure Year 1:	2019	
Closure Period:	5 years	
Post Closure Period:	10 years	
ID Code Filter:		
FacilityType Filter:		
Phase Filter:		
Location Filter:		
Property Filter:		

Discount Rate:	6.0%
Discount Period:	MOP
Year of NPV:	2017

1. NPV Information

Engineering, Design and Construction Plan (%):	0.0%
Contingency (%):	0.0%
Contractor OH and Profit (C/P)(%):	0.0%
Contract Administration (%):	0.0%

Show how many years in schedule (10 to 150):	100
Show how many operating years in schedule:	2

2. Account Codes

Facility/Activity Type	Acct Code	Total Cost \$	LOM Cost	Scheduled LOM Cost \$	Plan Year Closure Year Calendar Year	9 -2 2017 \$	10 -1 2018 \$	11 1 2019 \$	12 2 2020 \$
1 Waste Rock Dumps		6,217,940	4,997,462	4,997,462		0	0	156,394	1,719,064
2 Process Ponds		59,164	59,164	59,164		0	0	13,470	37,638
3 Mobilization		235,681	235,681	235,681		0	0	0	235,681
TOTAL		6,512,785	5,292,307	5,292,307		0	0	169,864	1,992,383

Engineering, Design and Construction Plan	0	0	0	0	0	0	0	0	0
Contingency	0	0	0	0	0	0	0	0	0
Contractor OH and Profit	0	0	0	0	0	0	0	0	0
Contract Administration	0	0	0	0	0	0	0	0	0
TOTAL COST		6,512,785	5,292,307	5,292,307		0	0	169,864	1,992,383

3. Schedule

Discounted Cash Flow	0	0	146,837	1,624,899
NPV			4,137,893	

4. NPV Calculations

Calculation Check:	0.00
Difference:	0.000000%

*red indicates total less than shown in Schedule sheet

5. Calculation Check

Figure 6-9: Acct Codes Worksheet

NPV Information

In order to calculate the Net Present Value (NPV) of the closure cost, the user must assign a Discount Rate, define the Discount Period, and Year of the NPV. The Discount Rate is typically the aggregate of a number of rates. The Discount Period defines when the cash out flow occurs. The options are: beginning of the period (BOP); middle of the period (MOP); or end of the period (EOP).

Account Codes

The **Account Codes** section of the worksheet allows users to define their own account codes or Facility/Activity Types to summarize the cashflow schedule by categories (codes). These codes can be based on types of facilities, areas, closure actions, or a corporate chart of accounts. Only those costs included in the **Schedule** worksheet for the current Cost Type in will appear the **Acct Codes** worksheet. Any activity that does not have a valid Facility/Activity Type or has not been scheduled will be excluded.

Schedule

The **Schedule** portion of the **Acct Codes** worksheet compiles the annual closure costs from the **Schedule** worksheet by the categories defined in the **Account Codes** section of the worksheet.

NPV Calculations

The information provided by the user in NPV Information section will be applied to the total costs (direct + indirect) by year and totaled to present the NPV of the closure costs.

Calculation Check

Below the **Schedule** are several cells used as another QA check for the model. These are companion cells to the Calculation Check cells in the **Schedule** Sheet. These cells compare the total cost for the current Cost Type in the Schedule worksheet with the total cost in the **Acct Codes** worksheet. The difference is calculated in both costs and percent of the total cost. In theory, the difference should be zero. In practice, rounding in Excel formulas may result in slight differences.

In the **Acct Codes** worksheet, if the values are red, then there are costs in the **Schedule** worksheet that are not being rolled up into the **Acct Codes** worksheet.

Filters Worksheet

The Filters worksheet contains three tables of user-defined filters. These filters can be selected in the Facility/Activity worksheets and then set as filters in the Schedule worksheet. As defaults, the filters are Phases, Location, and Properties (**Figure 6-10**). However, the titles of these tables can be edited by the user.

Phases		
	Description	Phases Code (used in detail sheets)
1	Phase 1	Ph1
2	Phase 2	Ph2
Locations		
	Description	Locations Code (used in detail sheets)
1	North Area	North
2	South Area	South
Properties		
	Description	Properties Code (used in detail sheets)
1	Burnley Claims	Burnley
2	Davis Ranch	Davis

Figure 6-10: Filters

¹ Parshley, J.V., et. al; "An evolution of the methods for and purposes of mine closure cost estimating"; in Mine Closure 2009 - A.B. Fourie, M. Tibbett (eds); September 2009

² The User Override cell is not colored cyan as the other dropdown list cells are elsewhere in the model.

Chapter 7

How do I...?

Although the Model was designed to provide a standardized approach to reclamation and closure cost estimating, unique requirements of specific projects often require the use of different approaches to using the Model.

For simple projects, little additional effort is necessary to produce a viable cost estimate with the Model. However, many projects have unique requirements that necessitate the need for special techniques using the Model or external calculation using other tools or methods. Most of the worksheets in the Model allow the user to implement different approaches to calculating the reclamation costs. The most appropriate method in each instance will depend on the configuration of the facility and the requirements for reclamation and closure.

... Import Cost Data in to the Model

Cost data is imported into the Model using the “Import Cost Data” option from the custom SRCE ribbon at the top of the Excel window (**Figure 6-1**). The cost data files may be supplied by a corporate or regulatory organization, or created by the user as described in **Chapter 4 – Setting Up Cost Data Files**. If the cost data file changes, you will need to re-load the cost data to update the Model.

The data must be in the exact format contained in the user cost data file (SRCE 2.0 CostDataFile USR.xlsm) or a standardized cost data file available from your company or local regulatory agency. Links to some of these regulatory web sites are also listed on the Downloads page of the NVBond.org web site (www.nvbond.org).

The standardized versions of the cost data file are locked and cannot be edited by the user. These files are typically maintained and updated by corporations or regulatory agencies responsible for reviewing and approving reclamation cost estimates for financial reporting or surety purposes. The cost data cells in the user cost data file are unlocked to allow users to enter their own cost data (e.g. mine costs).

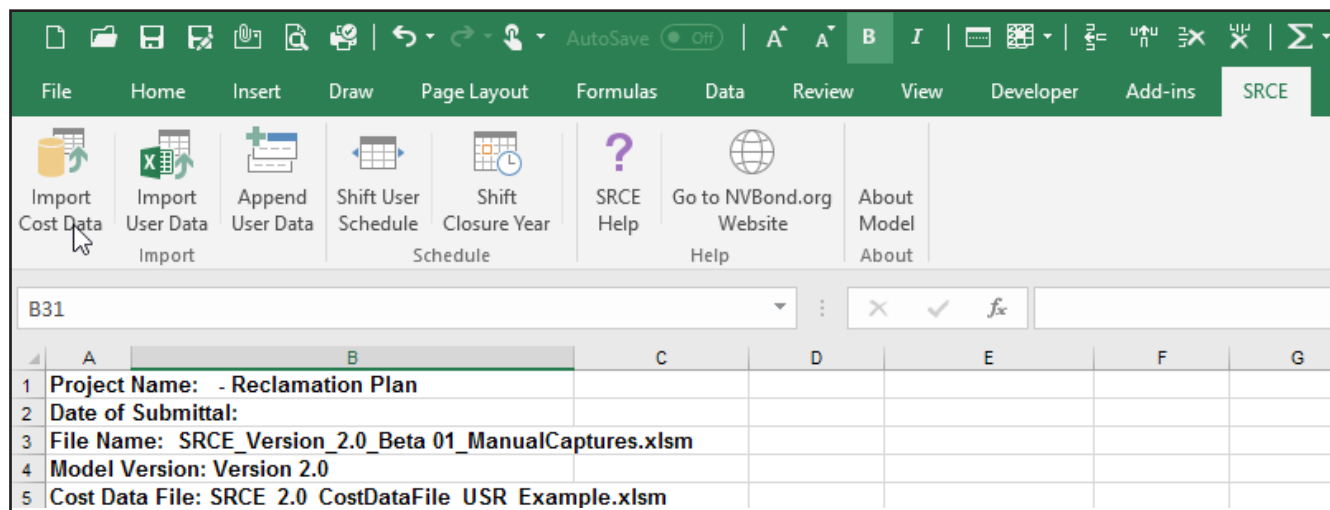


Figure 7-1: Import Cost Data Menu

... Import Data from a Previous Model File

As the Model evolves and new versions becomes available the user may need to update existing cost models by upgrading to a new version. In SRCE 2.0, this import routine will only work with version 2.0 models. **Models created in earlier versions will not import in to SRCE 2.0.** When importing a model from an earlier version, the only option is to manually add the number of facilities needed in each Worksheet and then manually cut and paste the information from the old file to the SRCE 2.0 file.



Tip

When performing a manual cut-and-paste operation, be sure to use the Paste Special/Values or Paste Special/Formulas options from the Edit menu in Excel. This will ensure that cell formats are not changed.

If you want to import a SRCE 2.0 file select the “Import User Data” option from the custom SRCE ribbon at the top of the Excel window (**Figure 7- 2**). This routine will check to see if the file the selected import file is the proper version.

During the import, the user will have an option to import the schedule information. If this option is selected, then a second option to increment the user schedule by one year. This shifts all of the user schedule information one cell to the left to allow the user to make the first column of the schedule be the current year (or some fixed number of years prior to the first year of closure).

