SimMine Manual

SimMine version 6.02

A Simulation Tool
2022-08-29

SimMine ® is an easy to use and powerful software to plan, simulate and evaluate production and the development of haul ways and ramps in underground mining. By using simulation as the method of verification of plans, SimMine can provide more accurate results than common calculation methods.

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1 Installation

1.1 Overview

SimMine application does require some common components to work. These common components are:

- Database services, which handles the database(s) where SimMine stores its simulations
- 3D library, which contains common components used for the 3D engine

The common components exist in its own installer and is downloaded and installed separately. The common files are only required to be installed once, while SimMine itself can be installed multiple times when new releases arrive.

1.2 Getting started

SimMine can work in several licensing modes. The license is a software license which you activate for your copy of SimMine. The license key is distributed through mail. SimMine Common files and SimMine application can be installed without a license key. Running SimMine requires a license key.

1.2.1 License modes

All licenses are online licenses, which requires the computer that will run SimMine to be connected to the Internet each time it will run. The different license modes that exist are:

- Trial version – A trial version is valid for 45 days from the first start of SimMine application. All features can be used.
- Node-locked – A node locked license is locked to a single computer. These licenses cannot be transferred to another computer once they have been activated.
- Server license – A server license is limited to a number of concurrent uses. Whenever SimMine is closed on one computer, another computer may start to use the released license. It means that a license is only used during the actual usage of SimMine application. A server license can be activated on multiple computers.

1.2.2 Installation steps

1.2.2.1 First time install

The first time SimMine is installed, the SimMine Common Files needs to be installed. The required components exist in the file "SimMine Common Files.zip" which can be downloaded from SimMine's site (in http://simmine.com/download/)
When new updates for SimMine is posted, only SimMine itself needs to be updated. The common files do not need to be updated.

1.2.2.1.1 Installing the Microsoft .NET Framework

SimMine requires .NET 4.5. The .NET frameworks are Microsoft components and are already included in Windows 10 and higher. In Windows 7, .NET Framework might need to be installed since it is not shipped with Windows. The below link opens the download page to download .NET 4.5.
https://www.microsoft.com/sv-se/download/details.aspx?id=30653
If you are unsure if you need to download this framework or not, you can first install SimMine and start it. It will then show a message if the correct .NET framework is missing from the computer. If so, then you can download and install the framework.

1.2.2.1.2 Installing the SimMine Common Files

Download and extract the file "SimMine Common Files.zip" to a location on your local hard drive. After the extraction is complete, open windows explorer and open the folder which contains the extracted files.
Start the file ***SimMine Common Files.exe***. For this installation, you are asked for administrator credentials.

The installation wizard opens:

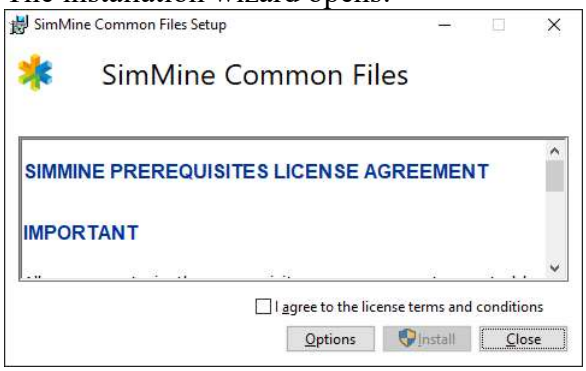


Figure 1-1 Common Files installation wizard

Read and agree of the license terms before clicking Install to continue.

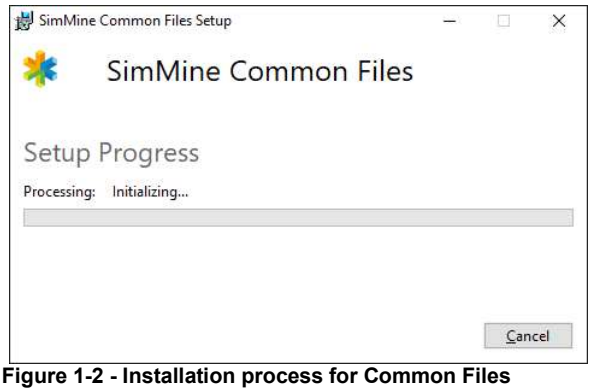


Figure 1-2 - Installation process for Common Files

During the installation, a dialog box may open asking for location where to unpack SQL Server files. Click OK to accept the default location. It will be removed after the Common Files have been installed.
Wait until the installation completes. This can take several minutes.

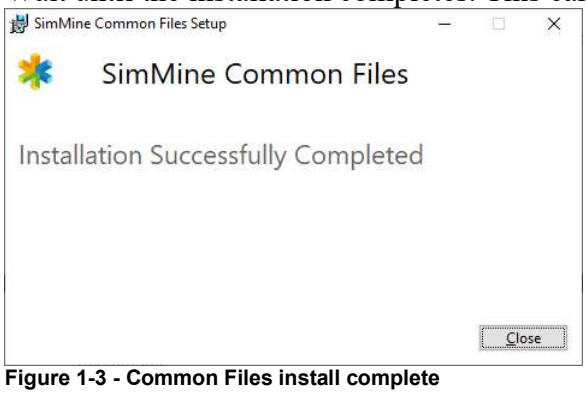


Figure 1-3 - Common Files install complete

Click Close when the installation of the Common Files is complete.

1.2.2.2 Installing the SimMine application

This section refers to the installation steps when installing SimMine software. These steps are required at each time that SimMine shall be installed or upgraded (i.e. when a new version exist that the user will upgrade to).
To install, you must have administrative rights.
Start the setup program by double-clicking the setup file (MineSimulator.msi). This will start the installation wizard. The first screen is shown below:

Figure 1-4 - Installation step 1

Click next to continue

Figure 1-5 - Installation step 2 license agreement

This step shows the license agreement. You have to accept the license before you can continue with the installation.
Check the “I accept the terms in the License Agreement” to agree to the license and then click Next. Before you accept the license terms, you cannot continue the setup process.

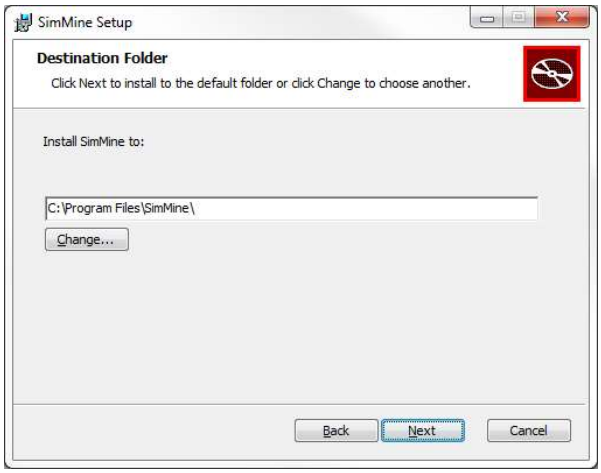


Figure 1-6 - Installation step 3 installation folder

Select where to install SimMine. Use the "Browse" button to browse for a location.
When done, click *Next*.
Select for which users the SimMine program will be installed for. "Everyone" creates an installation that is visible for everyone. "Just me", installs it so it's only visible for the currently logged in user.
Click next when done.

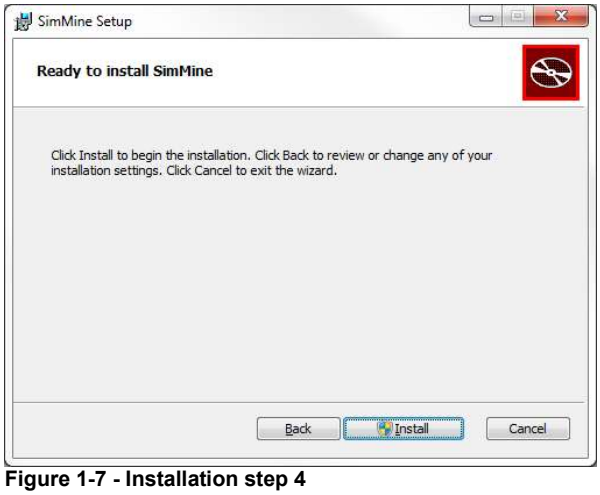


Figure 1-7 - Installation step 4

Confirm the installation. Click next when you want to start the installation

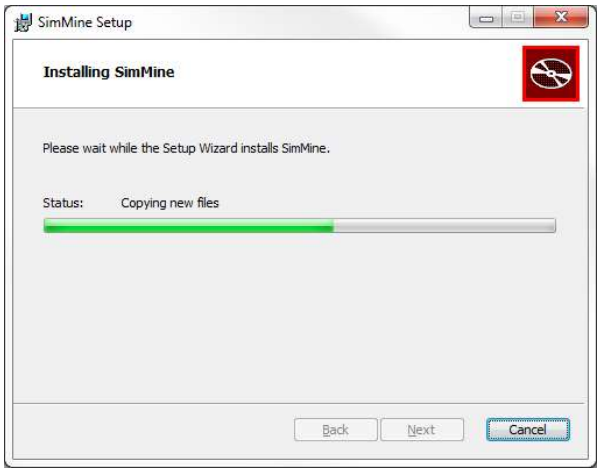


Figure 1-8 - Installation in progress

When the installation is done, the step below is seen.

Figure 1-9 - Last installation step

Close the installation wizard.

Note! For windows Vista and above, the Aero interface should be enabled. This will make the graphics more compatible with Windows

The installation is now complete.

The SimMine program is now found in the start menu, under “All programs->SimMine” folder.

1.2.2.3 Starting SimMine for the first time

After SimMine has been installed, it can now be started. When started for the first time, the default database is created and initialized. The default database is empty and doesn’t contain any data to use or play with. To populate the database with example data, see Import example data on page 270 for more information.

Note! When example data is imported into the database, current data may be overwritten. Therefor it is recommended that example data is only imported into an empty database. New

databases can be created if the default database isn't empty. See Database management tasks on page 31 for database management tasks

1.2.2.4 Tutorials

After the installation of all required components, the database containing the data for SimMine is empty. In SimMine there exist a function to import example data into the database. To get information how this is done, see Import a simulation on page 29.

2 License maintenance

2.1 Overview

The license is an online license, which has an end date. This is similar to a trial license, except that a real license will have a longer validity period. If the license is a subscription license, the license will continue to work until the subscription is cancelled. For a perpetual license, the end date will be prolonged when its end date.

2.2 License content

A license will activate or deactivate functionality within SimMine depending on what features are included in a license. Therefore, some images in this manual might not be enabled in your copy of SimMine.

2.3 Tips and advices

Before starting to create a simulation model, some guidelines to follow are recommended. These guidelines aim to make the building, simulation, analyze and troubleshooting easier

2.3.1.1.1 Concentrate on the problem – not on input data

The problem to be solved is controlling which type of input data is needed, not the opposite way around. Certain problems need more input information than others.

2.3.1.1.2 Begin with an easy model and add more logic afterwards

Start simple to produce some results from the tool.
When results are coming, go into more details in the model.
A complex model may be hard to search for errors if it has never been running.
When a first, simple model is up and running and produces results that are not too far from expected values or real-life values, you can start to add more details. It is very hard to control all the data when setting up a complex simulation from the beginning.

2.3.1.1.3 Simplify reality

Reality can be simplified. The model does not need to exactly correspond to the real-life, as long as the results correspond to real-life

3 SimMine overview

SimMine is used to simulate underground mining operations and processes, which results in a set of results. The results can be analyzed to tell the user where issues might arise, where a bottleneck lies, in which areas more capacity is required etc.

3.1 Simulation technology

The simulation technic is a process of learning by doing, and cannot give an answer about what to do to solve a particular problem. This is due to that the mining process is complex and multiple solutions can exist for any problem. There is also the fact that the simulation might only be there to get a more complete picture of the process to be prepared for the future. The simulation process is a continuous process seen below:

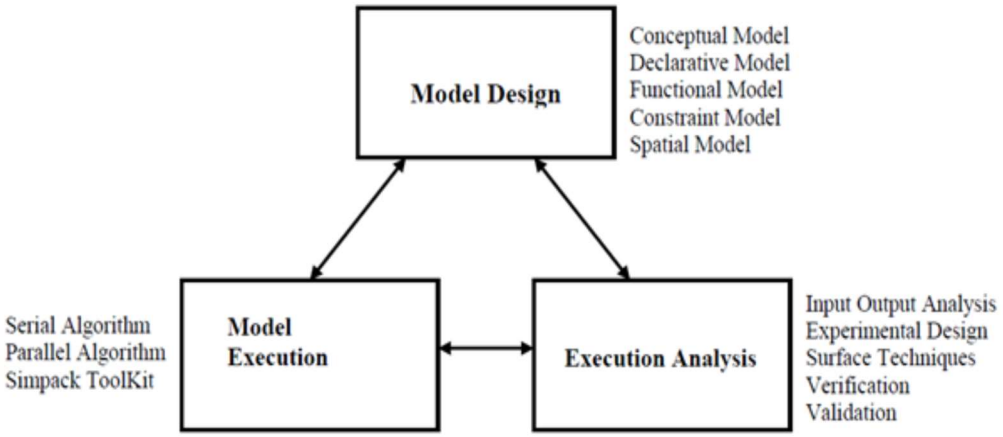


Figure 3-1 - Simulation execution process

An experienced mining engineer should analyze the results and draw conclusions based on his/her experience.
As an example, why SimMine itself cannot tell what should be done to solve a particular problem:
A mine want to reach a certain point in the mine at a particular date. A simulation is created for this purpose. After the simulation has been calibrated and run, it shows that the point cannot be reached on time. Multiple solutions to this problem are:

- Increase the number of vehicles. This might not be desired since it increases costs and might require more ventilation.
- Buy faster, better vehicles. This increases costs, but could limit the need for additional ventilation.
- Decrease development in some areas to focus on the area which needs to be done on time. This will force other areas in the mine to develop slower, which might cause a future requirement to be missed.
- Assign important vehicles to only work in the area where the point of interest is within. This could cause other issues.

As shown in the above example, SimMine would have difficult to propose a solution since the mine might have other requirements that the simulation cannot take into consideration.

3.2 Simulation work flow

When a simulation is created, there are important things that needs to be done to get the simulation results to be usable and trustworthy.
The simulation is a computer version of the real mine, so for the simulation model to behave close to how the reality behaves, a simulation model needs to be calibrated. The process to calibrate a model is in many cases done as:

1. Define a period in time which will be used as a calibration period. This period must be a historical period during which historical data exist.
    a. The period should be a period which is considered normal. A period in which any exceptional events did occur should not be used, such as an underground fire did cease all underground development during two weeks.
2. Collect data for vehicles, such as number of vehicles, their type and work speed, so that the real vehicles and simulation vehicles will perform equal fast.
    a. Other data for the vehicles also needs to be collected such as availability
3. Use the layout which was the layout at the start of the calibration period.
    a. The available headings and all heading which were developed during the calibration period should exist in the layout.
    b. Set the current state of the layout to correspond to the state of the calibration start.
4. Define and assign the same activity cycles to the layout which was used during the calibration period.
5. Collect other relevant data, such as preventive maintenance, shift schedule used etc.
6. Run the model.
7. The results from the simulation should now be compared with the historical results from the calibration period. Some key data should be used. Since the simulation is a computer model, the results from the simulation and the results from the real mine will never be exactly the same. Aim to get some key indicators equal or close to equal.
    a. This might be development meters and utilization of the vehicles.
8. If the results mismatch too much, adjust some of the inputs and rerun the simulation (step 6)
    a. The adjusted inputs should be possible to explain, so that inputs aren't adjusted just because it will give results closer to the real outcome. Examples of inputs to adjust and the explanation why:
        i. Adjust vehicle availability to compensate for small non-measurable occasions when the vehicles aren't available but not in workshop. For example, when an operator talks with shift bosses. This is not measurable but still affects the total available work time. The adjustment of vehicle availability should not be too big.
        ii. Adjust the Availability for simulation (see Set that a vehicle performs other, non-simulated tasks on page 143 for information regarding this). This sets the vehicle as unavailable in the simulation and can be due to that the vehicle is performing other tasks from time to time, which isn't simulated. Example: The vehicle does re-drilling, or drills to mount an electrical box. This is not simulated but the vehicle is unavailable for work. This can of course be

adjusted in the vehicle availability, but when Availability for simulation is used, it works differently compared to vehicle availability in the following areas:

1. it won't abort any ongoing work
2. A vehicle can become unavailable at any time, including off shift.
3. It can trigger even if the vehicle isn't working.

3.3 SimMine functionality

SimMine does support a number of options and settings. This part will list options which are not part of a simulation.

3.3.1 Multiple simulation models

Multiple simulation models can be opened at the same time. Each opened simulation will have its own tab as seen below:

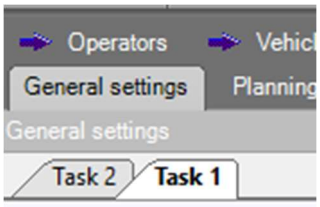


Figure 3-2 - Tabs for simulation models

When multiple simulation models are opened, all simulation models may be run at the same time. One simulation model can be opened multiple times, which is convenient when different settings should be examined without the need to save these settings.

3.3.2 Export data

Data, including the result can be exported to excel. Excel can then be used to further compare or analyze results. Export is described in Export on page 273

4 Main user interface

4.1 Overview

In this section you will learn about the common components and controls in SimMine. The common controls allow you to load a model, save a model, navigate within simulation models etc. No simulation tools are covered here.

4.2 Main window

The main window is the user interface which contains all ribbon bars, tool bars and other controls which are used to setup and control simulation models. The main window can be seen in Figure 4-1 Main window below.