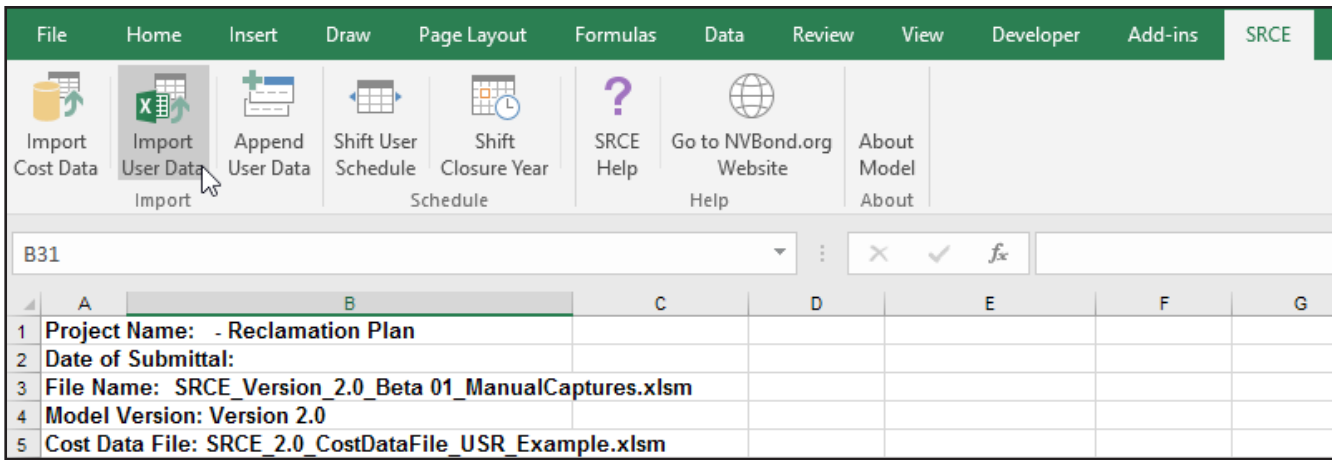


Figure 7-2: Import User Data Menu

... Shift the Schedule Data Left or Right

Occasionally, it can be useful to shift all the user entered schedule information either left or right in the schedule. This can be useful if the first year of closure changes, but the sequencing and relative schedule of activities will not. Rather than manually rescheduling the closure activities, this function will shift all the scheduled activities a user-defined number of years to the left (earlier) or right (later).

To shift the schedule, select the “Shift User Schedule” option from the custom SRCE ribbon at the top of the Excel window (**Figure 7-3**).

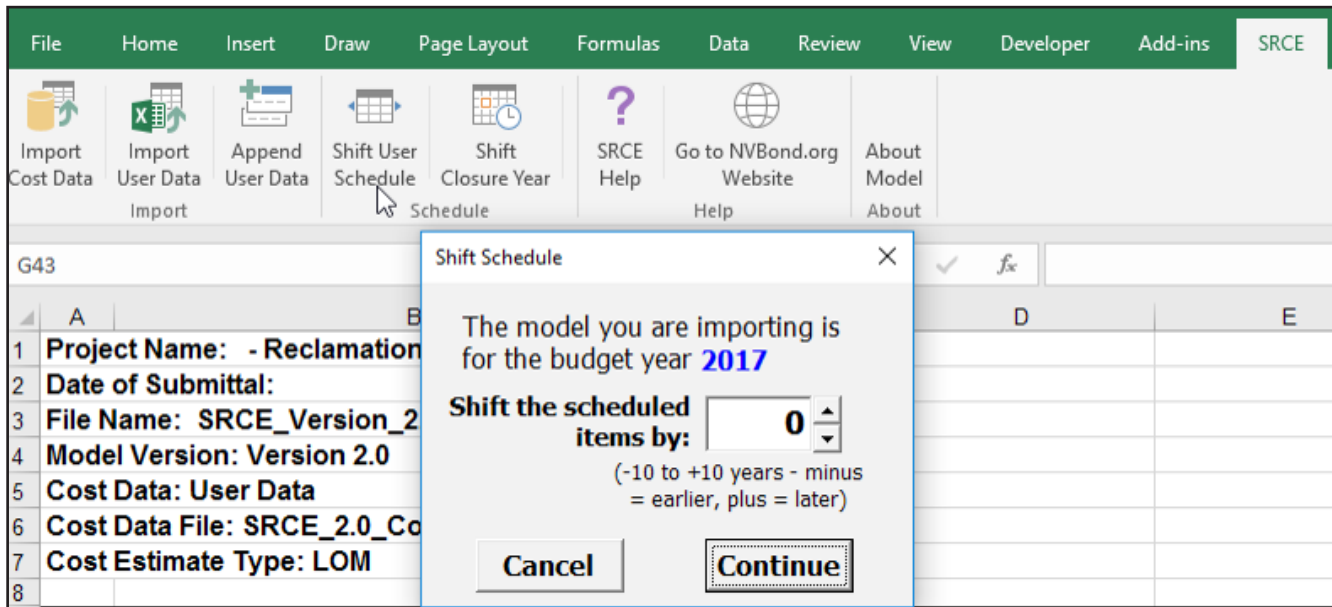


Figure 7-3: Shift Schedule

Shifting user-scheduled costs and adjusting the Closure Start/Closure End user entries.

Shift User Schedule

The Shift User Schedule option in the SRCE ribbon shifts all of the user-entered scheduled costs either to the left for negative values or right for positive values (Figure 1). This allows the user to adjust the schedule to change the First Year of Operation (the first schedule column), or change Closure Year 1 without rescheduling the entire model.

For example, if the mine will close 1 year earlier, entering a value of negative 1 (-1) will result in shifting all user entered values in the schedule one column (year) to the left. Likewise, entering positive 1 will shift all user entered values one column (year) to the right.

7	8	9	10	11	12	13	14	15	16	
-2	-1	1	2	3	4	5	6	7	8	
2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
0	0	0	5,436,343	3,145,342	2,922,066	0	0	0	0	0
0	0	0	5,436,343	3,145,342	2,922,066	0	0	0	0	0
		75%	10%	15%						
		50%	25%	25%						
		10%	70%	20%						
		5%	80%	15%						
			25%	75%						
0	0	0	0	0	0	0	0	0	0	0
				40%	10%	25%				
					50%	20%	30%			
					40%	30%	30%			
					10%	60%	30%			
						25%	75%			
0	0	0	0	0	0	0	0	0	0	0
					75%	15%	10%			
					50%	25%	25%			
					10%	40%	50%			
					10%	60%	30%			
							100%			

Close

Figure 7-4: Schedule shift help

... Calculate Closure of Multi-Lift Dumps

Multi-lift dumps can be estimates in a number of ways depending on how you need to treat the reclamation of the dump. Because the Model does not limit the user to using a single line item for each waste rock dump and heap leach, a complex dump can be subdivided into sections to increase the overall accuracy of the Model calculations for the facility.

First determine what the lift heights are, if the current slopes (both underlying ground and lifts) are the same for each lift, if any or all lifts need to be regraded, seeded, ripped, fertilized or any other specific reclamation activities. If all the heights, slopes and reclamation activities are likely to be the same you can enter as a Multi-lift (additive). If any of these are different the lift will need to be treated as a Multi-lift (separate).

Multi-lift (additive)

A multi-lift (additive) dump can be input into the Model as a single line. You will need to determine the mid-bench length of each lift and then you can add them together to get the total mid-bench length (**Figure 7-3**). All of the lifts on the dump can then be entered as a single line with a single lift height and the total mid-bench length.

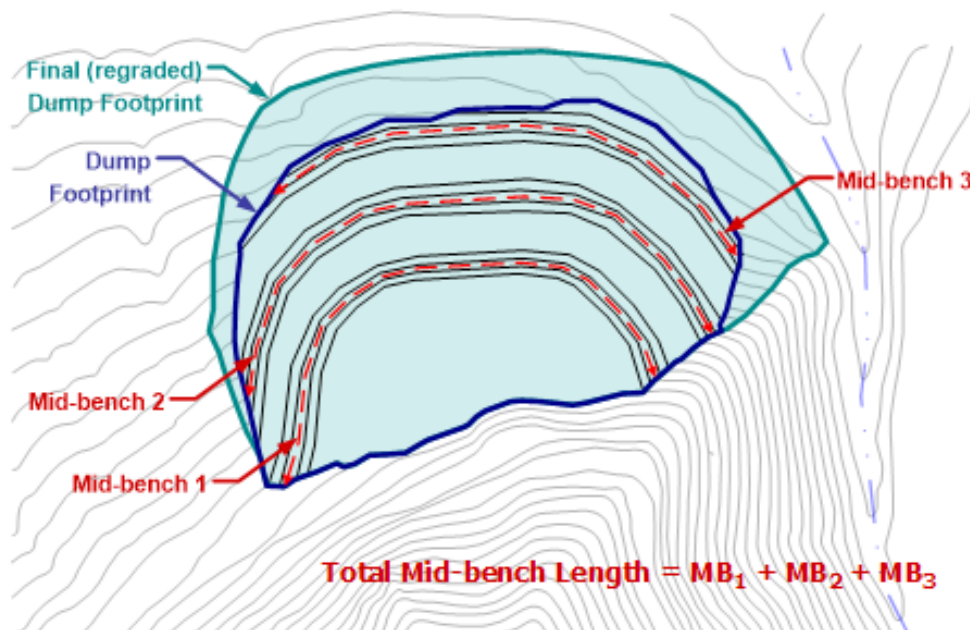


Figure 7-5: Multi-Lift Slope Inputs (additive)

Multi-lift (separate)

A dump with different lift heights or on steep ground will need to be entered as a multi-lift (separate) dump. In this situation, you need to treat each lift separately in the Model. You will need to determine the mid-bench length and the footprint associated with each lift, or area (**Figure 7-4**). The best method to do this is to start with the top lift and determine the final footprint area and other input for that lift. Then, using the toe of the final footprint of the top lift as the upper bound of the footprint for the next lift, repeat the process until you have included all of the lifts.