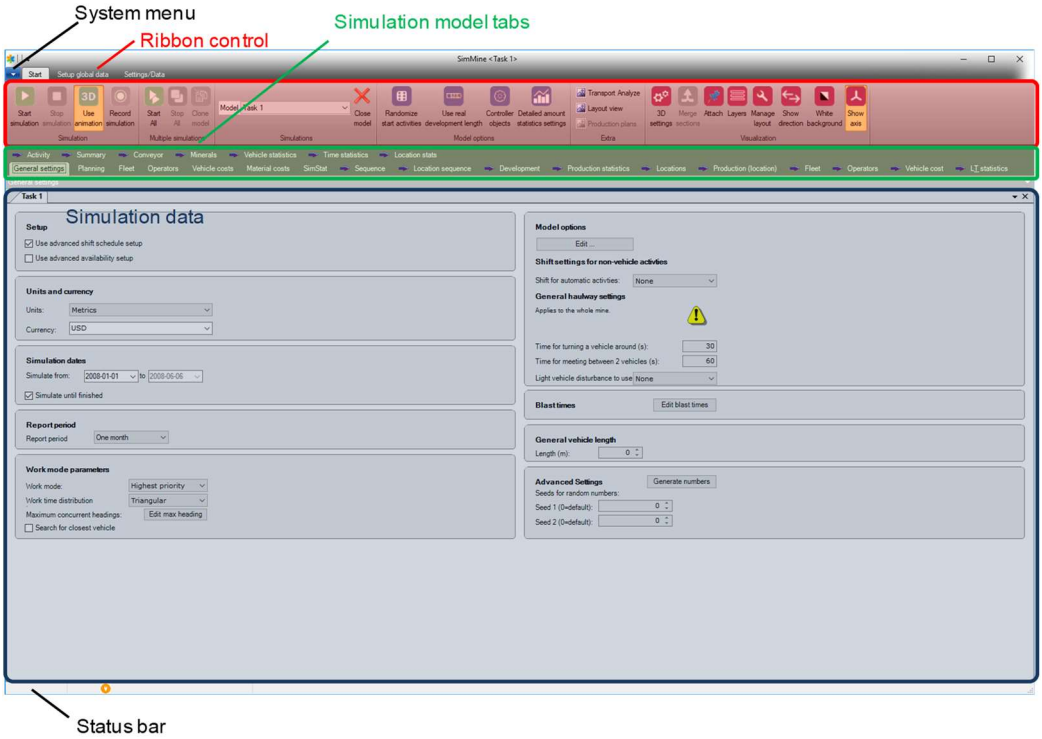


Figure 4-1 Main window

The main interface contains of these parts.

System menu

The system menu shows when the arrow at the top left cornet is clicked. It contains system functions such as load, save, about etc.

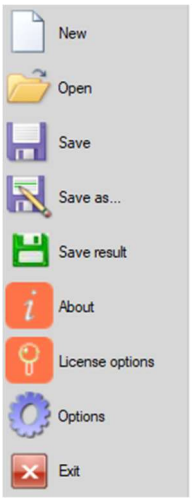


Figure 4-2 - System menu

Ribbon control

The ribbon control contains several controls divided into logical groups. The ribbon has several tabs on top, where each tab holds different types of controls. The controls seen in the ribbon can be used to set and control data in the current simulation model, specify which database to use, import or export etc.

Simulation model tabs

The tabs hold simulation model data. Each tab holds different data for the active model. This can be fleet data, layout data, and also the result. All tabs that contain results from a simulation are marked with a blue arrow.

Simulation data

The simulation data area shows one part of the simulation data depending on which model tab is selected. I.e. when the tab for the fleet is selected, the simulation data area contains fleet data.

4.3 SimMine common functionality

This section describes common functionality in how SimMine works and operates. The inner workings of SimMine cover functionality in how data is handled, how a model structure is constructed etc.

4.3.1 Simulation model structure

In SimMine, it exists three types of data:

- Global data – This data is shared between all simulations within the same database
- Simulation data – This is data specific to one simulation.
- Results – This is result from a previously run simulation. This data cannot be changed.

Each database does only have one set of global data and all simulations that are saved in that database shares this global data. When global data is changed, it will affect all simulation models which are using that global data.
Two different databases have their own set of global data.
The data structure in SimMine and the relationship between global data and simulation data is shown below

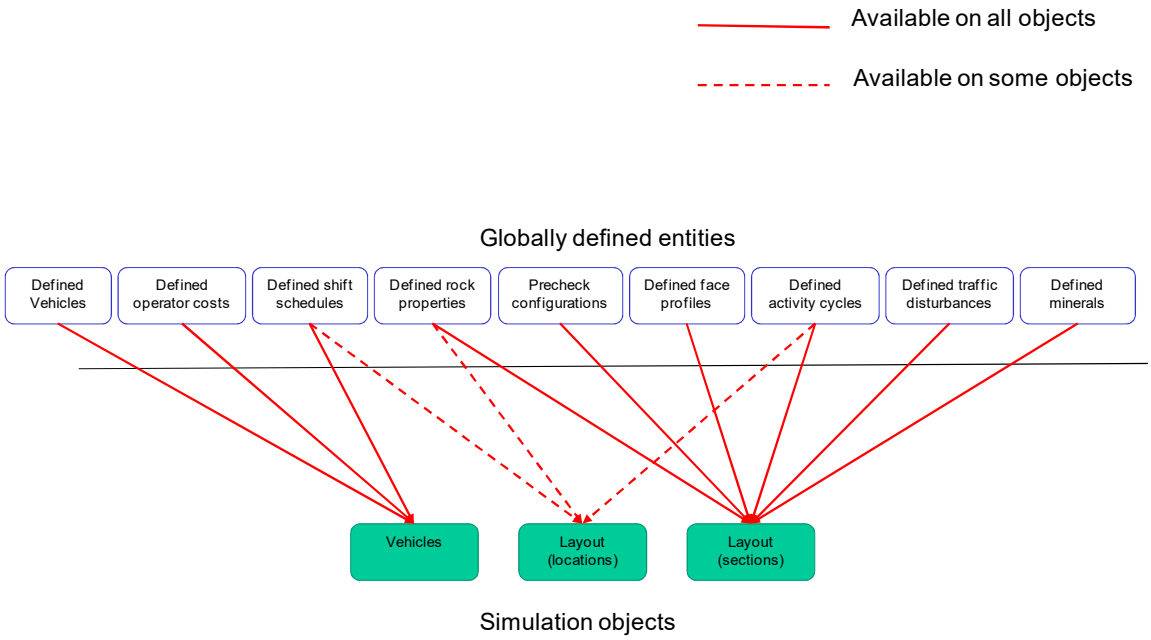


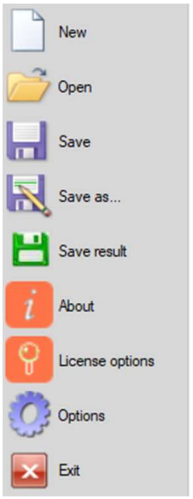
Figure 4-3 Schematic structure

4.3.2 Where is data stored for simulation models?

All simulation models created in SimMine, which are saved, are stored in a database. No files are created when a new save is done. There is no file dialog box asking for a location where to save the simulation model.
When you click “Open” to open a previously saved simulation, the list of simulations shown is all simulations that exist in the current database.
Different databases can be used, and each database will have its own simulations.
To set which database is used, see Change database on page 31 for further instructions.

4.4 Simulation model operations

Simulation model operations include operations for creating new models, loading and saving existing models, as well as deleting existing models. These operations are accessed through the system menu (see Main window on page 20 for more information) and through Import/export functions located in the ribbon.



4.4.1 New simulation

Create a new simulation by clicking the “New” menu option.
This will open up the new simulation dialog box as seen below:

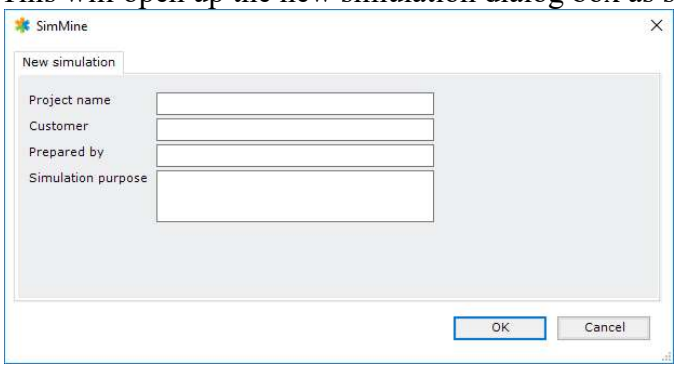


Figure 4-4 New simulation model

Fill in the project name, Customer and prepared by. Simulation purpose is not required.
Click ***OK*** to accept. This will create an empty simulation project. You will return to the main window.
After you have returned to the main window, you can start to enter simulation data in the input tabs. See input interfaces on page 76 for more information.

4.4.2 Open a simulation

To open a previously saved simulation, click the ***Open*** menu option. The open simulation dialog box shows. All save simulation models in the current database is listed:

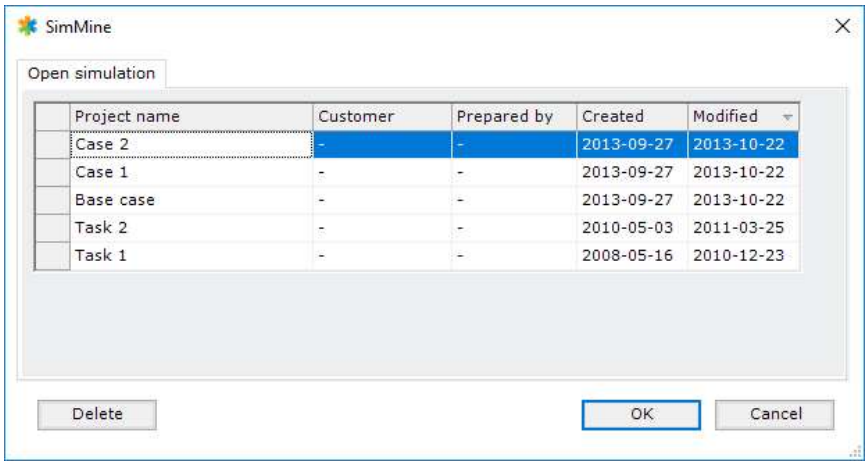


Figure 4-5 Open simulation model

Select the simulation to open by left clicking on the row containing the simulation model to open. The selected simulation model row will become blue. Click "OK" to open the simulation. You can select multiple models to open, which will then open all selected models at once. The opened simulation(s) can now be used.

4.4.3 Delete a simulation

To delete a previously saved simulation, click the ***Open*** menu option. The open simulation dialog box shows:

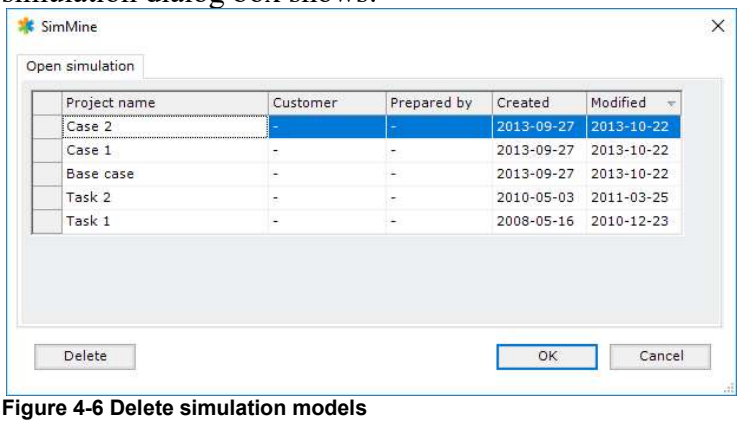


Figure 4-6 Delete simulation models

Select the simulations to delete by left clicking on the row containing the simulation. The selected simulation row will become blue. To select more than one simulation, hold the CTRL or Shift key while selecting more simulation models.
Click ***Delete*** button to delete all selected simulations. A question will appear to verify that you want to delete the simulations, before performing the delete.

4.4.4 Save a simulation

To save the current simulation, click the ***Save*** menu option.
If this is the first time the current simulation is saved, a save as dialog box appears where you can enter simulation file properties (similar to the new dialog box). If the simulation has been saved before, no dialog box will appear.

4.4.5 Save with a new name

To save the current simulation, click the ***Save as*** menu option. A save as simulation dialog box shows:

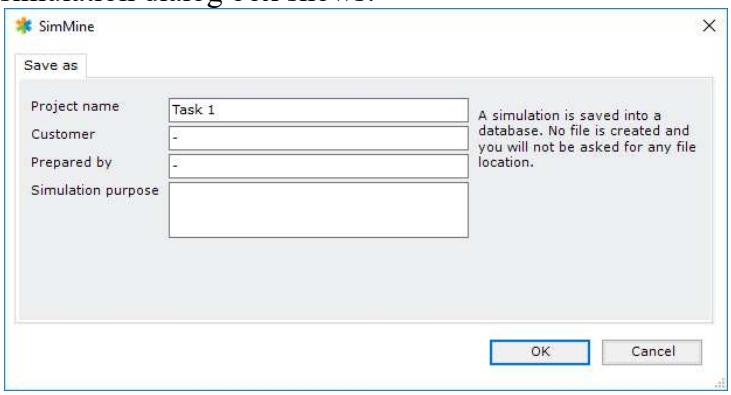


Figure 4-7 Save a simulation with a new name

Write the new information for the simulation and then click ***OK*** to save it. All saved simulation models will be saved to the currently active database, so you will not be asked for any file name or file location. If a simulation model with the same name already exists in the database, you will be asked if you want to overwrite it. Only the input data is saved. Any results that exist will not be saved.
When the save is complete, you are returned to the main interface.

4.4.6 Save results from a simulation

In normal cases, when you save a simulation model, only the input data is saved. After a successful simulation run, there exist output data (results). To save the results along with the input data, click the “Save result” menu option
This will work in the same manner as the save as function described earlier, but will also include the results. This is useful if the simulation run will take much time to complete, so you can quickly recall any results from the simulation run without the need to run it again.

4.4.7 About

This option opens up the about dialog box, which shows version information for SimMine.

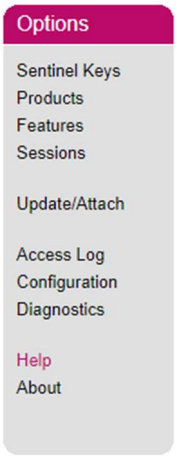
4.4.8 License options

The license options allows the user to specifically select from where its license will be taken (i.e. which license key). This opens up the license options dialog box:

Figure 4-8 - License options

Here, either default behaviour, which is to take a license from the first available key (not the first available license). If this is not desired, for example if there is a trial key with more licenses on it, you can specify which license key ID to search for and use. The possible license key IDs which are discovered by the computer can be retrieved by opening a web browser, and go to http://localhost:1947

It will show license key information. In the top-left corner is a menu as:



Click on the link ***Sentinel keys***, to open up a list of discovered sentinel keys. In that list, there is a column for ***Key ID***, which you can use in the license options dialog box to select a specific key to use.

4.4.9 Options

This option dialog has options for how the simulator processes continuous flows. Continuous flows are flows which doesn't have a fixed time interval between events, but instead has a flow of rock which happens all the time (at least during operational hours). This can for example be the rate at which a continuous miner loads rock onto a truck.

A lower value for the time chunk means finer grade-simulation, but the simulation will take a longer time to run since it need to process data more often.

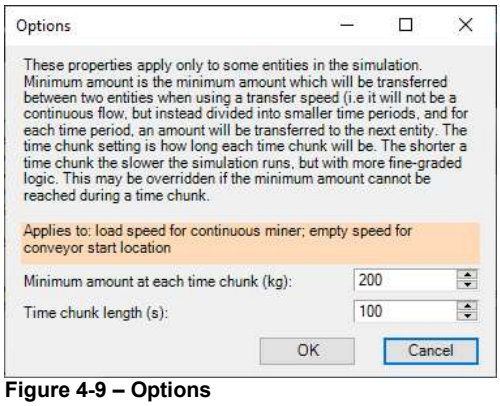


Figure 4-9 – Options

Note! This only applies to the continuous flow for a continuous miner and conveyor start locations. More entities will be included which obey to these settings later on

The options available here are:

MINIMUM AMOUNT AT EACH TIME CHUNK

This is the minimum amount that will be transferred at each time interval when there is a continuous flow or rock. This is the primary setting for controlling how big each time chunk will be.

TIME CHUNK LENGTH

The length, in seconds, of each time chunk. This is how the continuous flow is divided. If the time chunk results in a too low amount at each time chunk as specified in the **MINIMUM AMOUNT AT EACH TIME CHUNK** the length of each time chunk is expanded.

Example: Assume that a continuous miner has a load rate of 10 ton/h, and minimum amount at each time chunk is set to 200kg, and the time chunk is set to 20 seconds. It means that if will continuously load 10000/3600 kg/second = 2.78kg/sec = 55.56kg/20 seconds. Since this is less than the minimum amount per time chunk, the time chunk is set to 200/2,78 = 72 seconds. It means that every 72 seconds, 200 kg will be loaded onto a truck (or whichever the destination is for the continuous miner)

4.4.10 Change model properties

The properties associated with a simulation model (project name, customer, performed by etc.), is set when you create a new simulation or use the ***Save as*** function. To change these properties without having to re-save a simulation model you can open the model properties dialog box. This is accessible through the ***Settings/data*** ribbon tab, under ***Simulation properties*** group.

4.4.11 Export a simulation to a file

A simulation is normally saved in the current database. To be able to transfer a simulation to another database on the same or a different computer, export/import is used.
Export will data to a file, which can later on be imported into another database.
The data that can be exported to a file is:

- Global data
  - This will export global data, which then can be used by simulations in another database after they have been imported in the other database.
- One or more simulations
  - For each exported simulation, all the global data that is used by that simulation is also exported. When the simulation is imported, the global data is also imported (if it doesn't already exist), so that the simulation model can be used as it was in the database from where it was exported.