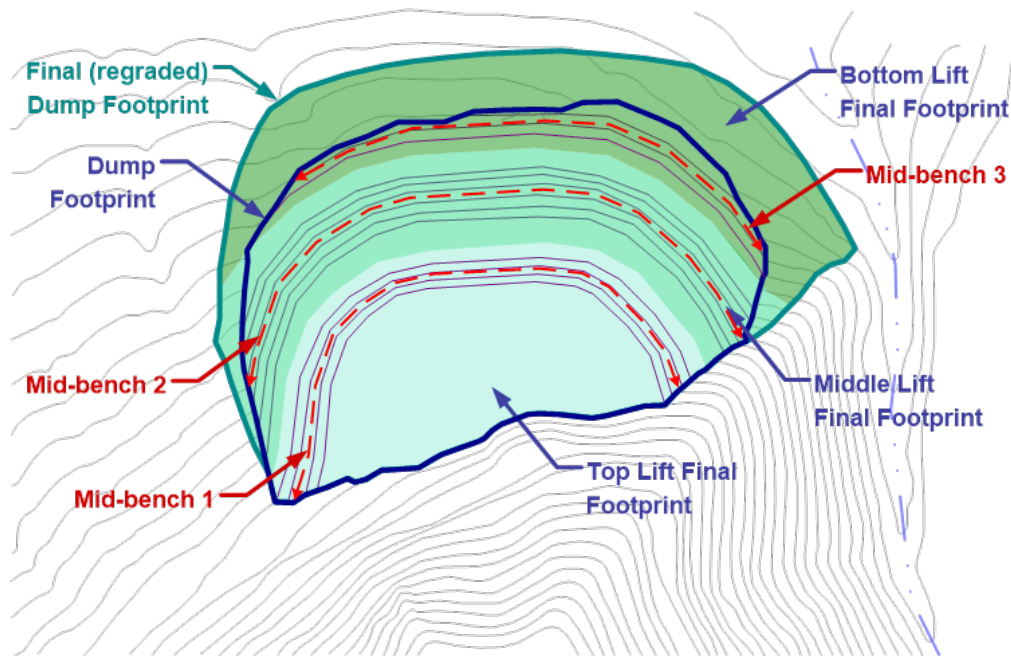


Figure 7-6: Multi-Lift Slope Inputs (separate)

Another example of a complex waste rock dump is given in **Chapter 5** and shown on **Figure 5-9**. The decision on the approach taken and how much detail is appropriate entering the data for each dump will be site and facility specific and highly dependent on the information available and the level of accuracy required from the cost estimate.

... Create a Cover with More than Three Layers

To create a cover with more than three layers you can either to enter multiple lines for the same facility or utilize the **Haul Material** worksheet separately or in association with the facility worksheets. Each line can have three layers for cover using the Cover 1, Cover 2 and Growth Media options. However, to avoid double counting regrading costs either make the Ungraded and Final Slopes equal or enter zero in the Regrade Volume override column. To avoid double counting scarifying and revegetation costs, only enter the required data in one of the lines for the facility.

If you chose to use the **Haul Material** worksheet, each line in the Haul Material worksheet will allow you to add another three cover layers – the first being the material you haul and then a cover and growth media over the hauled material.

Begin by inputting the geometry of the facility you wish to cover in the specific facility worksheet (i.e. WRD, Heap leach, etc.). Using the cover and growth material columns you can allow the Model to calculate volumes of each cover you will need to haul and place. To find the volume scroll down the worksheet until you come to Cover and Growth Media Costs (**Figure 7-5**).

Waste Rock Dumps - Cover 1 Costs			
		Material Volumes	
	Description (required)	Material Volume to Crusher m3	Final Material Volume m3
1	Ore Stockpile	0	60,864
2	WRD A	0	281,660
3	WRD B - Segment 1	0	123,895
4	WRD B - Segment 2	0	227,656
		0	694,075

Figure 7-7: Waste Rock Dumps - Cover and Growth Media Costs

Another approach to determining the volume required would be to use the surface area from the facility worksheet and multiply that area by the desired thickness of the cover. Surface areas can be found by scrolling down the facility worksheet until you come to *Scarifying/Revegetation Costs* (**Figure 7-6**). You can then transfer the volumes and Surface areas to the **Haul Material** worksheet.

Waste Rock Dumps - Scarify/Revegetation Costs				
	Description (required)	Slope Area ha	Flat Area ha	Total Surface Area ha
1	Ore Stockpile	2.87	9.31	12.18
2	WRD A	10.20	46.13	56.33
3	WRD B - Segment 1	15.88	8.90	24.78
4	WRD B - Segment 2	8.30	37.23	45.53
		37.25	101.57	138.82

Figure 7-8: Waste Rock Dumps - Scarifying/Revegetation Costs

The worksheet can now be filled out as any other worksheet, with surface area (as calculated above), average ripping distance of surface area, volume of material to haul (as calculated above), distances to the source material, and slope to source material. Cover and growth material can also be entered.

This worksheet also has options to include costs for crushing, screening and/or compacting the primary material hauled. If crushing or screening options are selected, the user must also input the additional distance that the material will be hauled from the crushing/screening plant. If compaction is selected, the Model assumes that a vibratory roller will be used for compaction. Costs for crushing, screening and compaction are based on per volume costs included in the **Misc. Unit Cost** worksheet. Up to two additional layers can be added by using the cover and growth material options in the same manner included in many of the other worksheets.

... Incorporate Cyanide Code Compliance

Compliance with the Cyanide Code requires that a closure cost estimate addressed all activities necessary to properly decontaminate and decommission process facilities that have come into contact with cyanide solutions during operations. Most of these activities are covered in the main worksheets of the Model. Others may require the use of the **Solution Mgmt.**, **Other User**, or **User worksheets**.

The **Solution Mgmt.** worksheet contains useful options for Cyanide Code compliance. The *Pumping of water*, *Forced Evaporation* for disposal of water, *Water Treatment* and *Decontamination* options in this worksheet provide a method to facility Cyanide Code compliance with the Model.

... Calculate Pit Backfilling

Pit backfilling is best handled in the **Haul Materials** worksheet in the Model.

For use in calculating pit backfilling costs, this worksheet allows the placement of additional cover and topsoil after backfilling. If infiltration reduction is required, then compaction of the backfill can be included by selecting “Yes” in the *Compact After Placement?* cell.

... Add Mobilization and Demobilization Costs

The cost for mobilization and demobilization of equipment to a site is usually calculated separately and added to the total costs. Typically, mobilization costs are estimated for each piece of equipment that will be used for the closure work. In SRCE 2.0, the calculation of mobilization costs is typically a two-step process utilizing two new worksheets in the model – **Equip Use** and **Mobilization**.

To determine mobilization costs the user must determine the number of each type of equipment that must be mobilized. To assist the user in this, the Equip Use worksheet totals the equipment hours for each piece of equipment that is included in the current schedule for each year in the schedule. The hours will change as filters, such as Cost Type or Facility/Activity Type are changed. For this reason, the user may need to refresh the Equipment Use table after any changes to the facility worksheets or filters (**Figure 7-8**). For example, if some earthwork activities are only included in a LOM cost estimate, when ARO is selected as the cost estimate type in the Schedule worksheet, refreshing the Equipment Use table will calculate only those hours for equipment that are include in an ARO estimate. The second table in the **Equip Use** worksheet coverts the hours of equipment per year into the required number of each type of equipment per year using the user-entered Average hours/year/unit. This can be used to determine the equipment that must be mobilized to perform the closure work.

Units Mobilized	Transport Method	Total Load/ Secure Unload/ Secure Time	Assembly/ Disassembly ⁽¹⁾	Assembly/ Disassembly Override	Equipment Weight	Road Distance (return trip)	Ship/Barge Distance (return trip)	Rail Distance (return trip)	Air Distance (return trip)
#	(select)	hrs	Total \$	Total \$	tons	km	km	km	km
1	Road only	1.00	0		25.7	560			
1	Road only	2.00	24,500		69.2	560			
1	Road only	1.00	0		32.0	560			
2	Road only	3.00	46,700		98.5	560			
1	Road only	1.00	0		35.5	560			
2	Road only	1.00	48,300		163.7	560			
	Road only	1.00	0		163.7	560			

Figure 7-11: Equipment Transport

... Add Site Specific Costs for Materials

There may be times that a site specific material cost is not included in the cost data worksheet. These costs can be entered into the material costs tab within the Model. Costs can be entered for *Revegetation materials*, *Mulch*, *Fertilizers*, and *Monitoring Costs*.

To enter site specific costs you will need to enter the cost into the green cells under the appropriate headings making sure to enter an appropriate description, units and cost (**Figure 7-11**). A WAD Cyanide cost of \$125 per sample. Below the direct entry (green) cells for the specific costs there are another set of green direct entry cells where you need to enter the source of the costs you have just entered.

These costs will then be available in the blue dropdown list in the appropriate cells throughout the Model.

Revegetation Materials			
Seed Mixes			
Seed Mix	Description		Cost \$/ha
None			
Mix 1	Basins		696.30
Mix 2	Low Hills		749.86
Mix 3	Uplands		803.42
Mix 4	Riparian or Custom		856.98
User Mix 1	Permit Approved Seed Mix		\$750.67
User Mix 2			
User Mix 3			
User Mix 4			
	Cost/lb	kg/Ha	Cost/Ha
User Mix 5 (from Seed Mix sheet)	9.94	27.21	270.48
Notes:			

Figure 7-12: User Material Costs

... Get Additional Help

Additional help can be found on the NVBond.org web site (www.nvbond.org).