To export a simulation, do as below:
Click ***Export*** button in the ***Import/Export*** group in the ***Settings/Data*** tab. An export wizard appears:

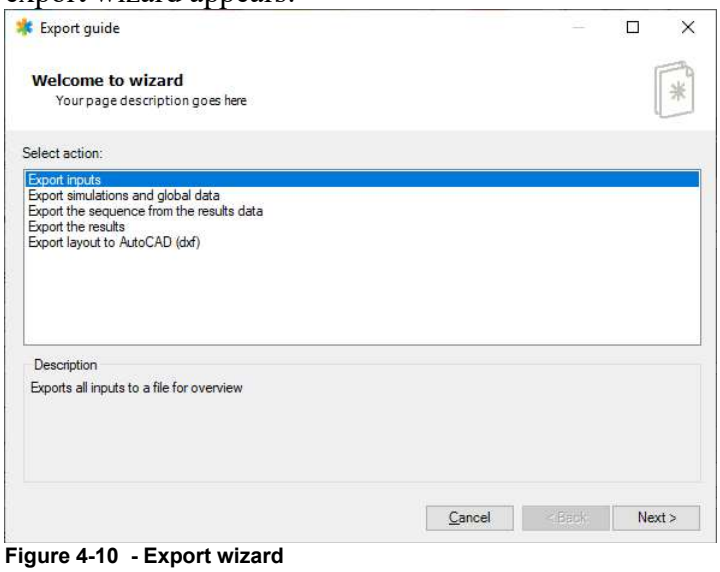


Figure 4-10 - Export wizard

In the export wizard, a number of export options is shown. The actual number and types of exports depends on the current SimMine license.
Select ***Import simulations and global data*** option and click ***Next***

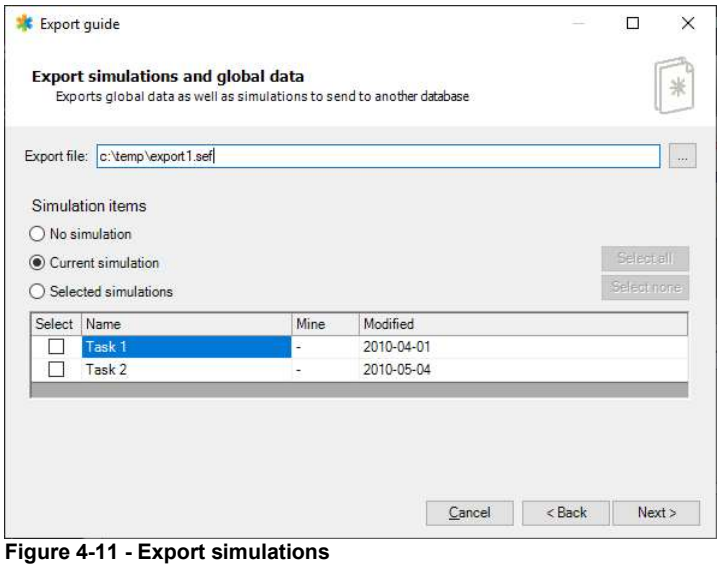


Figure 4-11 - Export simulations

Select which file to export to, and which simulations that shall be exported. If the option ***No simulation*** is selected, only selected global data will be exported. Global data is selected in the next step in the wizard. Several simulations can be exported in the same export file.

Click Next when done in this step

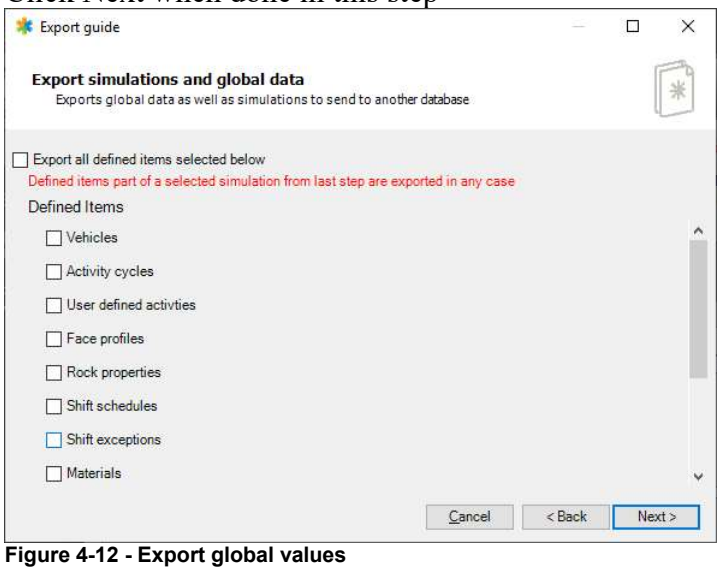


Figure 4-12 - Export global values

Select which global data to export. Note that if at least one simulation is selected from the previous step, all global data required for the exported simulations will also be exported. This step is only if any additional global data shall be exported. Click ***Next*** when done. The export will be done.

4.4.12 Import a simulation

Import of a simulation is done when global data or simulations shall be transferred between different databases, or that a backup shall be restored.

The import function is found in the ***Settings/Data*** tab, under the ***Import/Export*** group (see Figure 4-1 Main window on page 20 for information about the ribbon)

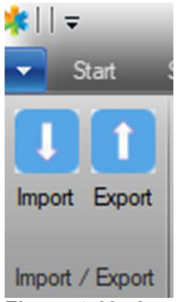
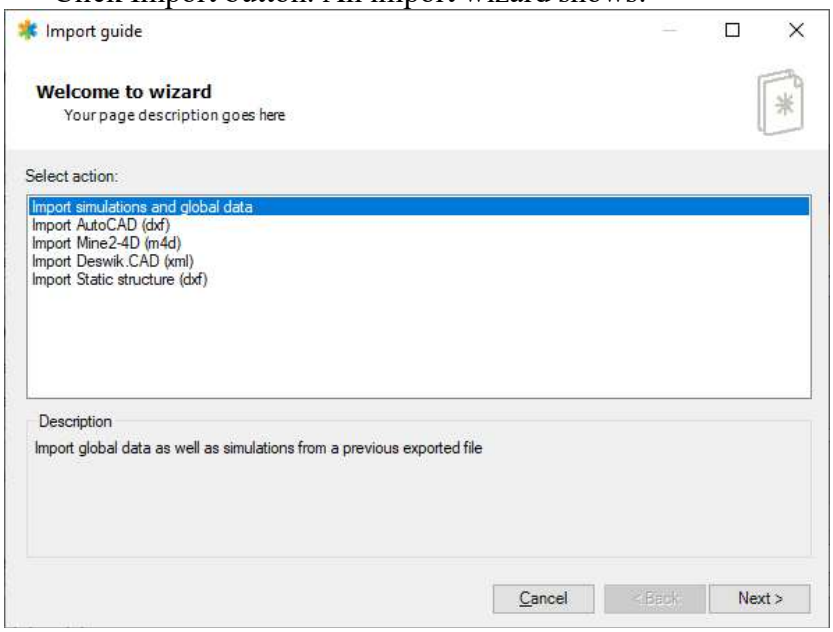


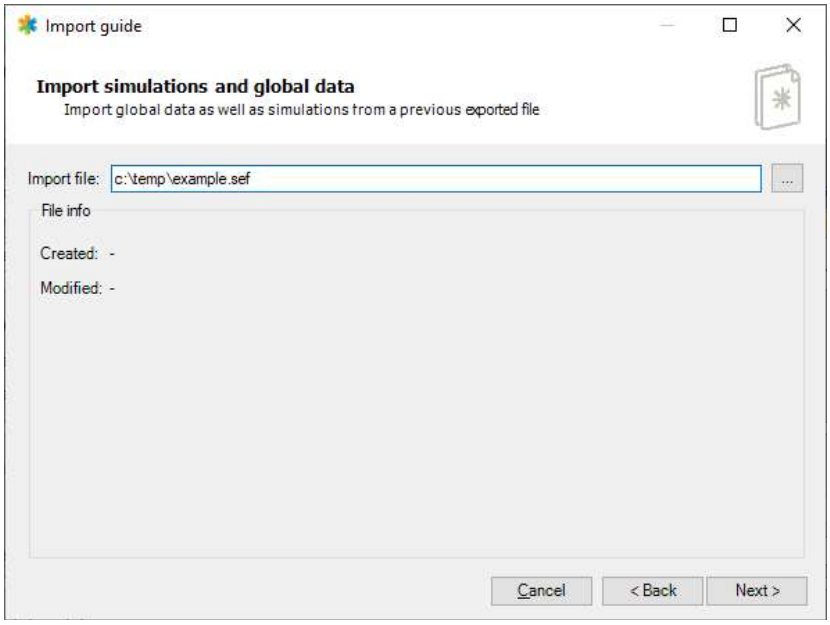
Figure 4-13 - Import and export buttons

To import a previously exported file which contains simulation data, do as:

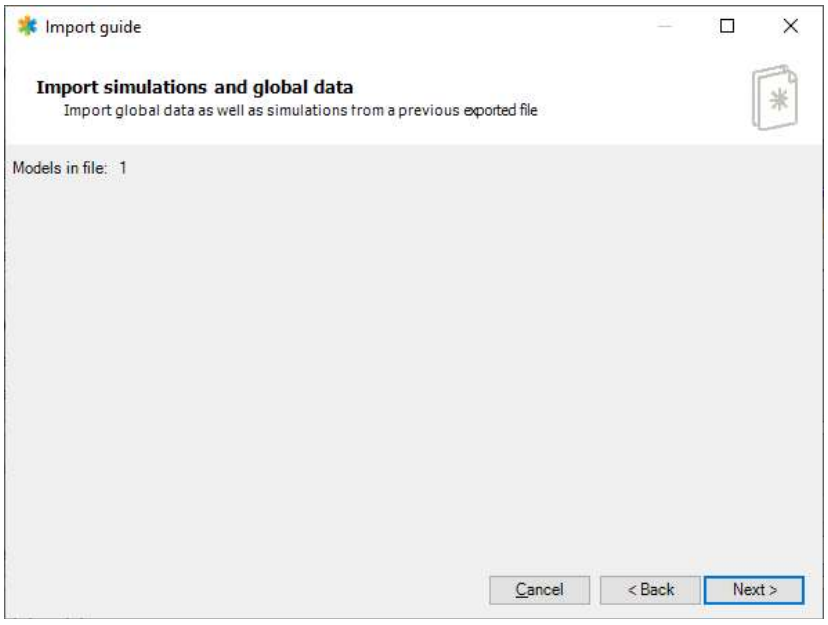
- Click Import button. An import wizard shows:



- Select ***Import simulations and global data*** from the list of available import formats. Click ***Next***.



- Select the file containing the data to import. Click ***Next***



- In the last step, and data which exist in the import file and in the current database is listed. At this point, the user can select which data to overwrite (i.e. take from the import file and overwrite the same information in the database). In the above list, no data exists in the database which can be overwritten from data in the import file. Click ***Next*** when done.
- The file is now imported into the database and the wizard will close when the import is complete. The imported simulation models can be seen when you click ***Open*** to open an existing model.

4.5 Database management tasks

In SimMine, the data created, is stored in a SQL Server database. When the common files are installed, a database engine named SQLSIMMINE is installed, which contains the default database used by SimMine. This can be started to be used directly after installing SimMine without any further steps.

4.5.1 Change database

In situations when a new database is required, or that data shall be sent to other persons, there exist a set of database management tasks which will aid the user in doing basic database tasks.

The database management tasks are found in the ***Settings/Data*** tab, under the ***Database*** group

Figure 4-14 - Database tasks

4.5.2 Select SQL database to use

Click the ***SQL database*** button to open up the SQL connection dialog. It allows the user to select which database to use. The reasons to use another database may vary, but remember that each database can only store one set of global data. If you will start work with simulations for another mine, which has a new set of global data, a new database is a good option to limit the number of different global data that needs to be defined in a database. The database must already exist for this to work. The connection dialog is shown below:

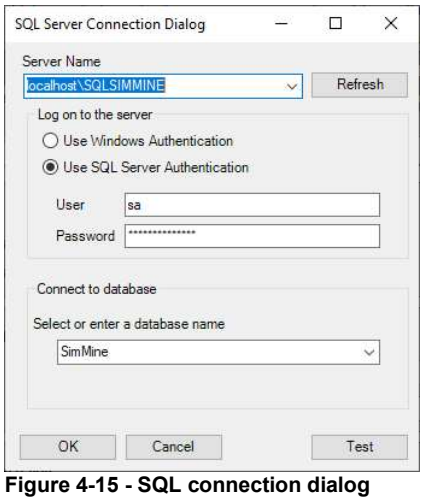


Figure 4-15 - SQL connection dialog

Server Name dropdown list

This is which database server to use. Click the Refresh button to refresh the list of discovered SQL servers. The dropdown list only contains SQL Servers which can be discovered (i.e. there is a service called SQL Server Browser, which by default is not started. This service is responsible for publishing which SQL Servers that exist on a particular computer). Even though an SQL Server isn't listed in the dropdown list, you can manually enter the SQL server name if you know it.

Log on to the server panel

This hold settings to specify credentials required to access the databases on the particular SQL server selected.

Select or enter a database name dropdown list

This list holds all databases on the selected SQL Server. Select which database to use.

4.5.3 Perform database tasks

Database tasks, such as backup and creation of new databases is done through the Database tools in the Database group in the application ribbon bar.
When this is clicked, the database tool window appears:

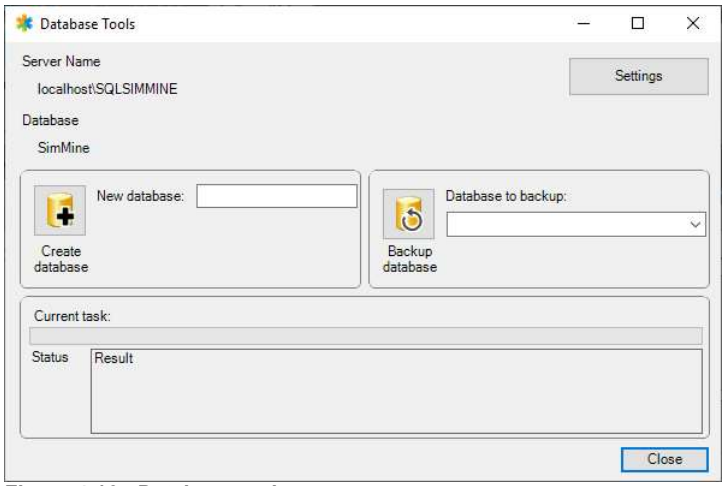


Figure 4-16 - Database tools

4.5.3.1 Database tool window description

Server name label

This shows the current SQL Server which holds the current database

Database label

This shows the current database which is used.

Settings button

This shows a dialog box where a backup path can be entered. The database backup path is where database backups will be placed.

Tool panels

There are two tools to perform; New database and Backup database. See below for further information how these are used.

Status view

At the bottom is a status panel which shows the status of the last task performed. It will show success, or if anything didn't work as intended, it will show an error message.

4.5.3.2 Create a new database

To create a new database, the current logged in user must have permissions to create a database. If the default SimMine database server is used, the user has permissions to create a database. If another database server is used, which isn't provided by SimMine, ensure that the current SQL user (specified in the SQL connection dialog at Select SQL database to use on page 32)

Enter a name for the new database in the textbox next to the **Create database** button. Click the button to create the database.

When the operation finish, a success message will be printed in the status box at the bottom.

4.5.3.3 Backup a database

To back up the current database, either for backup purposes or to send the database to SimMine (or other parties), select the database to back up in the Database to backup dropdown list. Click the Backup database when done. A success message will show in the status box at the bottom.

Note! The database backup is saved in the database backup folder, which is specified in the Settings button at the top. The SQL Server service logon user account must have permissions to the backup folder. Otherwise the backup will fail. If an error message appears in the status box, stating that there are access permission issues, ask your system administrator to assign correct permissions to the SQL database service user.

4.6 Other functionality

4.6.1 Run a simulation

To simulate your current model, you can simulate with or without animation. The animation doesn't change any results, but has a value in that the model can be visually verified (i.e. that the sequence and development are correct), and also for presentation, when the future of a mine needs to be shown and discussed.
The simulation controls are found in the ***Start*** tab, under the ***Simulation*** group in the ribbon bar.

Figure 4-17 - Simulation group

To start a simulation, click the ***Start simulation*** button. Checks will be made if the model is correct. If there are any errors, an error message will show the found error(s). A simulation cannot start if there are model errors.
The simulation could either run with or without animation. This is decided by the Use animation button. When this button is green (as above), animation will be used. When it is grey as seen below, the simulation will run without animation.

Figure 4-18 - no animation

A simulation model which runs without animation will run faster than a model that runs with animation.

4.6.2 Simulation state and success state

You can follow the progress of your simulation in the simulation status panel, which will open when a simulation is started. When the simulation status panel is shown, it will always show until the user closes it.

Figure 4-19 - Simulation status and progress

The simulation status shows the time in the current simulation, as well as its state. There will be one row for each run simulation. If the same simulation model is run multiple times, it will create multiple rows.
When a simulation finish, it will state Simulation finished in the status column, together with the total run time (wall clock time)
The color of each row shows the state of a simulation as:

Ongoing simulation without any issues
Finished simulation without any issues
Ongoing simulation, but with issues
Finished simulation, but with issues

To check which issues a simulation had, select the row which contains the simulation to examine, and then click the log book symbol to the left. An event window will open which holds any warning that has occurred during the simulation.

5 Create your first simulation model

This tutorial shows the steps involved in creating a basic simulation model. The simulation model that is created here is not created due to that a problem exist in a mine that shall be investigated. It is merely a short walkthrough in what is required for a very basic simulation model.