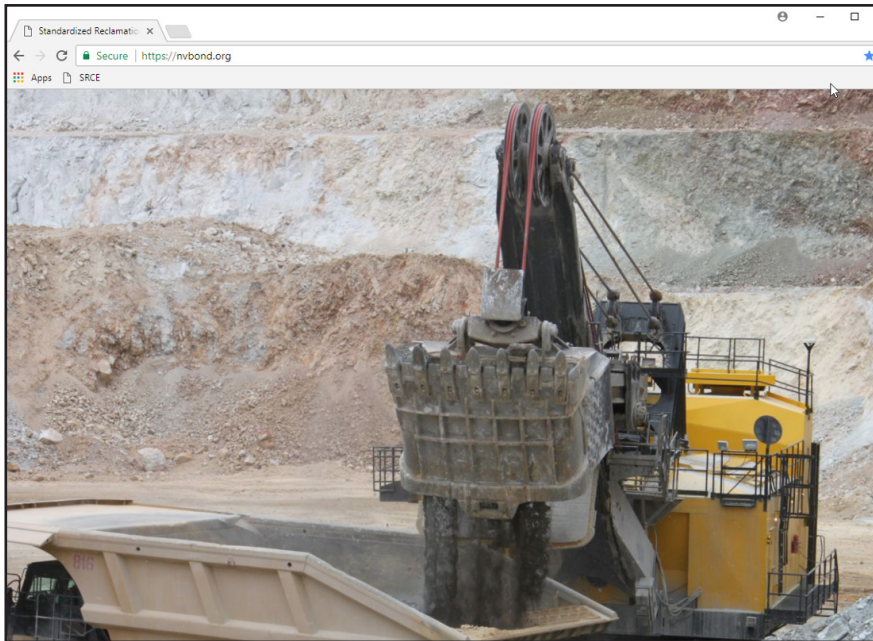
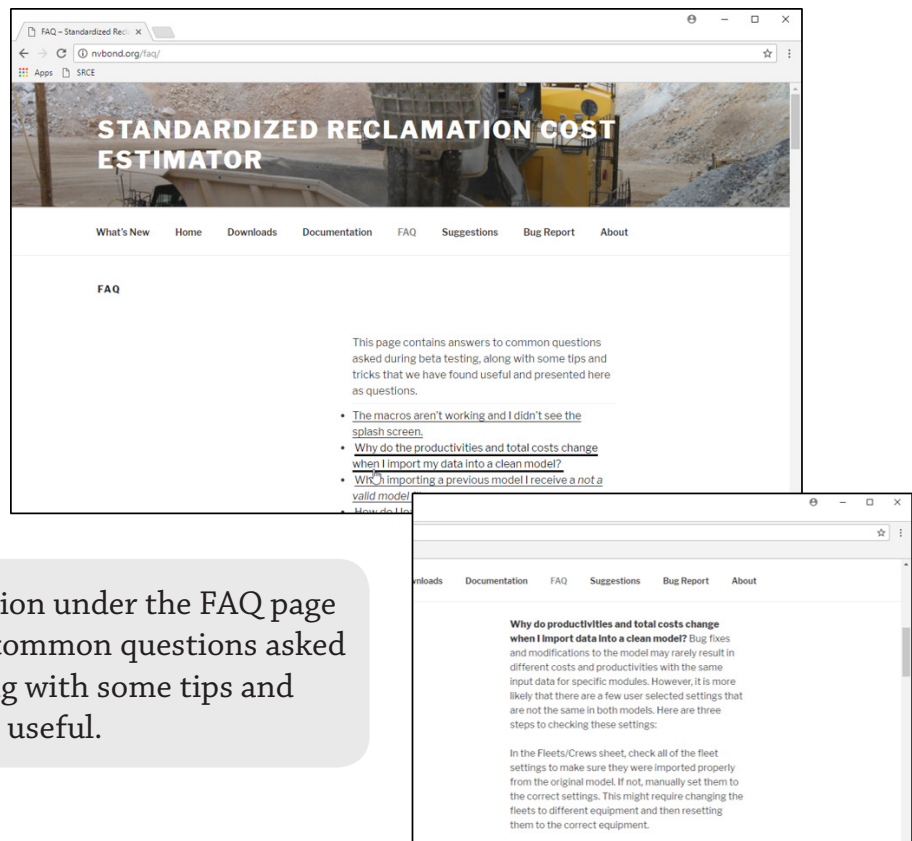


Figure 7-13: NVBond.org website



You can search for information under the FAQ page which contains answers to common questions asked during the beta testing along with some tips and tricks that were found to be useful.

Figure 7-14: Frequently Asked Questions (FAQ)

... Report a Model Bug

If you find a bug in the Model it can be reported on the NVBond.org web site (www.nvbond.org) by filling out and submitting a web-based Bug report.

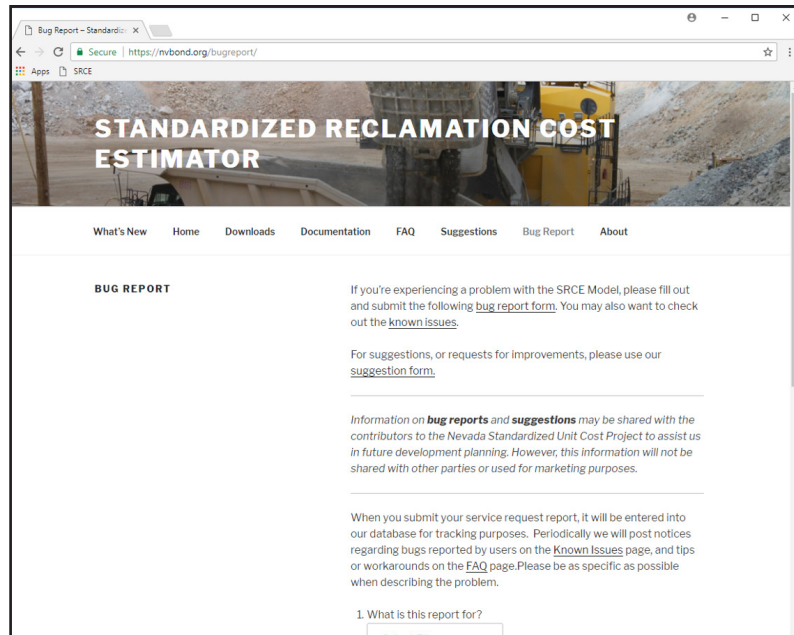


Figure 7-15: NVBond.org Bug Report

... Make a Suggestion for Future Versions

If you have a suggestion for future versions of the Model these can be submitted online through the NVBond.org web site (www.nvbond.org)

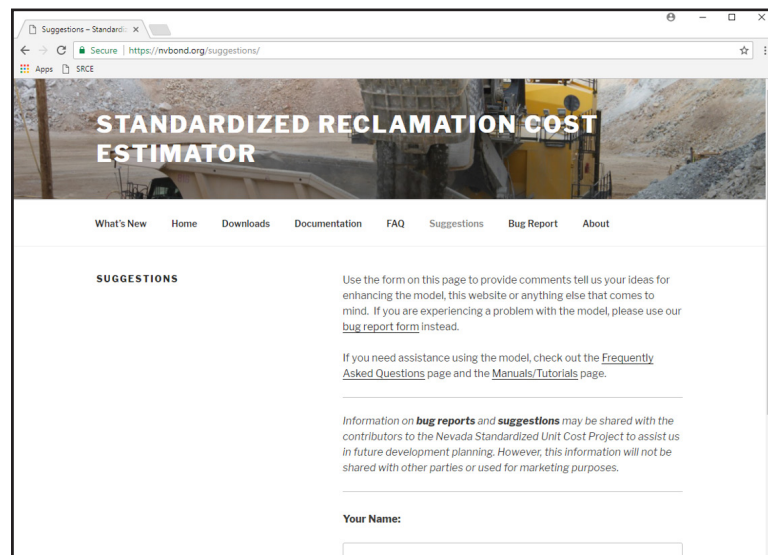


Figure 7-16: NVBond.org Suggestion Page

Glossary

Administrative expense

the overhead cost due to the nonprofit-specific operations of a company. Generally includes top management salaries and the costs of legal, central purchasing, traffic, accounting, and other staff functions and their expenses for travel and accommodations. ‡

The Angle of Repose

the maximum slope or angle at which loose, cohesionless material remains stable. ‡

Asset Retirement Obligation (ARO)

an ARO estimate is the fair value of abandonment liabilities associated with mining and mineral processing operations for financial reporting purposes. In other words, it is the amount a mining company would pay a third party to assume responsibility for completing all closure activities (including a reasonable profit margin). ARO cost estimates are prepared each year as part of the annual financial reporting requirements of some stock markets and adjusted to reflect any increases due to new development work or reductions resulting from completed closure work that occurred in the financial reporting year.

ARO (see Asset Retirement Obligation)

Aquifer

a geological formation, group of formations or part of a formation capable of yielding a significant amount of water to a well or spring.

Backfill

the material used to refill an excavation.

Basis

documentation that describes how an estimate, schedule, or other plan component was developed and defines the information used in support of development. A basis document commonly includes, but is not limited to, a description of the scope included, methodologies used, references and defining deliverables used, assumptions and exclusions made, clarifications, adjustments, and some indication of the level of uncertainty. ‡

Berm

a mound or wall of earth, rock or sand.

Best practices

measures, methods of operation or practices which are reasonably designed to prevent, eliminate or reduce water pollution from diffuse sources and which are consistent with the best practices in the particular field under the conditions applicable. This term is intended to be equivalent to the term “best management practices”*

Best Management Practices (BMP) (see Best Practices)

Bund (see Berm)

Chemically Stabilized

means the condition which results when contaminants in a material are bound or contained so as to prevent them from degrading the waters of the State under the environmental conditions that may reasonably be expected to exist at a site.*

Closure Completion

the time when a closed mine progressed to a state where mining lease ownership can be surrendered/relinquished and responsibility accepted by the next land user (Department of Industry, Tourism and Resources, 2006). Mine completion aims to (ibid.):

Cyanide Code, The

the “International Cyanide Management Code for the Manufacture, Transport and Use of Cyanide in the Production of Gold” (Cyanide Code) is a voluntary industry program for the gold mining industry to promote, responsible management of cyanide used in gold mining, enhance the protection of human health, and reduce the potential for environmental impacts. (www.cyanidecode.org)

Deterministic cost estimating methodology

a cost estimating method in which the independent variable(s) are more or less a definitive measure of the item being estimated. A deterministic methodology is not subject to significant conjecture. (AACE International, 2003)

Facility

all portions of a mining operation, including, but not limited to, the mine, waste rock piles, or piles, beneficiation process components, processed ore disposal sites, and all associated buildings and structures.*

Field supervision

the cost of salaries and wages of all field supervisory and field support staff personnel (excluding general foreman), plus associated payroll burdens, home office overhead, living and travel allowances, and field office operating costs. ‡

Fixed cost

those costs independent of short term variations in output of the system under consideration. Includes such costs as maintenance; plant overhead; and administrative, selling and research expense. For the purpose of cash flow calculation, depreciation is excluded (except in income tax calculations). ‡

Fluid

any material or substance which flows or moves whether in a semisolid, liquid, sludge, gaseous or other form or state.*

Fluid management system

that portion of a facility which has been constructed to contain or transport process fluids.*

Footprint area

the area resulting from a horizontal projection of a facility.

Frustum of a Pyramid

the portion of a pyramid that lies between the base and a plane cutting through it parallel to the base.

Groundwater

all subsurface water comprising the zone of saturation, including perched zones of saturation, which could produce usable water.*

Growth medium

a material which is capable of supporting vegetation.*

Hazardous Material

Hazardous Waste

any waste material requiring special handling, transportation or disposal methods as proscribed by regulation or statute.

Home office cost

those necessary costs involved in the conduct of everyday business, which can be directly assigned to specific projects, processes, or end products, such as engineering, procurement, expediting, legal fees, auditor fees inspection, estimating, cost control, taxes, travel, reproduction, communications, etc. ‡

Infiltration

the entry of water or fluid into the ground through such means as infiltration basis, septic systems or infiltration trenches.*

Injection well

a well used for the subsurface emplacement of fluids, except fluids associated with active drilling.*

Job overhead or Project management cost

the expense of such items as trailer, toilets, telephone, superintendent, transportation, temporary heat, testing, temporary office power, water, and similar items. ‡

Labor cost

the salary plus all fringe benefits of construction workers and general labor on construction projects and labor crews in manufacturing or processing areas which can be definitely assigned to one product or process area or cost center. ‡

Liner

a continuous layer of man-made or reconstructed natural materials, or a combination thereof which restricts the downward or lateral movement of liquids.*

Maintenance

the preservation of the functional integrity and efficiency of the equipment and structures of a mine closure project and includes, without limitation, any necessary preventive maintenance, corrective maintenance and replacement of equipment or structures.

Maintenance and repair cost

the total of labor, material, and other related costs incurred in conducting corrective and preventative maintenance and repair on a facility, on its systems and components, or on both. Maintenance does not usually include those items that cannot be expended within the year purchased. Such items must be considered as fixed capital. ‡

Map Area (see Footprint area)

MCP (see Mine Closure Plan)

Meteoric waters

any form of precipitation falling from the earth's atmosphere.*

mg/L

means the concentration of a substance, in milligrams, present in one liter of the water.

Milestone

an important or critical event and/or activity that must occur when scheduled in the project cycle in order to achieve the project objective(s). ‡

Mine Closure Plan (MCP)

a plan prepared in accordance with applicable regulations, corporate requirements or international standards that describes the objectives, actions and success criteria necessary to close a mine, or portion thereof.

Mining

means the process of extracting ores from the earth.*

Mitigation

means by which an environmental impact is avoided or minimized and may include:

1. Avoiding an environmental impact by not taking a certain action or parts of an action.
2. Minimizing an environmental impact by limiting the degree or magnitude of the action and its implementation.
3. Rectifying an environmental impact by repairing, rehabilitating or restoring the part of the environment affected.
4. Reducing or eliminating an environmental impact over time by preservation and maintenance during the life of the action.
5. Compensating for an environmental impact by replacing or providing substitute resources or environments.

Operating cost

the expenses incurred during the normal operation of a facility, or component, including labor, materials, utilities, and other related costs. Includes all fuel, lubricants, and normally scheduled part changes in order to keep a subsystem, system, particular item, or entire project functioning. Operating costs may also include general building maintenance, cleaning services, taxes, and similar items. ‡

Performance bond

a bond that guarantees the work will be completed in accordance with the contract documents. The bond also assures the owner that the contractor will fulfill all contractual and financial obligations. ‡

Permanent closure

the time in the operating life of a facility when activities for the final stabilization, removal or mitigation of sources are initiated.*

Permit

a written document issued pursuant to applicable commonwealth or provincial regulations, which describes the responsibilities and obligations of the holder of the permit during the construction, operation, and temporary or permanent closure of a facility.

pH

the negative log of the hydrogen ion concentration.

Plan

a predetermined course of action over a specified period of time which represents a projected response to an anticipated environment in order to accomplish a specific set of adaptive objectives. ‡

Planimeter

a planimeter is a device, which mechanically integrates an area and records that area on a drum and disk as a tracing point moves over the boundary of the figure to be measured. A planimeter consists of a graduated drum and disk, vernier, tracing point, anchor, and anchor point.

Plugging

the stoppage of the flow of water, oil or gas into or from a formation through a borehole or well penetrating that formation.*

Pond

a process component which stores, confines or otherwise significantly impedes the horizontal movement of process fluids. The term does not include tailings impoundments, vats, tanks or other non-earthen containers.*

Process solution

any liquids, including meteoric waters, which are intentionally or unintentionally introduced into any portion of the beneficiation process components.*

Process solution stabilization

binding, containing or otherwise treating contaminants in a fluid, including, without limitation, meteoric waters, that have intentionally or unintentionally been introduced into a heap leaching facility or tailings facility to prevent the contaminants from degrading the surface water or groundwater through naturally occurring environmental conditions which may be reasonably expected at the mine site.*

Productive postmining land use

means a use which supports activities including: wildlife habitat; livestock grazing; agriculture and ranching; industry; recreation; or any other activities which benefit the Commonwealth, Providence, or the owner of the land.*

Productivity

in general terms, productivity can be defined as the ratio of the value that labor and equipment produces to the value invested in labor and equipment. It is an absolute measure of work process efficiency, i.e., a measure of the extent to which resources are

minimized and wasted effort is eliminated from the work process. ‡

Profit ‡

- (1) Gross Profit - earnings from an on-going business after direct costs of goods sold have been deducted from sales revenue for a given period.
- (2) Net Profit - earnings or income after subtracting miscellaneous income and expenses (patent royalties, interest, capital gains) and federal income tax from operating profit.
- (3) Operating Profit - earnings or income after all expenses (selling, administrative, depreciation) have been deducted from gross profit.

Project management cost (see Job overhead)

Reclamation

actions performed during or after an exploration project or mining operation to shape, stabilize, revegetate or otherwise treat the land in order to return it to a safe, stable condition consistent with the establishment of a productive post mining use of the land and the safe abandonment of a facility in a manner which ensures the public safety, as well as the encouragement of techniques which minimize the adverse visual effects.*

Quality assurance

all those planned or systematic actions necessary to provide adequate confidence that a product, process, or service will conform to established requirements. ‡

Quality control

inspection, test, evaluation or other necessary action to verify that a product, process, or service conforms to established requirements and specifications. ‡

Quality management

concerns the optimization of the quality activities involved in producing a quality product, process or service. As such, it includes appraisal, training, and prevention activities. ‡

Regrade (regrading)

reshaping of a surface to create a different surface profile - reprofile, reshape.

Resale value

the monetary sum expected from the disposal of an asset at the end of its economic life, its useful life, or at the end of the study period. ‡

Revegetation

the actions taken to establish vegetation at a mine site, or portion thereof that will be consistent with the post-mining land use and self sustaining.

Salvage value

(1) the cost recovered or which could be recovered from a used property when removed, sold, or scrapped; (2) the market value of a machine or facility at any point in time (normally an estimate of an asset's net market value at the end of its estimated life); (3) the value of an asset, assigned for tax computation purposes, that is expected to remain at the end of the depreciation period. ‡

Schedule

the plan for completion of a project based on a logical arrangement of activities, resources available, imposed dates or funding budgets. ‡

Specification, design (prescriptive)

a design specification providing a detailed written and/or graphic presentation of the required properties of a product, material, or piece of equipment, and prescribing the procedure for its fabrication, erection, and installation. ‡

Specification, performance

a statement of required results, verifiable as meeting stipulated criteria, and generally free of instruction as to the method of accomplishment. ‡

Specifications

written directions regarding the quality of materials and the nature of the workmanship for a job. Specifications may be written directly on the drawings, or presented in a separate document. ‡

Spring

a naturally occurring point of discharge where groundwater becomes surface water, regardless of whether the water is developed for use.*

Stochastic cost estimating method

a cost estimating method in which the independent variable(s) used in the cost estimating algorithms are generally something other than a direct measure of the units of the item being estimated. The cost estimating relationships used in stochastic methods often are somewhat subject to conjecture. (AACE International, 2003)

SU

standard pH units.

Supplier

a manufacturer, fabricator, distributor or vendor.‡

Surety

1) a bond that provides sufficient funds to ensure a responsible government agency that

the approved reclamation and closure activities for a project can be performed by a third-party should the operator default on their obligation; 2) a bonding company licensed to conduct business which guarantees the owner that the contract will be completed (Performance Bond) and that subcontractors and suppliers will be paid (Payment Bond).

Surface area

the area of the (non-planar) surface of a facility to accurately estimate cover and revegetation areas.

Surface water

all water open to the atmosphere and subject to surface runoff.*

System

a collection of hardware (equipment and facilities) and related software (procedures, etc) designated to perform a unique and useful function. A system contains everything necessary (except personnel and materials or supplies) to perform its defined function. ‡

Tailings impoundment

a process component which is the final depository for processed ore discharged from a mill.*

Task

smallest unit of work planned. It must have an identifiable start and finish, and usually produces some recognizable results. ‡

Temporary closure

the cessation of the operation of a process component for more than 30 days as a result of a planned or unplanned activity.*

Topsoil

the material at or near the surface of the earth which has been modified and acted upon by natural, physical, chemical or biological agents in a manner which will allow it to support revegetation.*

Uncertainty

unknown future events which cannot be predicted quantitatively within useful limits, eg, accidents which destroy invested facilities, a major strike, a competitor's innovation which makes the new product obsolete. ‡

Unit cost

cost per unit of production. It is usually total cost divided by units of production, but a major cost divided by units of production is frequently referred to as a unit cost; for example, the total unit cost is frequently subdivided into the unit costs for labor, chemicals, etc. ‡

Updating

the regular review, analysis, evaluation, and reporting of progress of the project, including recomputation of an estimate or schedule. ‡

Useful life

the period of time over which an investment is considered to meet its original objective. ‡

Wastewater

a combination of the liquid- and water- carried wastes from a residence, commercial building, industrial plant or institution and any groundwater, surface water or storm water that is present.*

Water well

an encased excavation made by any drilling method for the development of groundwater from its source.*

Zero discharge

the standard of performance for the protection of surface waters which requires the containment of all process solutions.*

Definition sources:

* Nevada Administrative Code (NAC) - NAC445A or NAC519A.

† Dictionary of Geological Terms, 3rd Edition, American Geological Institute.