When SimMine has started up, you will see the main interface.

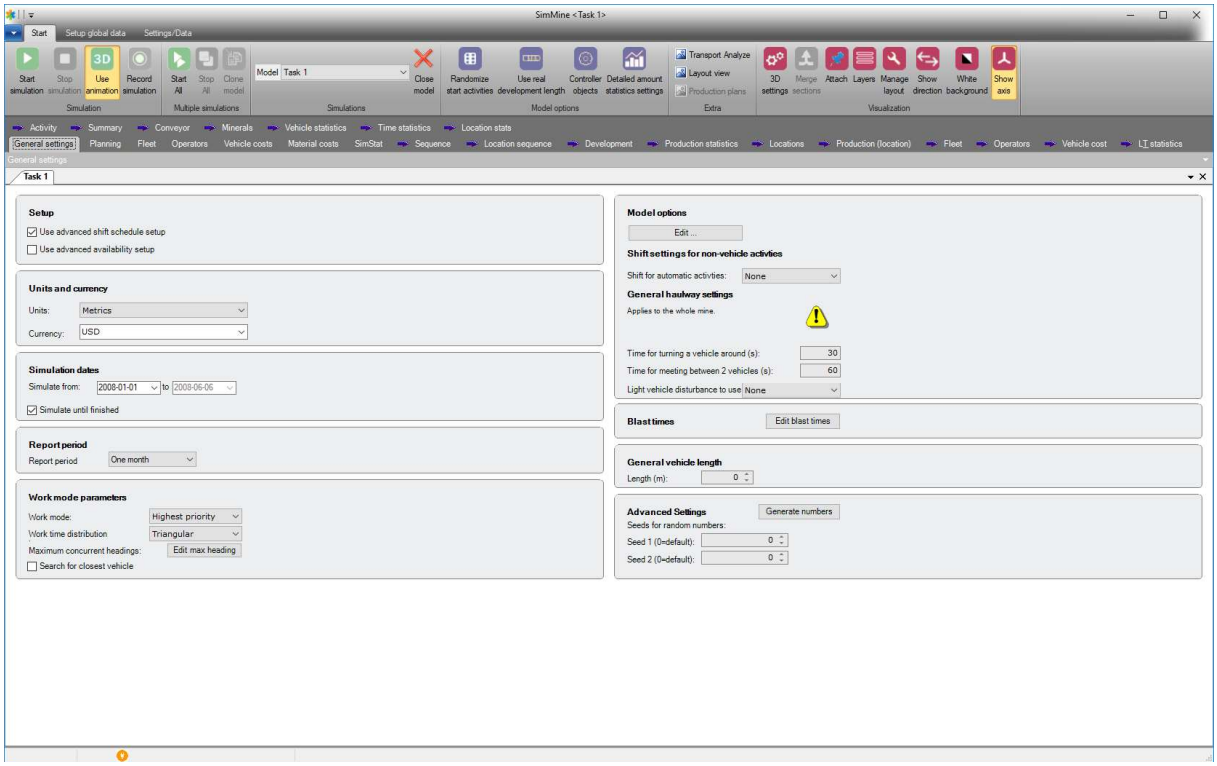


Figure 5-1 Main interface

When SimMine is started the first time, it has already created a new model. If you have already created a model, or opened an existing one, you need to start by creating a new model by clicking “New” in the system menu (the small arrow in the left top corner of the ribbon menu).

5.1 Model definition

The model that shall be created will contain a small mine layout that consists of a main drift with a crusher at one end. At the other end there will be two sections that shall be developed. All blasted rock shall be transported to the crusher by a loader. The development cycle is simplified and contains only a few activities:

- Face drilling
- Charging
- Blasting
- Loading and transport

5.2 Model building

To build the simple simulation model, the following things are required:

1. Define global data, which includes:
    a. The vehicles that will be used to perform the activities. The vehicle definition holds the type of vehicle and their travel speeds.
    b. The face profile for the development sections. The face profile contains a property for face area, which in turn will affect the amount blasted, based on the drilled length (i.e. the blasted drift length, and not the actual length that was drilled)
    c. The activity cycle, which will contain the 4 activities stated in the model definition.
    d. The rock property for the development sections. This holds rock type (ore or waste), and rock density, which will affect the blasted amount.
2. Setup common simulation options for the model
3. Create the layout with correct properties
    a. The properties include what to do, and any constraints that may exist.
    b. The properties also include which face profile, rock property and activity cycle shall be used for the development sections.
    c. No data for how fast each activity is done is entered here. It belongs to the vehicles.
4. Specify which vehicles to use
5. Run a simulation and analyze the results
    a. The analyze part is not covered here, but should be the way to go in a real simulation project.

5.2.1 Step 1: Define global data

The global data is defined through the "Setup global data" ribbon tab. In this tab, each type of global data can be setup:

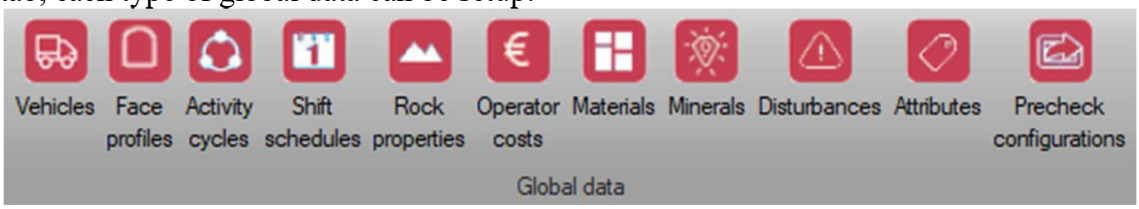


Figure 5-2 Global data ribbon group

5.2.1.1 Vehicle definitions

Define the vehicles which shall participate in the simulation model. When the vehicles have been defined that can be reused in many simulation models. Click on the ***Vehicles*** button to open up the vehicle definition window.

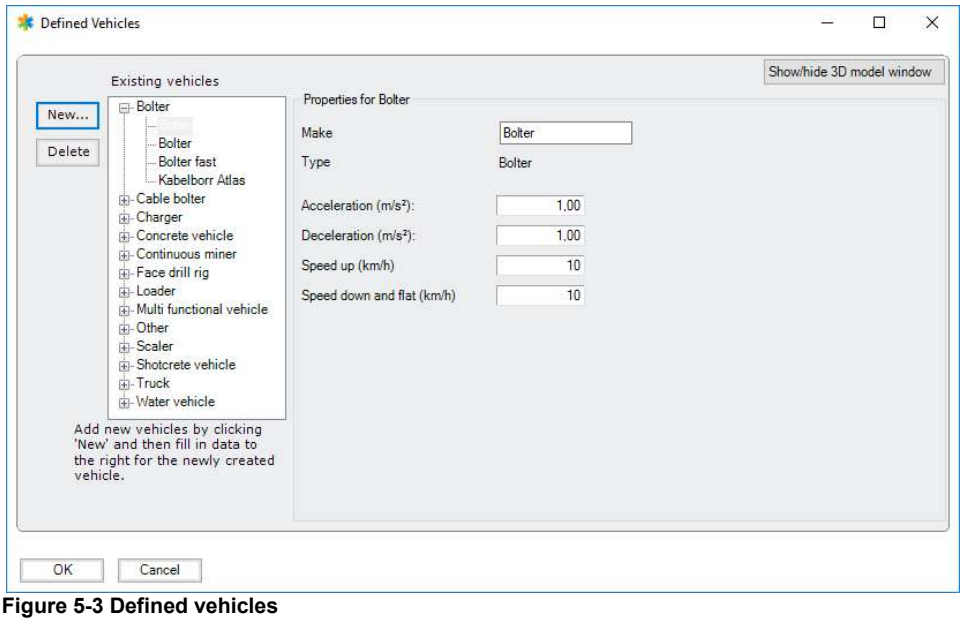


Figure 5-3 Defined vehicles

Note! In the screen shot above, there are already some defined vehicles. This list can differ from the list shown in your version of SimMine.

Click the ***New*** button. In the dialog box which appears, enter the vehicle name and type. Click OK. The vehicle is added in the list of defined vehicles and selected. The properties are shown to the right for the selected, newly created vehicle. Enter data for the vehicle.
Do the above for each vehicle type that will be used. In this model, we will use three different vehicle types:

- Face drill rig for face drilling activity. Name it “Drill tutorial”
- Charger, for the charging activity. Name it “Charger tutorial”
- Loader, for the loading and transport activity. Name it “Loader tutorial”

No vehicle will be created for the blast activity. It is modelled as automatic without any need for a vehicle. Click OK when all vehicles are created. This will close the dialog window. The vehicles are automatically saved as global data to the database and can be used in any simulation.
For further information, see page 58,Vehicles.

5.2.1.2 Face profiles

Next select ***Face profiles*** from the global setup group. This opens up the face profiles window. Defined face profiles can then be assigned to development sections to give the section values for face area and width of haul way.

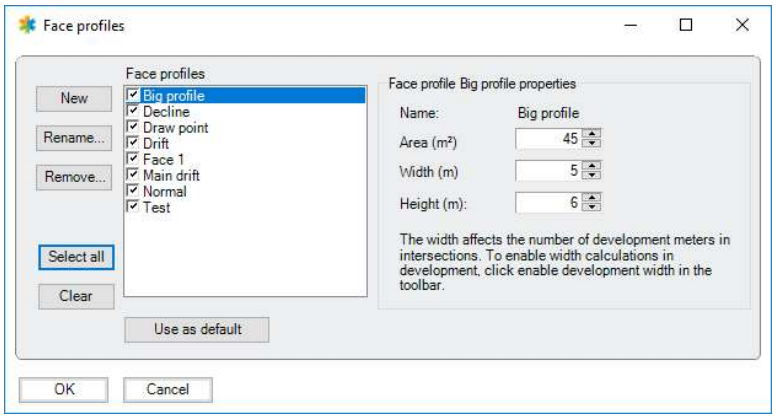


Figure 5-4 Face profiles

We shall create one face profile to use for both of the development sections in this tutorial. Create a new face profile by clicking the ***New*** button. Give the face profile the name "Face tutorial" and click OK in the "Create new face" dialog box that appears. The newly created face profile is added to the list of face profiles and selected. Its properties are shown to the right.
Note! In the dialog box, there is a property Height. This property is only visible when the license for SimMine contains the Graphics+ option.
Set the face profile area to 35 m^2, and its width to 6m. Click OK to save and close the face profile dialog. The face profile is saved in the global data in the active database.
For more information, see, page 59, Face profiles.

5.2.1.3 Activity cycles

Next select ***Activity cycles*** from the global setup group. This opens up the Activity cycles windows where you can create your activity cycles. The activity cycles can be assigned to development sections for which they define which activities that will be performed in the development cycle.

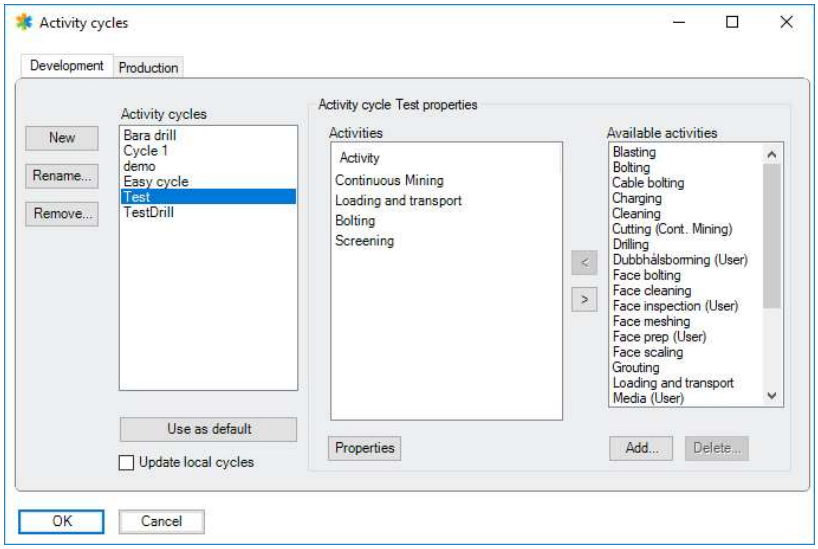


Figure 5-5 Activity cycles

Create a new activity cycle by clicking ***New*** and give it the name "Cycle tutorial". The newly created cycle is added to the list of defined activity cycles

and selected. The list in the center shows which activities the selected activity cycle contains, which is none at this point when it is just created.
Add all activities that shall be part of the newly created activity cycle from the list to the right to the list in the middle. In this example, the cycle contains 4 activities – drilling, charging, blasting and loading and transport. To add them, repeat the steps below:

1. Select the activity to add from the list to the right
2. Click to add button (<). The activity is added to the center list

After all four activities have been added, we will set that each activity will require a vehicle, except the blast activity. Enter activity properties in the center list by highlighting the activity and clicking ***Properties***, or double-click on the activity. A property window is shown:

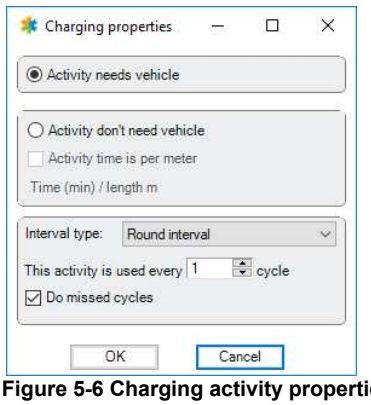


Figure 5-6 Charging activity properties

The look of the property window differs depending on which activity is show properties for. In this tutorial, ensure that all activities have the radio button ***Activity needs vehicle*** checked, except for the blast activity which shall have the radio button ***Activity don't need a vehicle*** checked. All other properties shall be left untouched.

See Activity cycles on page 60, for more info regarding how to setup activity cycles.

5.2.1.4 Rock properties

Next select ***Rock properties*** from the global setup group. This opens up the rock properties window. Defined rock properties can then be assigned to development sections to give the section values for its rock.

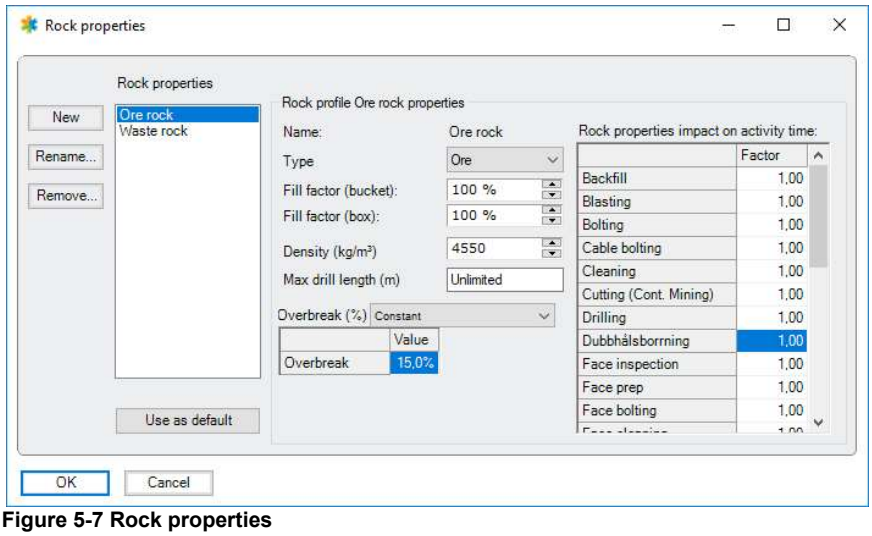


Figure 5-7 Rock properties

We shall create one rock property to use for both of the development sections in this tutorial. Create a new rock property by clicking the ***New*** button. Give the rock property the name “Waste tutorial” and click OK in the “Create new rock” dialog box that appears. The newly created rock property is added to the list of rock properties and selected. Its properties are shown to the right.

Set the rock properties as:

- Type to Waste
- Fill factors to 100
- Density to 2700
- Leave all other properties untouched

Click OK to save and close the dialog. The rock property is saved in the global data in the active database.
For more information, see, page 70, Rock properties

5.2.2 Step 2: Set common simulation options

At this point, we have defined all global data that is needed in our test simulation. It is now time to start entering data for the simulation model. Simulation model data is found in the ***Simulation data*** area (see Figure 4-1 Main window). Simulation model tabs, seen in the same figure. Select the ***General settings*** tab. The general settings show up in simulation data area as:

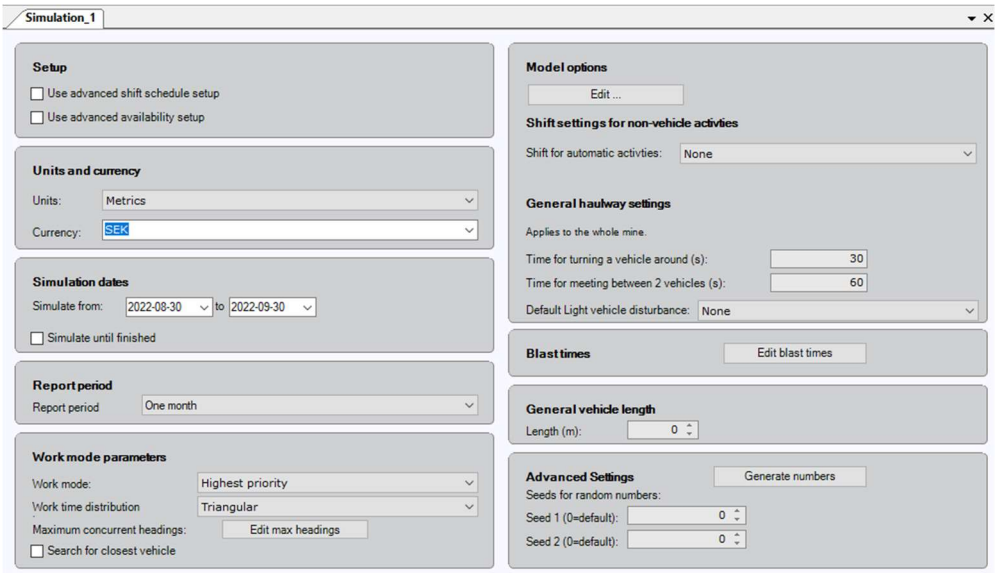


Figure 5-8 - General settings

There are different setup modes which allows the shifts and availability for vehicle to be specified with different level of details. This example describes how to configure a basic simulation with as easy as possible setup for shifts and availability.
The following common simulation options are set:

- Unit system is set to metric, which uses meters as distance, metric tons etc.
- Set currency to SEK. The dropdown list contains a number of preset currencies. If another currency is desired, write the currency text in the dropdown. The currency is just for presentation in all the forms and doesn't involve any convert rate when switching between currencies.
- As simulation period, set the period to the current month. Do not check the option to ***Simulate until finished***. This option will simulate until all development, production and loading is complete. As stated in Tips and advices on page 16, you should start with a simple model, and add more options as you go. If there are any configuration error in the model, and this option is set, the model may run forever. To prevent this, select a fixed simulation period.
- As report period, set "One month". This is how often results are gathered.
- Vehicle meeting time and turn-around time, you can leave the defaults, even if they seem a bit high. These values are the times it takes for two vehicles to meet each other in a haul way, and how long time it takes for a vehicle to turn around (i.e. to change its travel direction). See Set time for turn-around and meetings on page 83 for more information for these options.