‡ AACE International Recommended Practice No. 10S-90 - Cost Engineering Terminology, Copyright © 2004, Association for the Advancement of Cost Estimation.

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References

Appendix A

Truck/Loader Fleet Productivity Calculations (Version 1.3)

Truck and Loader Capacities = from CAT® Handbook (see Productivity worksheet)

Average Capacity of Loader =

Struck Bucket Capacity + $\frac{1}{2}$ (Heaped Bucket Capacity - Struck Bucket Capacity)

Loader Cycle Time = from CAT® Handbook (see Productivity worksheet)

Haul Operator Efficiency = 0.75 (average)

Job Efficiency = 0.83 (50min/hr)

Number of Passes to Fill Truck =
$$\frac{\text{Heaped Capacity of Truck}}{\text{Average Capacity of Loader}}$$

[heaped truck capacity used because that is how trucks are loaded by a FEL (i.e. they keep loading until material spills out of bed of truck)]

Truck Loading Time = Loader Cycle Time x Number of Passes to Fill Truck

Truck Loading Time = from curves [uphill] or grade retarder (speed) tables [downhill]

Empty Travel Time = from curves [uphill] or grade retarder (speed) tables [downhill]

Total Truck Travel Time = Loaded Travel Time + Empty Travel Time

Truck Cycle Time = Maneuver to Load Time + Truck Loading Time +
Maneuver to Dump Time + Total Truck Travel Time

Number of Trucks Required =
$$\frac{(\text{Truck Cycle Time} - \text{Truck Loading Time})}{\text{Truck Loading Time}^*}$$

[*rounded up to the nearest integer]

Truck Productivity =
$$\frac{60 \text{ min/hr}}{\text{Total Cycle Time}} \times \text{Average Truck Capacity}$$

Fleet Productivity = Number of Trucks Required \times Truck Productivity \times
Haul Operator Efficiency \times Job Efficiency

Work Hours =
$$\frac{\text{Total Volume to be Hauled}}{\text{Fleet Productivity}}$$

Conservative Assumptions

- Average Loader Capacity is used for Number of Passes to Fill Truck
- Average Truck Capacity is used to calculate Truck Productivity even though cycle time is calculated based on Heaped Capacity of Truck
- Average Haul Operator Efficiency factor (1.0) is applied to trucks in Nevada SRCE, can be adjusted in International SRCE.
- Job Efficiency of 50min/hr in Nevada SRCE, can be adjusted in International SRCE.

References

Appendix B

Tutorial Exercises

NOTES PAGE

Exercise 1: Simple Waste Rock Dump

This exercise uses an example of a single lift waste rock dump with a consistent height.

The first step is to determine what the closure plan for the dump is. What does it say about the following:

- **Regrading**
- **Cover**
- **Topsoil**
- **Ripping**
- **Seeding**

The next step is to determine the key geometric parameters that the Model needs to perform the volumetric and area calculations. Use the map for Exercise 1 to fill in the blanks below.

- **Dump height = 20 m**
- **Mid-bench length = _____ m**
- **Underlying (toe) slope _____ % grade**
- **Current dump slope ___H:1V**
- **Final dump slope 2.7H:1V**
- **Final footprint area _____ ha**
- **Final slope on top of dump 1 % grade**

Other things that need to be considered:

- **Cover borrow sources**
- **Topsoil borrow sources**
- **Revegetation types**



Waste Rock Dumps

Pits

Yards

Tailings Facilities

Ponds

120m Pit Buffer

Pit Berm In Place

EXERCISE: Callop WRD

Project: SRCE Training

Originator	Projection	Drawn	Date	Scale	Worksheet	Plate No.:
	AM0 Zone 50 (NAD 84)		25/02/2017	1:5000		

Exercise 1: Answers

Here's how our measurements came out:

- **Dump height = 20m**
- **Mid-bench length = 1147m**
- **Underlying (toe) slope = 1% grade**
- **Current dump slope = 2H:1V**
- **Final dump slope 2.7H:1V**
- **Final footprint area = 11ha**
- **Final slope on top of dump 1% grade**

Exercise 2: Complex Waste Rock Dump

This exercise uses an example of a multiple lift waste rock dump with varying heights and current slopes.

The first step is to determine what the closure plan for the dump is. What does it say about the following:

- **Regrading**
- **Cover**
- **Topsoil**
- **Ripping**
- **Seeding**

The next step is to determine the key geometric parameters that the Model needs to perform the volumetric and area calculations. Use the map for Exercise 2 to fill in the blanks below.

- **Dump heights = _____, _____, _____, _____, _____, _____ m**
- **Mid-bench length = _____, _____, _____, _____, _____, _____ m**
- **Underlying (toe) slope = <1 %**
- **Current dump slope = _____, _____, _____, _____, _____, _____ H:1V**
- **Final dump slope = 2.7H:1V minimum**
- **Final footprint area = _____, _____, _____, _____, _____, _____ ha**
- **Final slope on top of dump 1 % grade**

Hint: there are six sets of blanks because we divided this dump into six areas for entry into the Model.

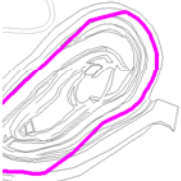
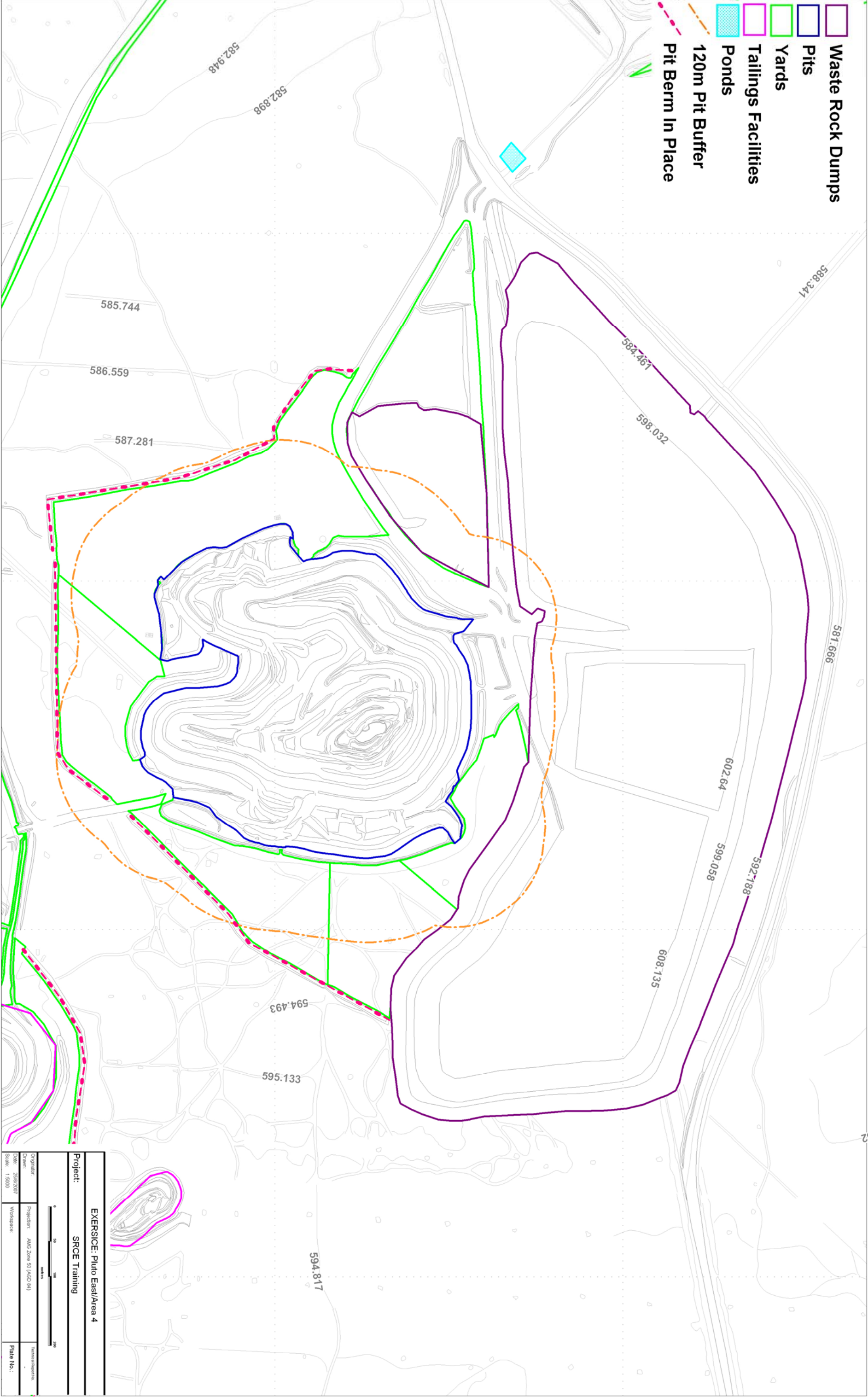
749,000 mE

750,000 mE

750,000 mE

750,000 mE

- Waste Rock Dumps
- Pits
- Yards
- Tailings Facilities
- Ponds
- 120m Pit Buffer
- Pit Berm In Place