When this is done, we have specified that we want our model to run for one month, with easy setup for shifts and availability. We have also set which currency all costs shall be presented in (even if no costs will be specified in this tutorial).

There exist several default values, which are not visible in the general settings tab, which defines how vehicles are allowed to meet in the mine. These will be used in this tutorial when the layout is defined.

The settings in general settings are further explained in General settings on page 79.

5.2.3 Step 3: Planning (layout)

To describe the mine that you want to test in your simulation model you need to import or draw the mine layout in SimMine.

In this tutorial we will draw the layout in SimMine. A better option is to import the mine layout from the mine's CAD-program. This ensures that all distances are correct, and that the mine (the customer) recognizes their own mine.

Switch to the Planning tab to show the layout as:

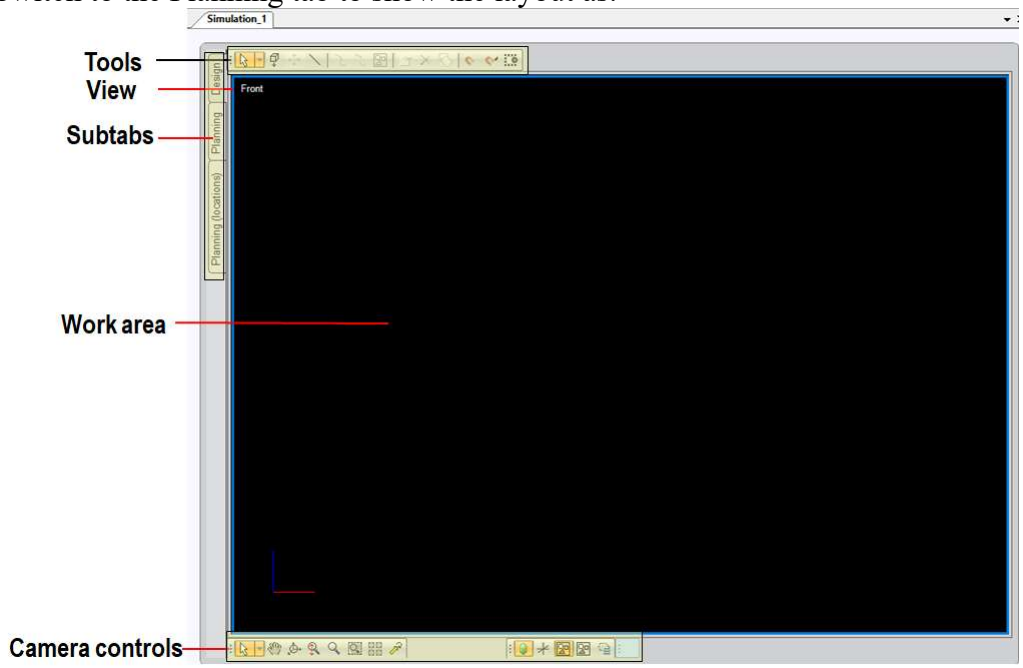


Figure 5-9 Planning tab

The figure above contains the following parts:

Tools

These allow you to select, create and modify the layout. The fourth tool ( ) is later used to draw new lines in the layout. This is the tool to use when we will draw our layout.

View

This shows in which perspective the layout is shown from. To change the view, right-click this label and select the view to show. The view can also be rotated with the camera controls

Subtabs

These holds different lists for the sections and objects which are part of the layout. The first subtab, the *Planning* tab does only show the 3D layout work area without any list

Work area

In the work area, the 3D layout is shown.

Camera controls

With the camera control, the layout can be shown from different angles or positions. As soon as the layout is rotated, the view mod label at the top switches to “Perspective”

Note! A common mode of operation for various tools, is that the left mouse button places a point or object, and the right mouse button confirms the set location. Example: When a line is drawn, it will continue to be drawn until the right mouse button is clicked to confirm the end of the line.
We will in this tutorial draw the layout our self, and since it is hard to draw a layout equal to the description here, this tutorial will describe the required steps without focus on exact values from the manual drawing. The intention is to draw a layout similar to the picture below. The distances are approximate and can differ in the final layout.

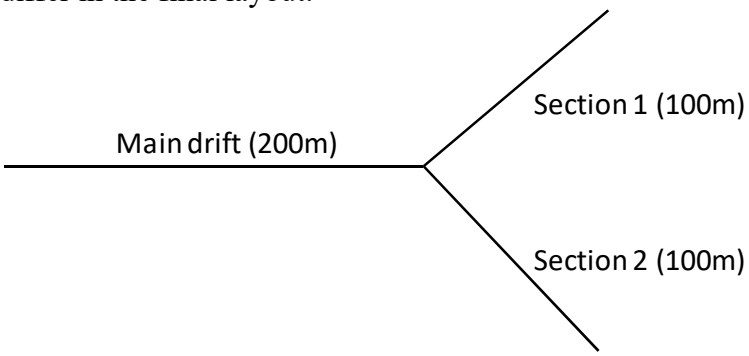
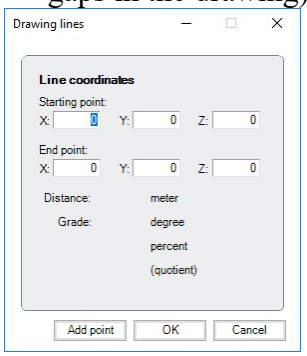


Figure 5-10 Layout in tutorial

Draw the layout by following the instructions below:

1. Switch to top view by right-click the ***View mode*** and select Top from the context menu.
2. Select the line tool from the ***Layout controls*** part. Also switch the snap function on from the ***Layout controls*** tool bar ( ) This helps to start drawing a new section from where another section ends (there will be no gaps in the drawing). The line tool window is shown:



In this window, the current length of the drawn line is shown.

3. Start drawing a line by left-click anywhere in the ***Work area***. Do not hold the left mouse button pressed.
4. Drag the mouse cursor. The line that will be created is shown while you drag the mouse cursor around. Drag the mouse to create a line approx. 200m long (distance is shown in tool window). This will become the main drift section.
5. Left-click again when the line length is approx. 200m. The line is continued when you drag the mouse cursor. At this point, right-click anywhere to finish the line. The main drift is now created.
6. You can use the camera controls, or the mouse scroll wheel to zoom out if the work area doesn’t cover enough for all sections to fit.

7. Start a new line by moving the mouse cursor close to the end of the main drift. The red cross will become green when the mouse cursor snaps to the end location. When this happens, left-click to start a new line.
8. Repeat steps 4 and 5 to create Section 1 to approx. 100m of length
9. Repeat steps 7 and 8 to create the last section, also of 100m length.

At this point, the layout should look like below:

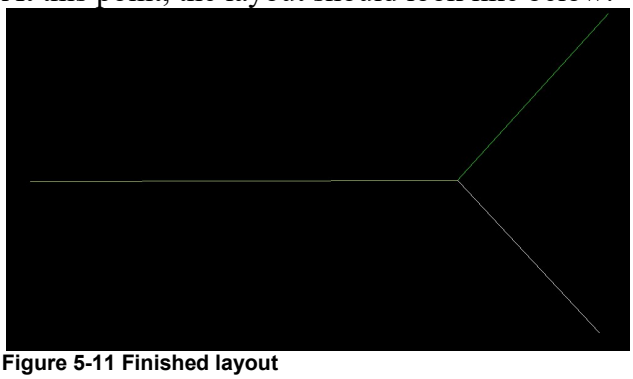


Figure 5-11 Finished layout

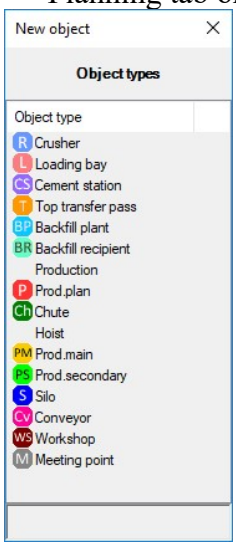
The colors of each section may differ.

The layout does now contain 3 sections. In SimMine, the layout is divided into smaller parts according to:

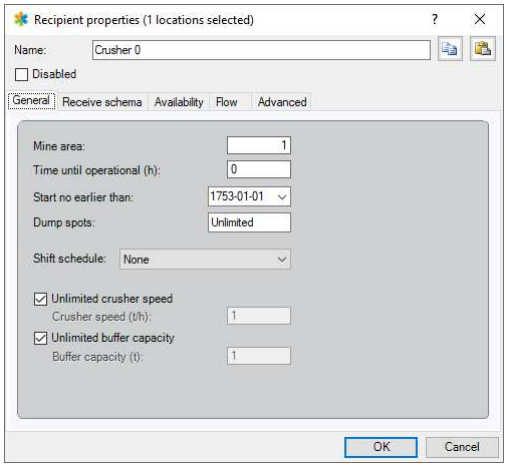
- Sections. Each section is a user defined part of the layout. One layout can consist of only one section.
- Segments. Each segment is a part without any intersections. In the example layout, each section does only contain 1 segment. If the whole layout would have been one section, that section would have contained 3 segments.
- Lines and points, which are the lines and points that the drawing contains. One segment contains one or more lines, and at least 2 points (the start and finish point)

In the layout, a crusher will exist at the left end of main drift. Place a crusher there with the following steps:

1. Check that the snap function is still active (in the ***Layout controls*** toolbar)
2. Select the Place object tool ( )from the Layout controls (see Figure 5-9 Planning tab on page 43). An object selection window shows:



3. Select the Crusher object from this list and move the mouse cursor to the open end of the main drift. The red cross will become green when the cursor snaps to the end point. Left-click to place the crusher.
4. When you are satisfied with the location of the crusher, right-click to confirm its location. If you continue to left-click elsewhere, the crusher will move to the new location.
5. Close the ***New object*** dialog box. This closes the tool.
6. Select the select tool ( ) and select the new crusher in the work area.
7. Right-click and select ***Properties*** from the context menu. The properties for the crusher show:

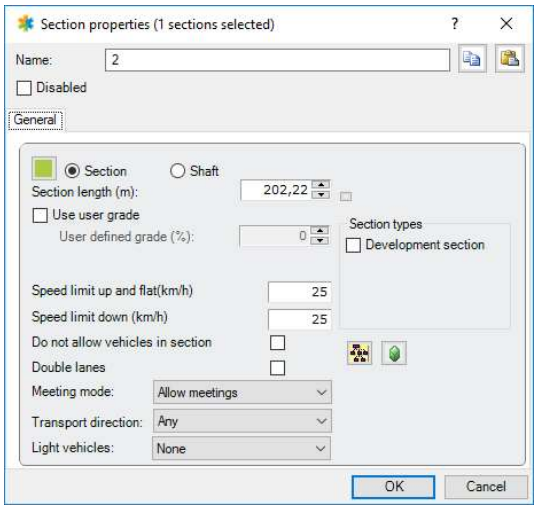


8. Set the name to “Main crusher” and click OK

Next, we will assign properties to each section. A common rule is that each section can be assigned unique properties, which means that we need to have multiple sections, since the main drift will already be developed, and section 1 and 2 will be developed during this simulation.
We will start to give properties to the main drift. It will already be developed when the simulation starts.

5.2.3.1.1 Set properties for the main drift

1. Select the Select tool ( ) from the Layout control in Figure 5-9 Planning tab on page 43.
2. Select the main drift section in the layout
3. Right-click and select ***Properties*** from the context menu. The property window shows:

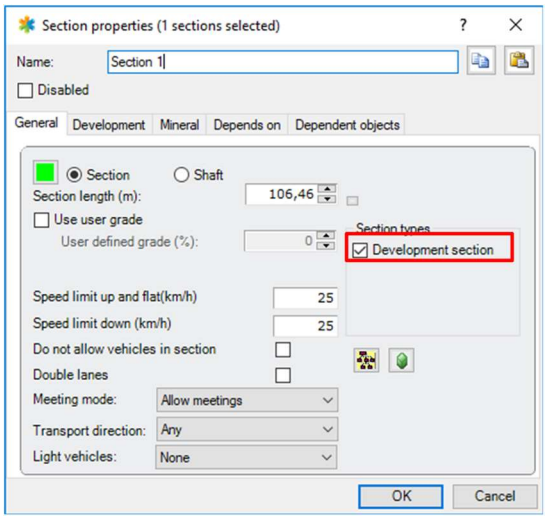


4. Set the name of the section (at the top) to “Main drift”.
5. Other properties are left untouched. However, some properties are of interest:
    a. Speed limits – the maximum allowed speed in this drift.
    b. Meeting mode – Specifies how vehicles are allowed to meet. The simplest setting is “Allow meetings”, which will cause one of the meeting vehicles to stop for a certain time. This meeting time is set in General settings tab (see page 41, Step 2: Set common simulation options). This option doesn’t require that any meeting bays exist in the mine layout, which other meeting options require.
6. Click OK to save the settings for the main drift.

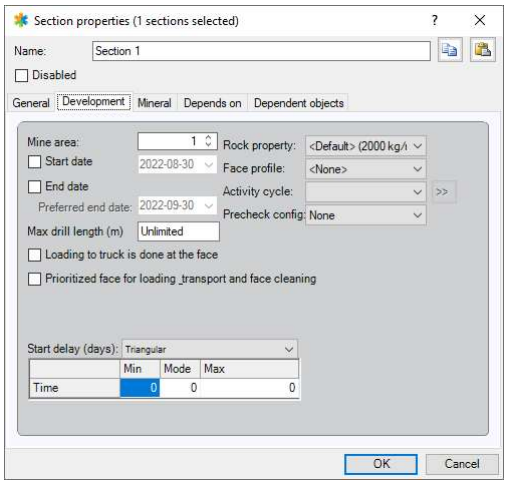
5.2.3.1.2 Set properties for the development sections

The other two sections, which will become “Section 1” and “Section 2” will be developed during the simulation, and needs more settings. The steps here will show and describe the settings required for one of the sections, but the same settings apply to the other section as well (except the name). Both sections can be selected at the same time and set properties for. This saves time when multiple sections share the same settings. However, this tutorial describes the settings when only one section at a time is set.

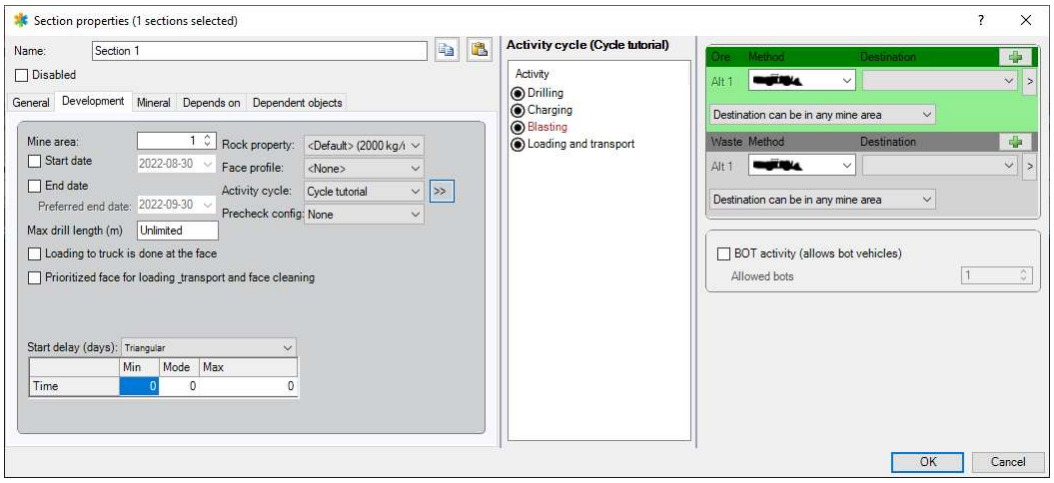
1. Select the Select tool ( ) from the Layout control in Figure 5-9 Planning tab on page 43.
2. Select the section 1 section in the layout
3. Right-click and select ***Properties*** from the context menu. The property window shows:



4. Set the name of the section (at the top) to “Section 1”.
5. Check the Development section checkbox (marked in red). When this is checked more tabs appear.
6. Other properties are left untouched.
7. Go to the “Development tab”. This is where all properties for development is set.



8. Only the properties in the red box will be set. These properties are the three main properties for a development section as they define the rock, the face area and the activities to be performed when developing this section. All these lists are filled from the global data in the active database.
    a. Assign the rock property created earlier in this tutorial (“Waste tutorial”
    b. Assign the face profile created earlier in this tutorial (“Face tutorial”)
    c. Assign the activity cycle created in this tutorial (“Cycle tutorial”)
9. If the activity cycle is not shown after the activity cycle is assigned, click on the button besides the activity cycle list to open them up. The property window will now look like:



10. When an activity cycle which contains a loading and transport activity is assigned, basic loading and transport properties are shown to the right (the part with green and gray colors). There it is possible to set method and destination for the loading and transport. To get to more advanced loading and transport properties, open them up by double-click the loading and transport activity. The loading and transport properties are how rock shall be transported *from* this section.
11. Since we have assigned a rock property for waste, we only need to set the waste properties for loading and transport (the gray part in the right-most part of the property window).
    a. Method – let the loader remain as it is since we do want only loading by a loader from this section.
    b. In the destination list, select “Main crusher”. The “Nearest destination” can be there and will behave the same as specifying the main crusher since we only have one possible destination – the main crusher. However, it will be of good practice to set this as it would be done in the real mine. Example: In the real mine, the rock from this section shall be transported to the crusher (“Main crusher”). If this destination is not set in the destination list, the waste will still be transported to the crusher, but when the model expands, and another destination is added, that new destination might be selected as a destination from this section. Since it is hard to know and keep track on all destination settings and where “Nearest destination” is set, it is easier to specify the main crusher as the destination if this is what actually will be done.
12. All other properties are left untouched.
13. Click OK to save the settings for the Section 1.
14. Do steps 1-13 for Section 2 as well.

At this point, we have created a mine layout with two development sections. We have assigned the rock property, face profile and activity cycle to them. We have also set that all waste created at them shall be transported to the main section by a loader.
Next, it is time to add the vehicles that will perform the activities.

How to section and set properties in the mine layout are further explained in section Planning on page 86.

5.2.4 Step 4: Set which vehicles shall be used

Our simulation needs some vehicles which will perform the activities. Go to the Fleet tab to show and configure the vehicles that will take part in the simulation.

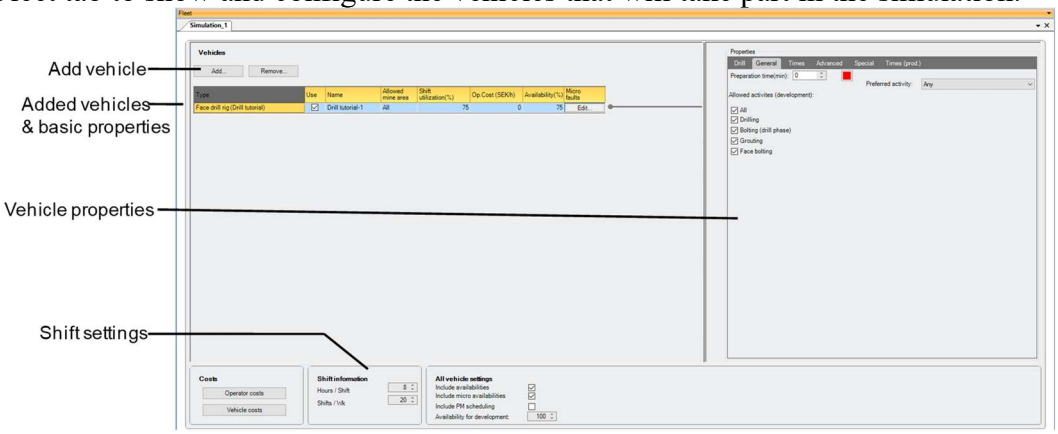


Figure 5-12 Fleet

The parts in the figure above:

Add vehicle

Click the Add button, which will show a list of all defined vehicles. That list is taken from the global data for defined vehicles (we did define 3 vehicles for this tutorial)

Added vehicles & basic properties

The list holds all added vehicles and some basic properties for them, such as vehicle name, shift settings and availability

Vehicle properties

The tabbed properties will show more properties for the selected vehicles. There is an indicator which shows for which vehicle the properties are shown (the indicator is the grey line between the added vehicles list and the vehicle properties)

Shift settings

The basic settings for how many shifts per week and length of each shift that will be used. These settings are for basic shift scheduling. For more advanced shift scheduling, this will show a button which will show the shift schedule configuration window. The shift mode (basic or advanced) is set in the ***General Settings*** tab.

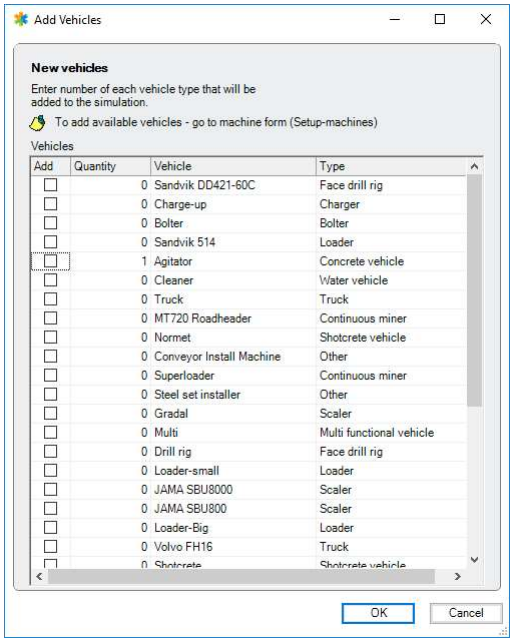
In this example we will add 3 vehicles, one for each activity type: Face drill, charger and a loader. The blast activity is without vehicle, which was configured when we specified the activity cycle.

The tasks that we shall do here are:

- Add the vehicles
- For each vehicle, specify its shift settings, availability and which activities it can perform
    - Each shift will be 8 hours and have 2 hours of lunch breaks/other breaks
- For each activity a vehicle can perform, specify how fast it is to perform the activity

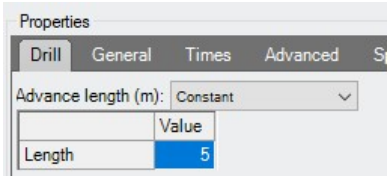
To add and configure the required vehicles, perform the following steps:

1. Specify that each shift is 8 hours, and that it is 21 shifts a week in the **Shift settings** (see Figure 5-12 Fleet). The shift length here is without any meal breaks.
2. Click the Add button. A vehicle selection dialog will show up



3. For each vehicle to add, check the Add checkbox. In this tutorial, mark the vehicles “Drill tutorial”, “Charger tutorial” and “Loader tutorial” vehicles which we created earlier. When a vehicle is marked, quantity is set to 1. At this point, you can add more than one of each vehicle. For now, add one vehicle of each type. Click OK to add and close the Add vehicle dialog box.
4. The added vehicles are now in the **Added vehicles & property list** (see Figure 5-12 Fleet)
5. Set that each vehicle will have 2 hours of breaks during each shift by entering 75% in Shift utilization column in the **Added vehicles & property list**. The shift utilization is the part of the total shift length that the vehicle is able to work. 8 hours shift length, and 75% of available work time = 8*75% = 6h. The remaining 2 hours are simulated as meal breaks. Remember to take into consideration any travel time down to the vehicle at start (and end) of each shift. This can either be done by creating shorter shifts, or decreasing shift utilization.
6. Set the availability for each vehicle to 80%. This is the mechanical availability and is the percentage of the work time the vehicle will be available for work. Example:
    a. In the shift settings, we have stated that each vehicle will have 6h or available work time each shift. Out of these 6h, the vehicle will be broken 6*20% = 1.2h on average, if the vehicle will have work all its scheduled time (6 hours per shift).
    b. If the vehicle will only work 2 hours per shift on average, it will be broken around 30 minutes. This is based on that 80% available for work during 2,5 hours, result in 2.5*80%=2hours. Since the vehicle is scheduled for 6 hours, it will still have time to work 2 hours and be broken 0.5 hours. In the simulation, the result may be that the vehicle will work for several shifts without breaking down, and then be broken more than 30 minutes each broken period.

7. When a vehicle is selected from the **Added vehicles & basic properties** list, additional properties are shown to the right. Some vehicles will have a vehicle specific property tab, while the rest of the tabs in the additional properties are the same for all vehicles. Select the drill rig so its additional properties are shown.
8. Set advance length in the drill rig specific tab ***Drill*** to a constant 5 meter. It means that the face will advance exactly 5 meter after each blast



9. Specify preparation time to 20 minutes for the drill rig in the ***General*** tab. Set the same preparation time for the charger. The loader doesn't have a preparation time.
10. Set which activities each vehicle can perform by checking the activities in the Allowed activities part in the vehicle properties: [*1]

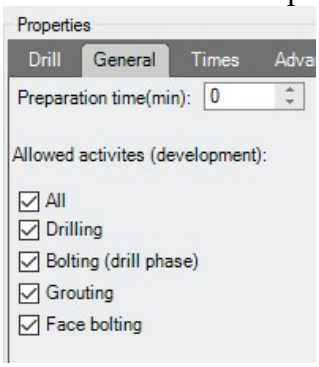
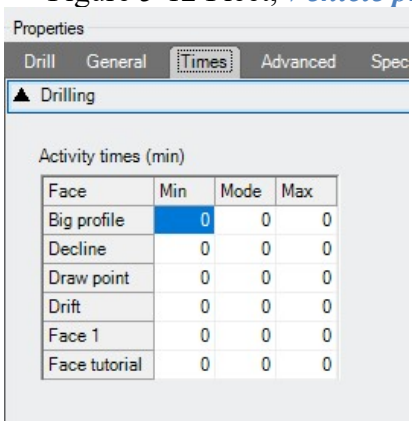


Figure 5-13 Allowed activities for drill rig

    a. Each vehicle type does have a different list of allowed activities. In the above list for the drill rig, select only ***Drilling***.
    b. For the charger, only charging exist, so that list shall not be changed
    c. For the loader, set only ***loading and transport***.

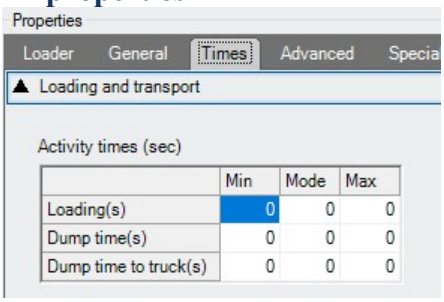
11. For each allowed activity, set how fast it can perform its activity. Do this by selecting one of the vehicles. This example shows how this is done for the drill rig, but the same apply to all vehicle types except loaders and trucks, which are described later. When the drill rig is selected in the **Added vehicles & property list**, switch to the Times tab in **Vehicle properties** (see Figure 5-12 Fleet, ***Vehicle properties***)



    a. The times tab contains activity times for each allowed activity. In this case only drilling is allowed.

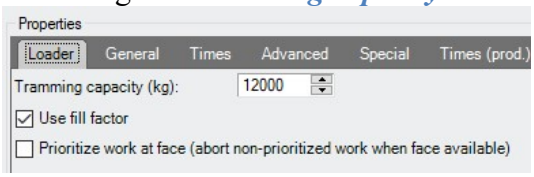
b. The activity times for drilling contain one row for each visible face profile. In this case there are 6 visible face profiles, even if they aren't used in the layout.
c. In the row for the face profile Face tutorial, set the min, mode and max values. These values are for a triangular distribution, where min and max are the min and max values, and mode is the peek value where most of the generated values comes around. Enter 60, 120 and 180 for the drill rig. Leave all other rows as they are. *2
d. Do the same for the charger, by specifying its charge time in the row for Face tutorial. Set its times to 20, 30 and 40. *3

12. For the loader, its activity times works a bit differently. Select the loader in the list of added vehicles, and switch to the ***Times*** tab in the **vehicle properties** to show its times for loading and transport



a. In this table, there are no faces, only times per load and dump for each bucket, and in seconds. Enter the times 40,45 and 50 for the load times, and 10,15 and 20 for the dump times.
b. These times are used for each bucket, so whenever the loader is loading a bucket, it will take the time to load the bucket from the ***Loading(s)*** row. Each time it will dump to a location, it will take the dump time from the ***Dump time(s)*** row, and each time it will dump onto a truck, it will take the dump time from the ***Dump time to truck(s) row***.
c. How will these fine-granular times help to achieve the correct cycle time for loading and transport from a face then? The reason why there is no total time to complete loading and transport is due to that it is highly dependent on the distance from the load point to the dump point. The time to complete loading and transport will become longer and longer when the distance increases along a section. For this reason, the loading and transport activity time must be calibrated using a known distance and a known activity time. More on this is described in Calibrate loading and transport on page 187).

13. For the loader, while it is selected, switch to the ***Loader*** tab. In there is a setting for ***Tramming capacity***. Set it to 12000 (12 tonnes).



*1 In the example of allowed activities for the drill rig, we did set that it can only perform the drill activity. In this tutorial, it wouldn't have mattered if we left all activities as allowed since there are no other activities in the only activity cycle that we are using, that can be performed by the drill rig. In a real model, it is important to set the properties for vehicles correctly, since it will be harder and harder to have a good overview of all settings done. If I do not uncheck the bolt drilling activity for the drill rig, and later on add a

bolting activity in the model, this drill rig can do the drilling. The results may then become strange if there are no times for the bolt drilling (it will take 0 seconds to perform).
*2 It is possible to filter out the face profiles that will not be used in a simulation model. This will give a cleaner user interface. The filtering is done in the Face profiles window. See Face profiles on page 59 for further info.
*3 Note the caption above the activity times. For the drill rig, it is ***Activity times (min)***, which means that the entered values are for a full activity. For the charger, it is the same, but there exist other activities where the caption is ***Activity times per length meter (min)***, which means that the total activity time is dependent on the previously done face drill activity and its advance length.

Now we are done with the vehicles. We have added the vehicles required, set their shift and availability properties, as well as specified which activities each vehicle can perform, and specified how fast they are to perform these activities.

How to set vehicle properties are further explained in Change properties for a vehicle on page 140.

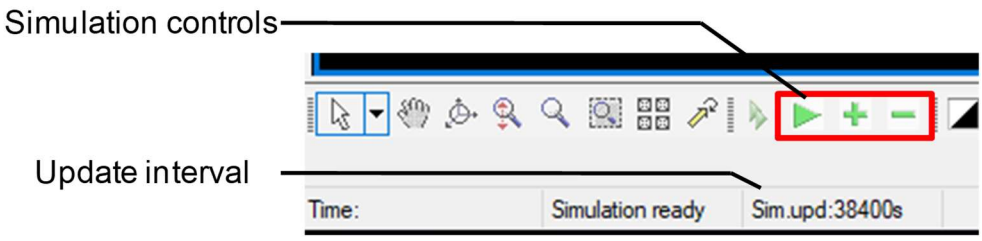
5.2.5 Step 5: Simulate

Now you are ready to start your first simulation! Before you start the simulation process you can save your settings for later editing. In the system menu, click Save. The first time the model is saved, a file property dialog is shown where you can enter information about the simulation.

A simulation can be run with or without animation. Animation doesn't change or affect any results, but is good for verification (that your development sequence is according to plan, and for demonstration purposes. It is useful in other areas as well, but once you have a configured model, while you are running the simulations for yourself, and not presenting the results, the animation will only prolong the time to simulate.
The simulation controls are found in the Simulate group under the Start ribbon tab

Start simulation button
This starts the simulation for the current model
Use animation button
This control if animation shall be used or not. When this is marked (yellow color), an animation window will open for the simulation.

If animation is used, you start the simulation from within the animation window. At the bottom of the animation window there are some animation controls:



Simulation controls

These controls allow you to start (and pause) the simulation, as well as increase/decrease the animation speed. Each click on the '+' button increases the animation speed, and a click on '-' button decreases the animation speed. The animation speed is visible in the **Update interval**

Update Interval

This shows how frequent the current simulation state is fetched and shown in the animation view. The example above shows 38400s, which is 10h40min. It means that every 10 hours and 40 minutes, the animation view will fetch the current state in the simulation and update the animation view.

In this tutorial, we will run the simulation without animation:

1. Uncheck the ***Use animation*** in the ***Simulate*** ribbon group
2. Start simulation by pressing the ***Start simulation*** button

At the bottom of the user interface, you can watch the progress of your simulation, and when it's done it will turn dark green [*1]

*1 The color of the simulation status row depends on how the run went. If there were any warnings during a simulation, the row will turn orange. The warnings can then be viewed with the button to the left (looks like a page from a notepad)

After the simulation is completed you can view and analyze the results of your simulation in the output interfaces. You are now done with the tutorial of creating your first simulation model and run it.
A more detailed description of the Output interfaces is found on page 149.

6 Global Settings

6.1 Overview

In SimMine you have many possibilities to describe your mine in order to get as correct results as possible from your simulation. A simulation model will use globally defined entities, which help speed up the model building so components can be reused between models, and also within the same model. Therefore, each database holds a set of global data (described in Simulation model structure on page 22). Each model saved in that database can use the predefined set of global data.
This part shows where and how these global data is defined.
In the ribbon bar, under the Setup global data tab, each type of global data is represented:

Figure 6-1 Global data menu

Changes made in the global data affects all simulations that use the changed global data. Some exceptions apply.
For example, changing a shift schedule, will affect all simulations that uses that shift schedule.

6.2 Common functionality

This describes common functionality in how global data is managed. Each global type is managed in the same way.
A form for global data looks like the figure below.