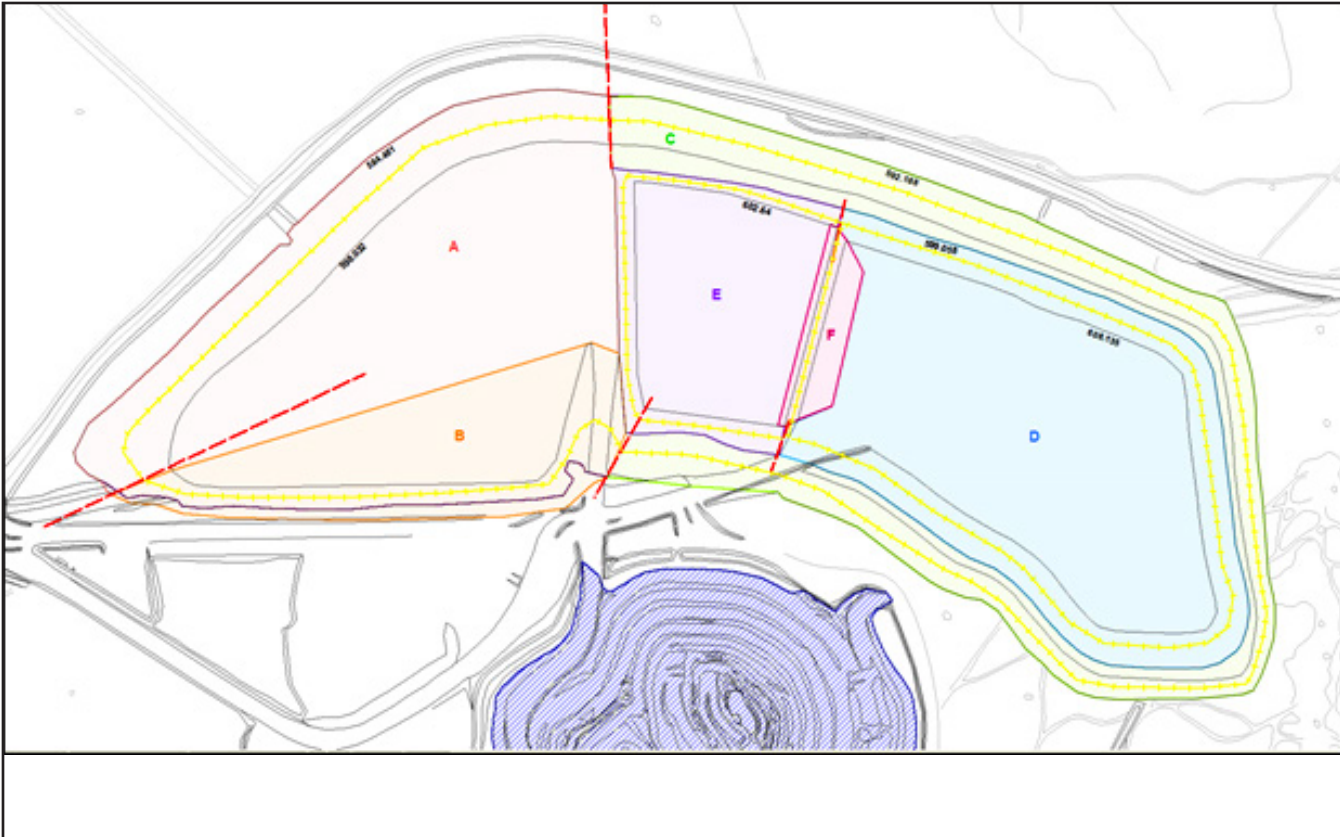
EXERSICE: Pitto East/Area 4			
Project: SRCE Training			
Originator	Project	AMIS Zone 50 (AGD 84)	Version/Revision
Drawn	25/05/2007		
Scale	1:5000	Worksheet:	Plate No.:

7,197,500 mN

7,197,500 mN

Exercise 2: Answers

Here's how we divided the waste rock dump into areas A through F:



- Dump heights = 14 , 14 , 7 , 9 , 3 , 6 m
- Mid-bench length = 691 , 554 , 1746 , 1176 , 631 , 230 m
- Underlying (toe) slope = <1 %
- Current dump slope = 3.7 , 1.6 , 3.7 , 3.7 , 6 , 2.1 H:1V
- Final dump slope = 2.7H:1V minimum
- Final footprint area = 12 , 5 , 8 , 14 , 5 , 1 ha
- Final slope on top of dump 1 % grade

Exercise 3: Tailings Impoundment

This exercise uses an example of a two cell tailings impoundment with different embankments heights.

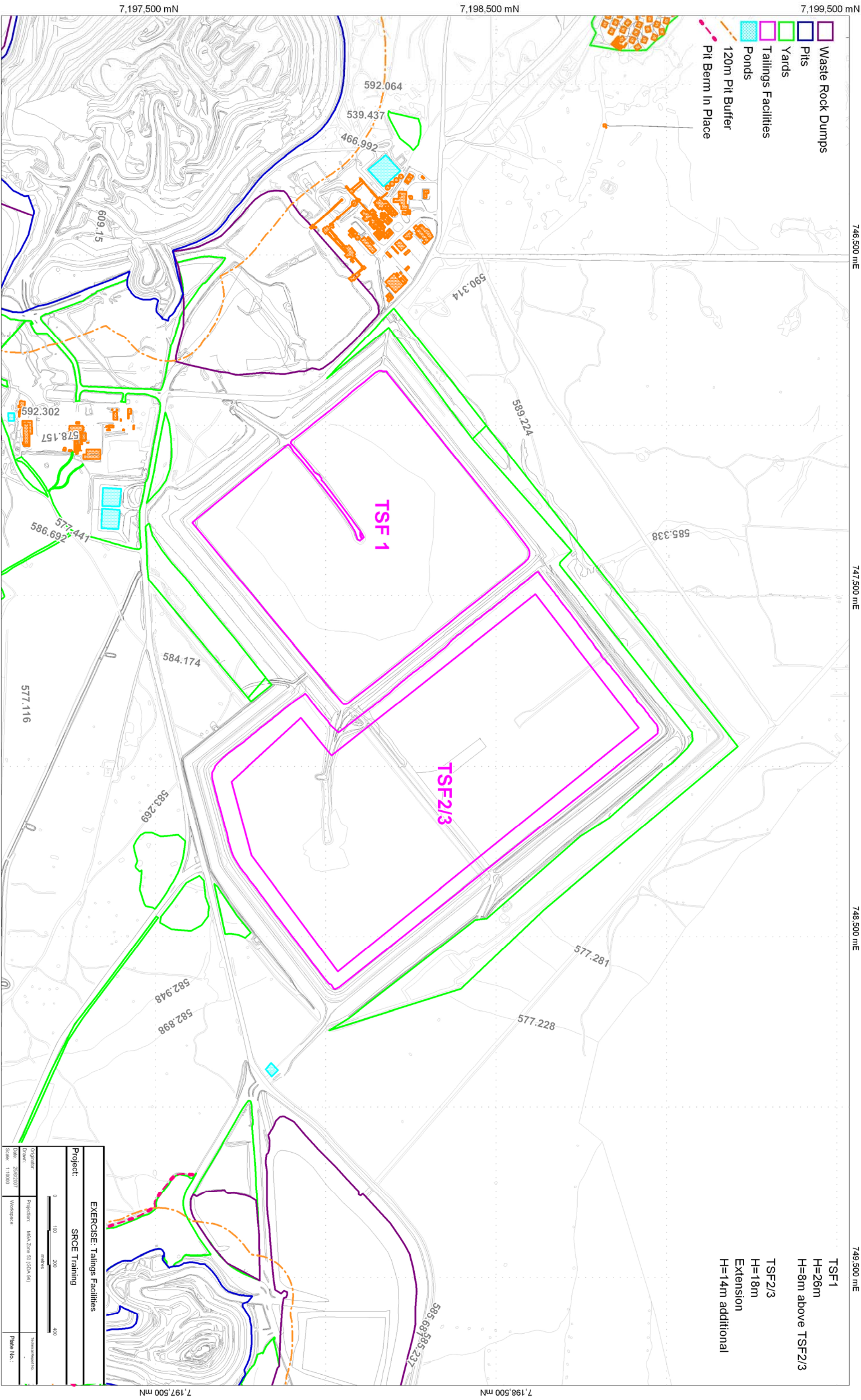
The first step is to determine what the closure plan for the tailings impoundment is. What does it say about the following:

- **Regrading**
- **Cover**
- **Topsoil**
- **Ripping**
- **Seeding**

The next step is to determine the key geometric parameters that the Model needs to perform the volumetric and area calculations. Use the map for Exercise 3 to fill in the blanks below.

- **Embankment height = 20, 8 m**
- **Mid-embankment length = _____, _____ m**
- **Underlying (toe) slope = ____, ____ %**
- **Current embankment slope = ____, ____ H:1V**
- **Final embankment slope = ____, ____ H:1V**
- **Tailings surface area = _____, _____ ha**
- **Tailings regrade volume = _____ m³**

Hint: there are two sets of blanks because we handled the two impoundment cells separately for entry into the Model.



Exercise 3: Answers

Here are our measurements for the two cells:

- **Embankment height** = 20, 8 m
- **Mid-embankment length** = 2306 , 867 m
- **Underlying (toe) slope** = <1 , <1 %
- **Current embankment slope** = 2.7 , 2.7 H:1V
- **Final embankment slope** = 2.7 , 2.7 H:1V
- **Tailings surface area** = 40.4 , 9.6 ha
- **Tailings regrade volume** = ? , ? m³ (for the regrade volume you will need a regrading plan to determine how much material must be moved to create the final top surface)

Exercise 4: Open Pits

This exercise uses an example of a single pit with a partial safety berm (bund) in place.

The first step is to determine what the closure plan indicates how far from the final pit highwall to construct the berm (bund). In the example shown in this figure the pit buffer line represents the maximum possible area that could collapse into the pit. The pit safety berm (bund) should be placed outside this area.

Use the figure for Exercise 2 to fill in the blanks:

- **How much of the existing safety berm (bund) needs to be replaced because it is inside the pit buffer? _____ m**
- **How much new safety berm (bund) need to be constructed? _____ m**

Hint: You shouldn't need a safety berm (bund) if there is a facility adjacent to the pit that would keep people from the pit (e.g. a waste rock dump).