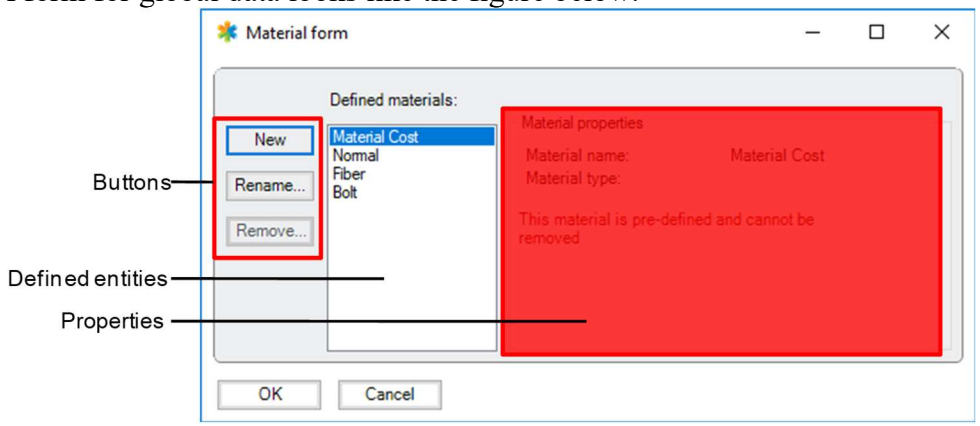


Figure 6-2 Global data form

This particular form shows the material global data type, but each form used to handle global data have same basic functionality for adding, removing and renaming the defined global data, as well as set properties for them. Some differences may exist for some global data types. The differences are explained for each global data type.

This part shows how global data handling is done. The following descriptions uses the figure for Materials data type, but can be applied to any global data type.

6.2.1.1.1 Add a new object

Click button ***New*** in the **Buttons** part to create a new object of the current global data type, in this example a new material. A new object dialog box shows, which asks for a name of the new object. Enter a name and click ok. The newly added object is added to the **Defined entities** list and selected.

6.2.1.1.2 Rename an existing object

Select the object to rename in the **Defined entries** list and click ***Rename*** button. Enter a new name for the object in the new name-dialog box that will appear.

6.2.1.1.3 Remove an object

Select the object to remove from the **Defined entities** list and click button ***Remove*** to delete it.

6.2.1.1.4 Change properties for an object

Select the object to set properties for in the **Defined entries** list. Its properties are shown in the **Properties** part of Figure 6-2 Global data form. The properties for each type of global data differ very much depending on the global data type. See each global data type description for more information which properties exist and what they are used for.
When the properties are changed, they are automatically saved to the database when you click OK.

6.2.1.2 Global data types

- Vehicles – Each vehicle that shall be used in a simulation must first be defined. You define the different types of vehicles in the global data
- Face profiles – Each section that shall be developed shall have a face profile that describes the area and width of it.
- Activity cycles – Activity cycles are global data which defines the activities to perform and in which order they shall be done.
- Shift schedules – Shift schedules define during which times work is scheduled to happen. Shift schedules are used in several placed within a simulation model, such as how vehicles will work, work times for conveyor or crushers etc.
- Rock properties – The rock properties define different properties associated with the rock that is developed or produced.
- Operator costs – salary for the machine operators are defined as global data, which can then be assigned to different entities in the simulation.
- Materials – Different types of materials can be defined, so that a basic cost can be calculated for each different type of material for sections.
- Minerals – The global definitions of minerals include which type of mineral it is, and the grade it is measured in. The defined minerals can then be used where ore is created.

- Disturbances – These are defined traffic disturbances which are used to simulate traffic disturbances from vehicles not part in the simulation, such as light vehicles. These can be used within the layout to setup the amount of disturbance that occurs
- Attributes – Globally defined attributes which can be assigned to sections. They do not provide any functionality in the simulation. Instead, they are used for different filtering functions.
- Precheck configurations – These are configurations regarding priority setup for activities. A precheck configuration contains how long time in advance the next activity will become active, so that vehicle can check work at it. It is used to prioritize (release) the next activity for work search, so when it becomes active, a vehicle is already at the face or work location

6.3 Vehicles

Vehicle properties are used to create and handle defined machines.
The defined machines can then be used in a simulation.

6.3.1 Update exceptions

When a vehicle is changed in the global data, the corresponding vehicles that are based on it, will be changes in the simulations where they are used.
Each vehicle in a simulation has a number of simulation specific properties that aren't affected when changing the global data. The properties that are simulation specific are found in the fleet form. For example, the truck's tramming capacity can be changed in the fleet form, and thus will not be affected when changing the tramming capacity in the global data.

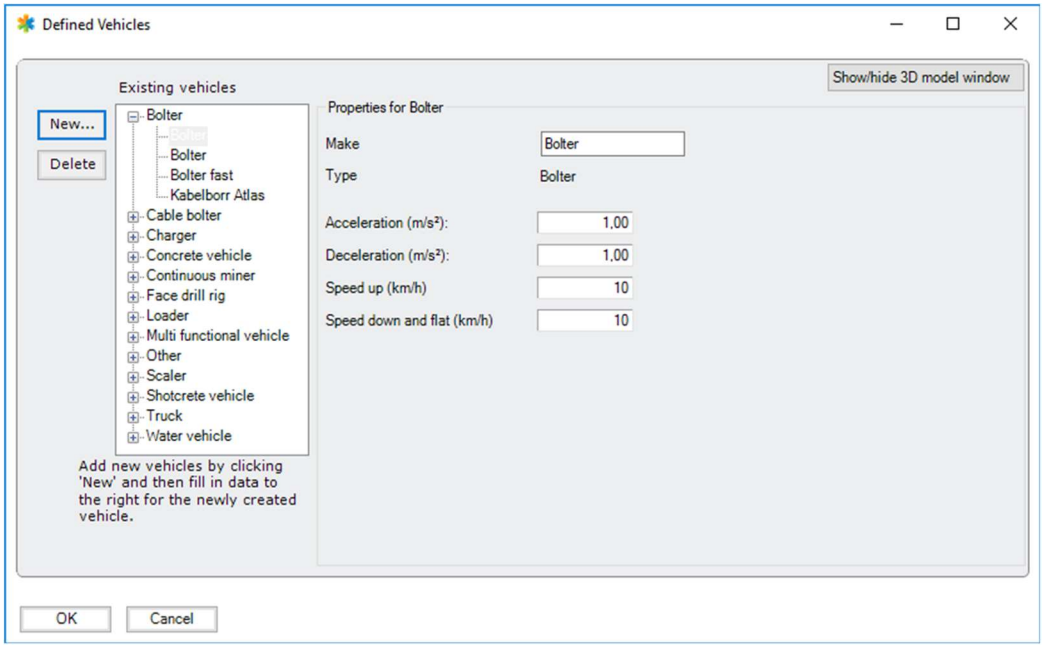
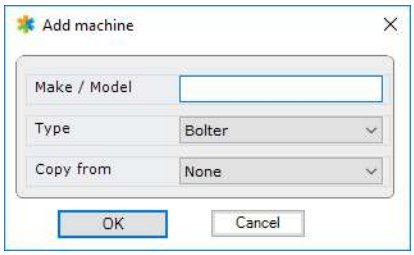


Figure 6-3 Vehicle global data

6.3.1.1 Functionality

6.3.1.1.1 Create a new machine

The way to create a new vehicle is similar to how the common functionality works, with the exception that the new vehicle dialog box has its own look and functionality. To create a new vehicle, click the ***New*** button. A new vehicle dialog box appears:



Enter the "Make/model". This is the name that will be visible in the ***Existing vehicles*** list in Figure 6-3 Vehicle global data above.
Select which type of vehicle you wish to create. Once a machine is created, the type cannot be changed.
In the ***Copy from*** box, select a vehicle to copy its settings from. If left with "None", the new vehicle will begin with default values.
Click "OK". The vehicle is added to the "Existing Vehicles" list, and selected.

6.3.1.1.2 Change vehicle name

There are differences from the default behavior for how to change the name of a vehicle. Once a vehicle is selected, its properties are shown to the right. In the properties, the name can be changed in the ***Make*** textbox.
Find a created vehicle
The list of created vehicles differs from the default behavior in that sense that the list is not a flat list of created objects. Instead it is grouped based on vehicle type, so all bolters are grouped together etc.

6.4 Face profiles

Face profiles hold properties for the area and width of a face. These face profiles can then be assigned to different sections. The face area is used to calculate the amount of rock created after a blast, and the width is used to calculate how much of the section's length that doesn't needs to be developed in intersections. In intersections, two sections will share a bit of development as the program measures the developed length along the centerline. One or more of the sections in the intersection will have their development length decreased with half of the profile's width.

Note! If license Graphics+ exist, a height property will also exist. It will affect the animation which will correctly draw each section's height based on the assigned face profile.

6.4.1 Update exceptions

There are no exceptions for face profiles. When a global face profile is changed it will affect all simulations where the changed face profile is used.

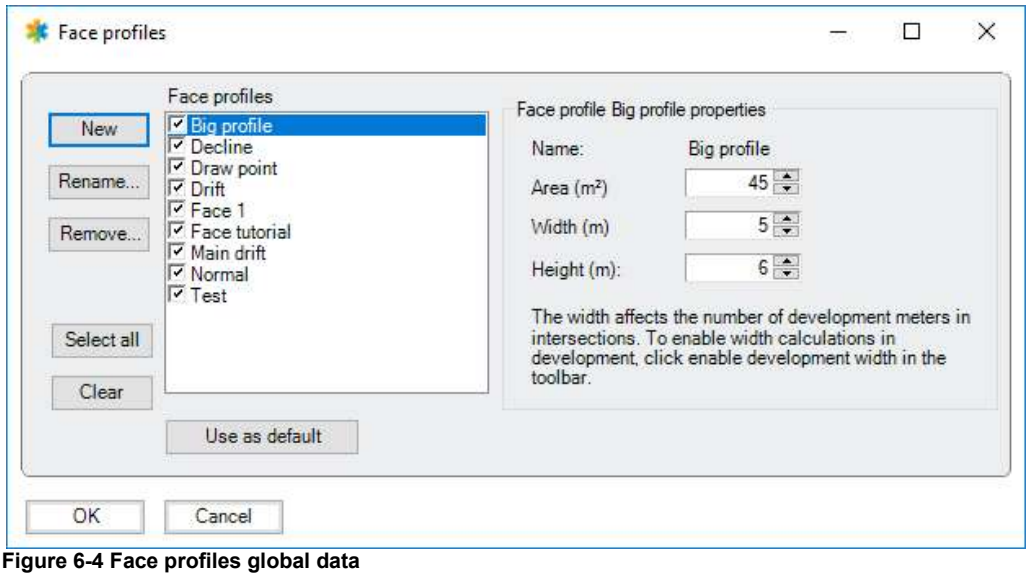


Figure 6-4 Face profiles global data

6.4.2 Functionality

6.4.2.1.1 Set that a face profile shall be used as default for newly created sections

Highlight the face profile that you want to use as default in the development sections. Click the button "Use as default". The default face profile will be printed in bold. If any other face profile was a default face profile before, it will now become a normal face profile.

6.4.2.1.2 Set which face profiles shall be available in a simulation

In a simulation setup, there may only be a small number of face profiles that are in use. To stop all face profiles to be visible in all lists, you can select which face profiles that shall be available in the current simulation by checking the checkboxes next to them. The two buttons named ***Select All*** and ***Clear*** will select all face profiles or clear them respectively.

6.5 Activity cycles

Activity cycles are a defined list of activities that shall be performed. The activity cycles can be assigned to a development face or other entities that support activity cycle functionality (such as a stope production location). The activities within each activity cycle can be configured how often it shall be performed. Some of the activities have extra properties, like ventilation times for blasting.

6.5.1 Update exceptions

Activity cycles are not affected by any changes in this form. Each activity cycle configured in the simulation holds its own properties.
However, if you check the ***Update local cycles*** checkbox before clicking "OK", the changed cycles will be updated in the current simulation only. The update only includes updating which activities are in the cycle – no activity properties are changed on the local cycles.

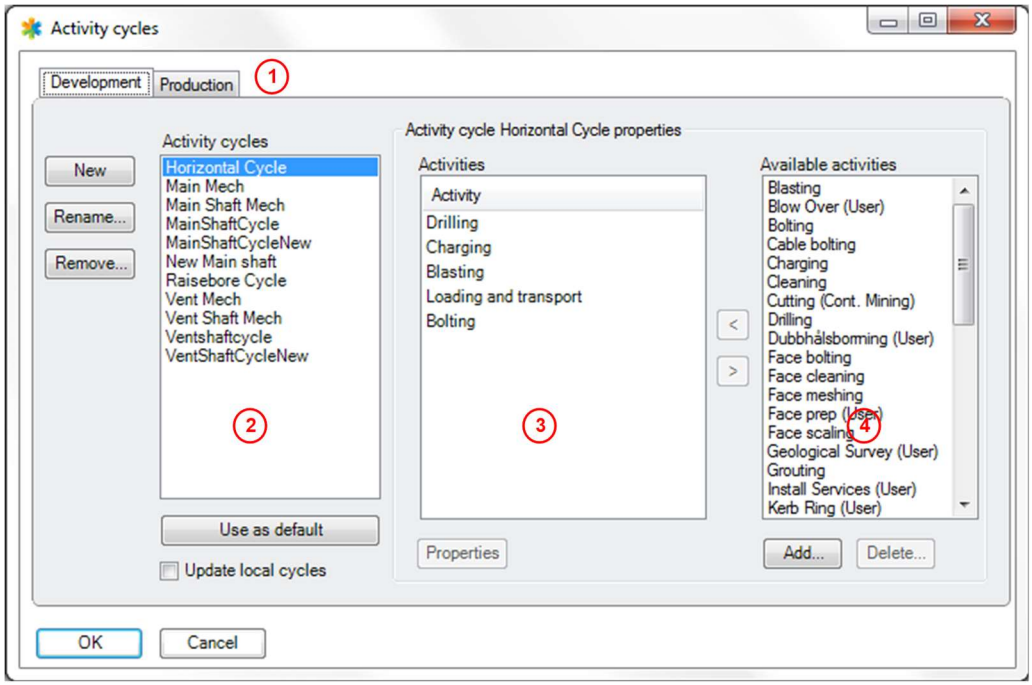


Figure 6-5 Activity form

6.5.2 Functionality

6.5.2.1.1 Order of activities

The order of activities within an activity list does affect how the activities are performed and their total time to be performed. The guidelines to follow are:

- Drill or cut activity should be the first activity. This is due to that many other activities depend on a previously done length, and if drilling or cutting hasn't been performed before that activity, a default length of 3 meter is assumed, which can cause the following activities to calculate with a shorter activity time.
- Blast activity creates rock when no cut activity is present. When the blast occurs, it calculates the amount of rock blasted based on previously drilled length, the face profile at the section, the rock density and overbreak factor according to:
  - Nominal amount = drill length * face area * rock density
  - Total amount = nominal amount * overbreak

6.5.2.1.2 Create a development or production cycle

Activity cycles for development and productions are setup equal, but activity cycles setup for development cannot be used for production and vice versa.

Note! Depending of your license, it may not be possible to handle cycles for production or development.

Select the development or production tab at the top (1) in Figure 6-5 above. The activity cycles created under the development tab belong to that category, and the same is true for activity cycles created under the production tab.

6.5.2.1.3 Add or remove activities to/from an activity cycle

Highlight the activity cycle to modify from the list to the left (2). The selected activity cycle's activities are listed in the middle list (3). For a newly created activity cycle, there are no activity cycles in that list.
Add an activity by selecting the activity to add from the list to the right (4), and then click the "<" button. The activity is copied to the middle list. Newly added activities are added below the current selected activity in the middle list. If no activity is selected, it is added at the end.
To remove an activity from the selected activity cycle, select the activity to remove from the middle list (3) and click the ">" button. The activity is removed from the cycle.
It is also possible to drag and drop activities from one list to the other to perform these

6.5.2.1.4 Change order of activities within an activity cycle

Highlight the activity cycle to modify from the list to the left (2). The selected activity cycle's activities are listed in the middle list (3). Drag an activity within the middle list to change its position within the activity cycle. The moved activity is moved in the list when you release the mouse button.

6.5.2.1.5 Set that an activity cycle shall be used as default for newly created sections

Highlight the activity cycle that you want to use as default in the development sections. Click the button "Use as default". The default activity cycle will be printed in bold. If any other activity cycle was a default one before, it will now become a normal activity cycle.

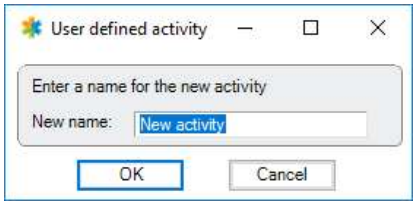
6.5.2.1.6 Update activity cycles in a simulation based on changes done here

In normal case, no activity cycles used in any simulation is updated when changes are made here.

To force an update of activity cycles used in the current opened simulation, check the checkbox "Update local cycles" before clicking "OK". This will only update the activity cycles in the current simulation. To update the activity cycles in several saved simulations, you need to repeat this process for each open simulation, by selecting a new simulation, open up this form and check the "Update local cycles" checkbox, and then click OK. This update will not update any activity properties – it will only update which activities, and their order within the activity cycle.

6.5.2.1.7 Create user defined activities

You can create user-defined activities that can be part of an activity cycle. You do this by clicking the "Add" button below the list to the right (4). A dialog box asking for a name of the user defined activity shows:



Enter a name and click “OK”. The new activity is added to the list of possible activities (the right list).

Note! User defined activities can only be performed by some vehicle types, such as Other, Loader and Multifunctional vehicles. No trucks, drill rigs etc. can perform these types of activities.