Waste Rock Dumps

Pits

Yards

Tailings Facilities

Ponds

120m Pit Buffer

Pit Berm In Place

EXERCISE: Callop WRD

Project: SRCE Training

Originator	Projection	Drawn	Date	Scale	Worksheet	Plate No.:
	AMG Zone 50 (ACD 94)		25/02/2017	1:5000		



Exercise 4: Answers

Here are our answers for Exercise 4:

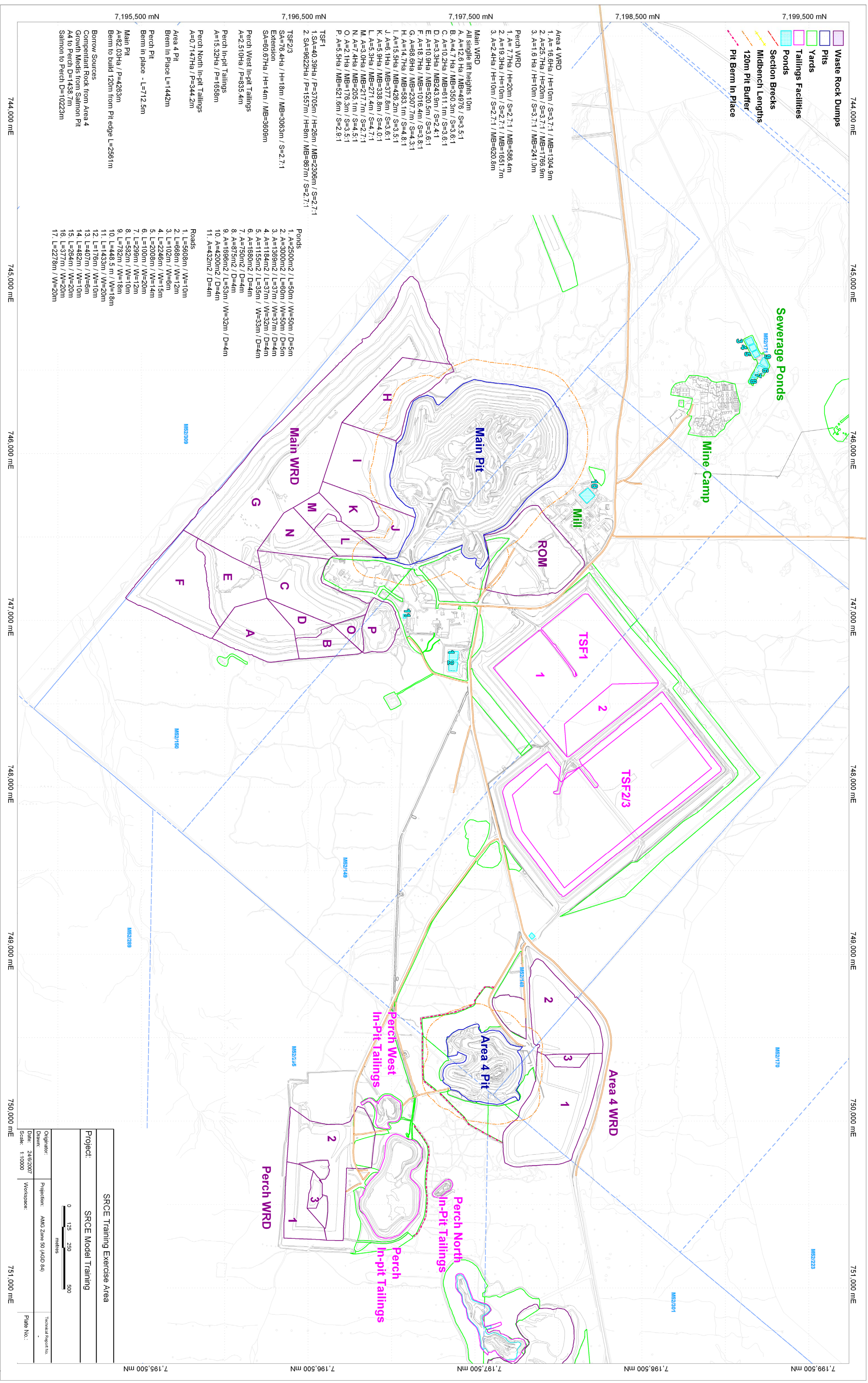
- *How much of the existing safety berm (bund) needs to be replaced because it is inside the pit buffer? **550** m*
- *How much new safety berm (bund) need to be constructed? **970** m*

Exercise 5: Roads

This exercise uses a site map (in back pocket) to determine the length and width of several roads.

Use the large Training Exercise Area figure to fill in the blanks:

- **How long is the road from the main access road (intersection southeast of the ROM pad) to the intersection at the southwest corner of the Area 4 WRD? _____ m**
- **What is the average width of this road? _____ m**
- **What is the slope of the natural ground over which this road traverses? _____% grade**
- **How long is the road from the main access road to the mine camp? _____ m**
- **What is the average width of this road? _____ m**
- **What is the slope of the natural ground over which this road traverses? _____% grade**



Exercise 5: Answers

Here are our answers for Exercise 5:

- *How long is the road from the main access road (intersection southeast of the ROM pad) to the intersection at the southwest corner of the Area 4 WRD? : **2020** m*
- *What is the average width of this road? : **10** m*
- *What is the slope of the natural ground over which this road traverses? : **1** % grade*
- *How long is the road from the main access road to the mine camp? : **675** m*
- *What is the average width of this road? : **10** m*
- *What is the slope of the natural ground over which this road traverses? : **1** % grade*

Exercise 6: Roads

This exercise uses a site map (in back pocket) to determine dimensions of ponds.

Use the large Training Exercise Area figure to fill in the blanks:

- **What are the dimensions of Pond #1? width:_____ m, length:_____m, depth: 5 m**
Pond #1 sideslope angle = 2H:1V
- **What are the dimensions of Pond #2? width:_____ m, length_____ m, depth: 5 m**
Pond #2 sideslope angle = 2H:1V
- **What are the dimensions of Pond #10? width:_____ m, length_____ m, depth: 5 m**
Pond #10 sideslope angle = 2H:1V

Exercise 6: Answers

Here are our answers for Exercise 6:

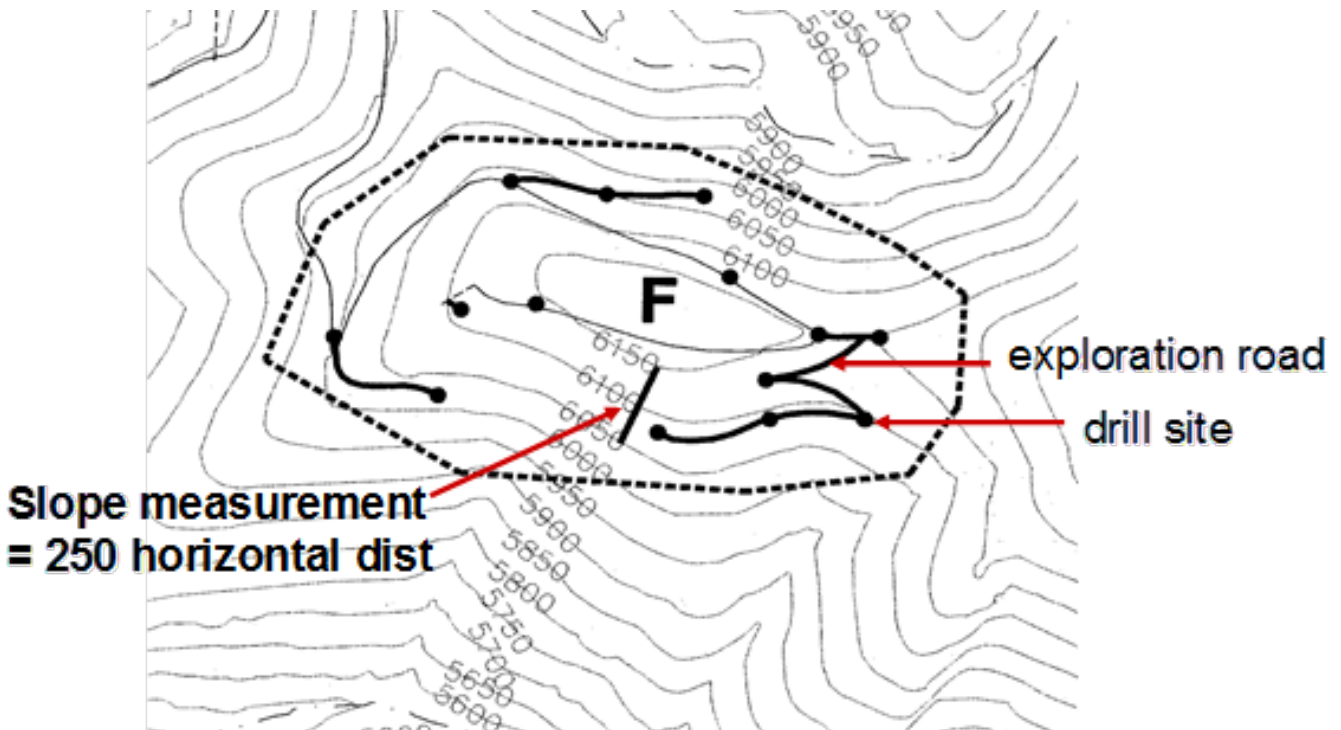
- **What are the dimensions of Pond #1?** width: **55** m, length: **55** m, depth: **5** m
Pond #1 sideslope angle = 2H:1V
- **What are the dimensions of Pond #2?** width: **55** m, length: **55** m, depth: **5** m
Pond #2 sideslope angle = 2H:1V
- **What are the dimensions of Pond #10?** width: **68** m, length: **70** m, depth: **5** m
Pond #10 sideslope angle = 2H:1V

Exercise 7: Roads

This exercise uses an example of a two cell tailings impoundment with different embankments heights.

Use the figure for Exercise 7 to fill in the blanks:

- No. of Drill Sites = _____
- Avg. Pad Width = 15 m
- Avg. Length = 20 m
- Avg. Sump Dimensions: 7L x 3W x 2D
- Length of Road = 610 m
- Width of Road = 5 m
- Slope = _____ % grade
- Cut Slope Angle = 70 deg
- Fill Slope Angle = 1.3H:1V



Contour interval = 50

Exercise 7: Exploration Drill Roads and Pads

Exercise 7: Answers

Here are our answers for Exercise 7:

- No. of Drill Sites = **14** total
- Avg. Pad Width = 15 m
- Avg. Length = 20 m
- Avg. Sump Dimensions: 7L x 3W x 2D
- Length of Road = 610 m
- Width of Road = 5 m
- Slope = **40** % grade
- Cut Slope Angle = 70 deg
- Fill Slope Angle = 1.3H:1V

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