6.5.2.1.8 Set properties for an activity

Open up the properties for an activity by selecting the activity to view the properties for, from the middle list (3). The “Properties”-button below that list will then become enabled. Click to show the selected activity’s properties. Typical activity properties look like:

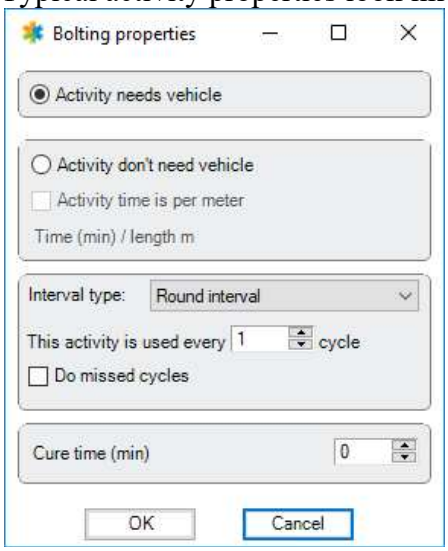


Figure 6-6 Activity properties

Settings in activity properties:

Vehicle needed setting

An activity can be set to require a vehicle or not. When it requires a vehicle (radio button ***Activity need vehicle*** checked), the time to perform an activity is set at the vehicles that can perform the activity. For activities that doesn’t require a vehicle (radio button ***Activity don’t need a vehicle*** checked), it will show a grid for enter performance times for the activity.

Interval of the activity

Activities can be set to perform at certain intervals, such as every 2nd round, or that it has a probability to be performed. This setting is done in the ***Interval type*** dropdown list as:

- Round interval – This allows the user to set how often this activity shall be performed.
    - When the interval is set to 1, it means that the activity shall be done every round.
    - The checkbox Do missed rounds will force any missed rounds to be done when the activity is performed. Example: If round interval is set to 3 for the bolting (every 3rd round), and when the 3rd round is performed and bolting becomes the current activity, the vehicle that will perform bolting will bolt 3 rounds at once.

The missed round settings don't have any effect when round interval is 1.

- Round interval with probability – this allows to set how often there is a chance to perform an activity
    - Round interval works as with the Round interval option
    - Probability to perform the task is the chance that the task is done. Example: If round interval is set that every 3rd round the activity shall be performed. The probability number is set to 40%. At round 3, when the activity becomes the current one, there is only 40% chance that it will be performed.
- Meter interval – allow the user to specify how often an activity shall be performed by using meters instead of round.
    - Example: If a round is 5 meters, and the meter interval is set to 12 meters, the activity will be done on the 3rd round, since the number of meters has become at least 12.
- Meter interval with probability – this works as the round interval with probability with the difference that meters are used to measure how often the activity shall be performed.
- Probability to be performed – is the same as Round interval with probability but with a round interval of 1.

6.5.3 Shift schedules

All changes made here will affect all simulations that use the changed shift schedules. No exceptions exist.

6.5.4 Supported shift schedules

Standard shift schedule – A shift schedule that has up to 6 start- and stop-times during each day of the week.
Rolling shift schedule – A shift form that uses several other shift schedules – where each shift is used for one week, another for week 2 etc. For example, a rolling shift schedule can be configured to use 3 different shifts. This means that shift 1 is used week 1, shift 2 during week2, and shift 3 during week 3. During week 4, shift 1 will be used again.
Exceptions – This is not a shift schedule. It is the possibility to specify exceptions – for example free days, and then assign an exception list to a shift schedule.

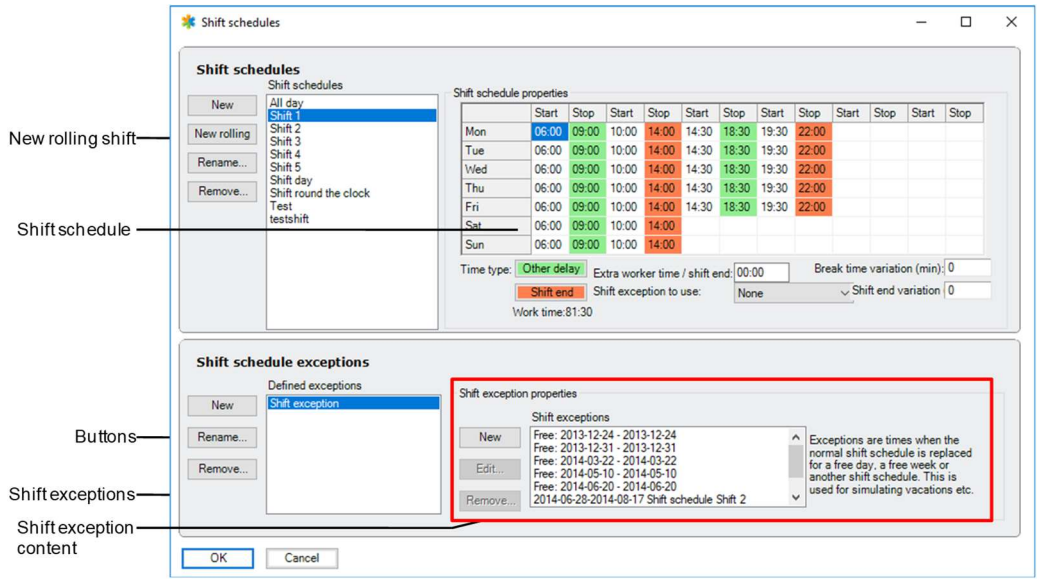


Figure 6-7 Shift global data

6.5.5 Functionality

6.5.5.1.1 Create a new shift schedule

Creating new shift schedules, renaming existing and remove schedules work as described in the common functionality for global data (see Common functionality on page 56. For the shift schedules, there is an extra button to add a rolling shift schedule, named **New rolling shift** in Figure 6-7.

6.5.5.1.2 Edit a shift schedule

Highlight the shift schedule to edit from the list of defined shift schedules. The selected shift schedule's properties are printed in the **Shift schedule** area in Figure 6-7 above.

6.5.6 Shift schedule properties

To change the properties for a shift schedule, select it in the "Defined shifts" list. Its properties will appear to the right. Depending on which type of shift schedule you select from the list, different properties will show.

6.5.6.1.1 Normal shift schedule

For a normal shift schedule, the properties will look as below:

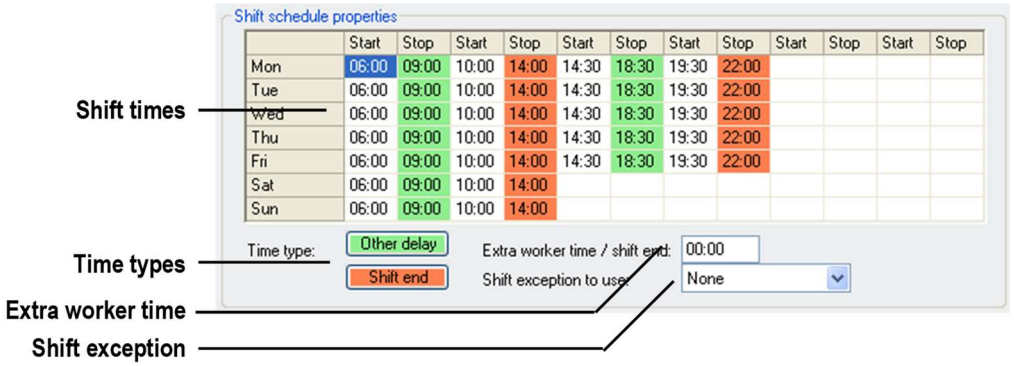


Figure 6-8 – Normal shift schedule properties

6.5.6.1.2 Functionality for a normal shift schedule

When a shift is assigned to an object, the object will start to work at each specified start time, and stop to work at each end time.
Each stop time in a shift can be either a stop time for a meal break, or a shift end. Shift periods that belong to non-shift times (e.g. times between a shift end and a start time) will not be visible in any statistics. In all other aspects, it will not differ, and will not affect the simulation results.
For example, if a shift schedule with an 8-hour work time each day during a week is specified with no meal breaks, each vehicle with this shift assigned will work for 56 hours each week.
However, in statistics these 56 hours will be shown as work percentage. If the end time for each day in the shift schedule is specified as a meal break, these 56 hours will be seen as 33% (56 hours out of 168 hours total)
In the other case, if all end times are set to shift end types, these 56 hours will be seen as 100% due to that off-shift times will not be seen in any statistics. The simulation results otherwise will not change (equal amount of tonnage, drill meters etc.).

6.5.7 Extra worker time

A shift schedule assigned to a vehicle will specify the effective time a vehicle will work. However, the operators controlling the vehicles, will often work more time than the effective time the vehicle will run, such as establish time for each shift when the workers are travelling down to a vehicle. To set that the workers driving or controlling the vehicles will have more work time than the vehicles (to calculate operator costs), you can specify an extra amount of time that will be added to each shift start and end time.

6.5.8 Functionality

6.5.8.1.1 Change shift times

Set the cursor in the shift time's table for the time you wish to change and enter a new one. The time can be in different formats:
H – a number expressing the hour (0-24), which corresponds to a time during a day
H.m – a decimal number expressing the time. 6.5 will for example be 6:30 AM.
HH:MM – a string in time format.

The shift times are written in a table, where each table row holds times for one day. Each day can hold several start and stop times.
Each time in the grid must be higher than the preceding one for each day. This means that even if a shift will last over midnight, you will need to specify one part of the shift on one day, and the rest of the shift on the other day.
(For example, if a shift will last from 10 PM to 6AM Monday to Tuesday, you must enter 10PM to 12PM on Monday, and 12 AM to 6AM on Tuesday).
Each start time must have a corresponding stop time. Blank start and stop times can exist in the end of each day.

6.5.8.1.2 Change stop time type

Select the times in the timetable that you wish to change time types for. Click the time type button for the time type to change the selected times to. These time type buttons are located below the timetable. You can also right click in the selection, and select the time type from the context menu.

Note! Only stop times can have a time type. Start time types cannot be changed.

6.5.8.1.3 Specify that workers do use more time than specified

Note! This does only apply when the shift schedule is assigned to a vehicle, controlled by one or more operators.

Set the extra worker time below the shift times in Figure 6-7 on page 65. This time will be added to each shift end and shift start time to calculate operator costs.

(For example, if you enter 00:15, 15 minutes will be added in the start of the shift and 15 minutes at the stop of the shift. If you have one shift each week, with one meal break, 1 hour will be added when calculating operator costs (15 minutes at shift start and end, and 15 minutes at meal break start and end).

Assign a shift exception configuration to a shift

Select the shift exception configuration from the dropdown list under the shift timetable (Figure 6-7 on page 65). If this list doesn't contain anything, no shift exceptions are configured.
Each shift can be assigned a shift exception configuration. When assigned, the periods specified in the shift exception will be used. During periods not specified in the shift exception, the normal shift times will be used.

6.5.9 Rolling shift properties

The properties for a shift schedule are visible in the "Shift times" part in picture Figure 6-7 on page 65.
A rolling shift schedule doesn't contain any shift times. It just contains other shift schedules. When a rolling shift schedule is selected, its properties will look as the picture below:

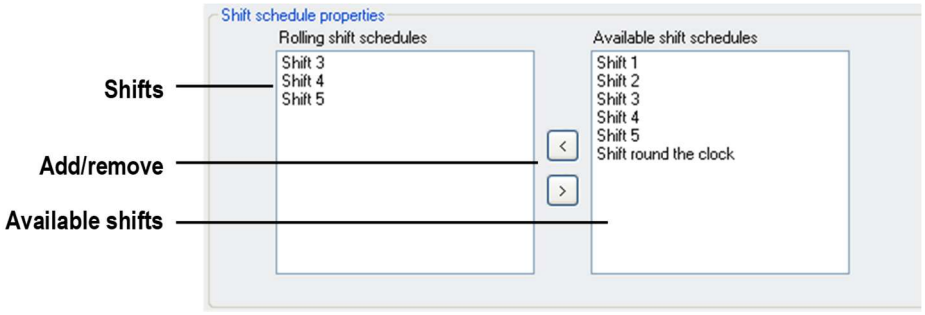


Figure 6-9 – Rolling shift schedule properties

A rolling shift's contained shift schedule is scheduled from the top to the bottom. In the example picture above, shift 3 will be the current shift during the first week in the simulation, shift 4 will be the current shift during simulation week 2 etc. During simulation week 4, shift 3 will be used again.

6.5.10 Functionality

6.5.10.1.1 Add a shift schedule to the rolling shift schedule

Select the shift schedule to add to the rolling shift schedule from the list to the right and click the "<" button. The shift is copied to the left list, which is the list of shift schedules that the rolling shift schedule contains of.

6.5.10.1.2 Remove a shift from the rolling shift schedule

Select the shift to remove from the list to the left and click the ">" button. The selected shift is removed from the configured rolling shifts.

6.5.10.1.3 Add a new shift so it can be added to the rolling shift

In the list to the right, all available shifts are listed that can be added to the rolling shift. If none of these shifts are the shift schedule you wish to add to the rolling shift schedule, you must first create a new normal shift schedule (see Create a new shift schedule on page 65 for more information). The newly created shift schedule will then be visible in the list to the right.

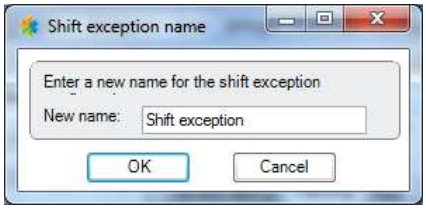
6.5.11 Shift schedule exceptions

Shift schedule exceptions are used to specify exceptions from the normal shift. Shift exceptions are different exception configurations, which can contain several exceptions. These shift exceptions can then be assigned to a shift schedule. When a shift schedule has an assign shift exception, the days specified in the shift exception configuration will be used instead of the times specified in the shift schedule. The shift exceptions are configured in the lower part of the shift schedule dialog box.
For example, if a shift schedule specifies work between 8AM and 5PM every Thursday, and it has a shift exception that says that the first Thursday in each month will be free, then the effective schedule will be that the first Thursday in each month is free, and the rest of the Thursdays it will work according to the shift schedule.
The shift schedules can contain:
Free periods (no work during these periods)
Other shift schedule – this uses another shift during a specified period.

6.5.12 Functionality for shift exceptions

6.5.12.1.1 Create a new shift schedule exception

Click button "New" (**Buttons** in Figure 6-7 on page 65) to create a new shift exception configuration.
Enter a name of the new shift exception in the dialog box that shows:



The newly added shift exception is added to the list of available shift exceptions (“Defined shift exceptions” in Figure 6-7 on page 65)

6.5.12.1.2 Rename a shift exception configuration

Highlight the shift exception to rename from the list “Defined shift exceptions” and click “Rename” button. Enter a new name in the rename dialog box (same as when creating a new shift exception)

6.5.12.1.3 Remove a shift exception configuration

Highlight the shift exceptions to remove from the list “Defined shift exceptions” and click button “Remove” to delete.

6.5.12.1.4 Edit a shift exception

Highlight the shift exception to edit from the list “Defined shift exceptions”. The selected shift exception’s properties are printed in the “shift exception periods” area in Figure 6-7 on page 65.

6.5.13 Shift schedule exception properties

Shift schedule exceptions are periods for which other rules will be in effect. This can be free period, or that another shift shall be used during a certain period – for example during the summer.

To change the properties for a shift schedule exception, select the shift exception to change from the “Defined shift exceptions” list in Figure 6-7 on page 65. The properties for the shift exception will show.

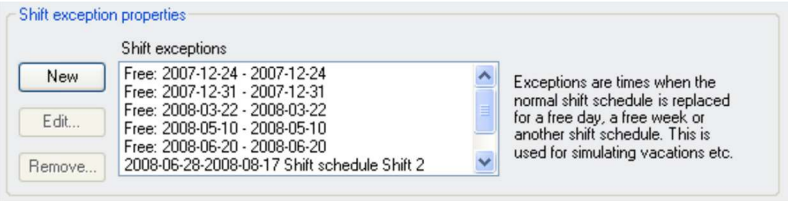


Figure 6-10 Shift exception properties

All shift exception periods are sorted based on start date.

6.5.14 Functionality for shift exception properties

6.5.14.1.1 Add a new period to a shift exception configuration

Click the “New” button next to the shift exceptions list. A new exception period dialog appears:

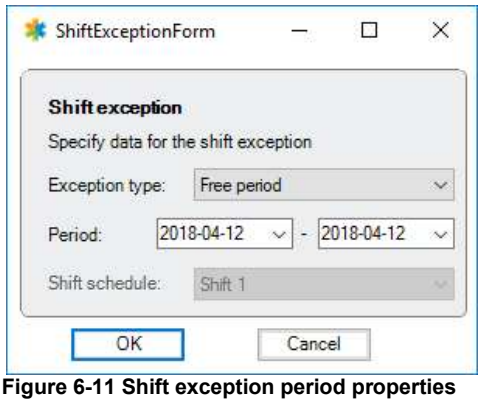


Figure 6-11 Shift exception period properties

Select the type of exception it will be (free period or other shift schedule).
Specify start and end dates for the new period
If the exception type is other shift schedule – select which shift that will be the active one during the specified period.
Click "OK". The new period is added to the list of exception periods in Figure 6-10 Shift exception properties above.

6.5.14.1.2 Edit an existing exception period

Select the period to edit from the shift exception properties list (in Figure 6-10 Shift exception properties). Click "Edit" to start edit that period. A similar dialog as in Figure 6-11 Shift exception period properties above, shows with the selected exception period properties already filled.
Click "OK" in the dialog box when done. The edited period is resorted based on its start date (if changed)

6.5.14.1.3 Shift exception: Remove a period

Highlight the shift schedule exception period to remove and click "Remove" to delete it. Be sure to click the remove button next to the shift exception period's list, and not the remove button to the left in the dialog in Figure 6-7.

6.6 Rock properties

Rock properties are predefined and can be assigned to a face or other entity within a mine to describe the rock. This can be the density, rock type, and any affection it has on the time it takes to perform a certain task. For example, a rock property for hard to drill rock can be defined, which will then affect any drilling performed.

6.6.1 Update exceptions

All changes made here will affect all simulations that use the changed rock properties. No exceptions exist.

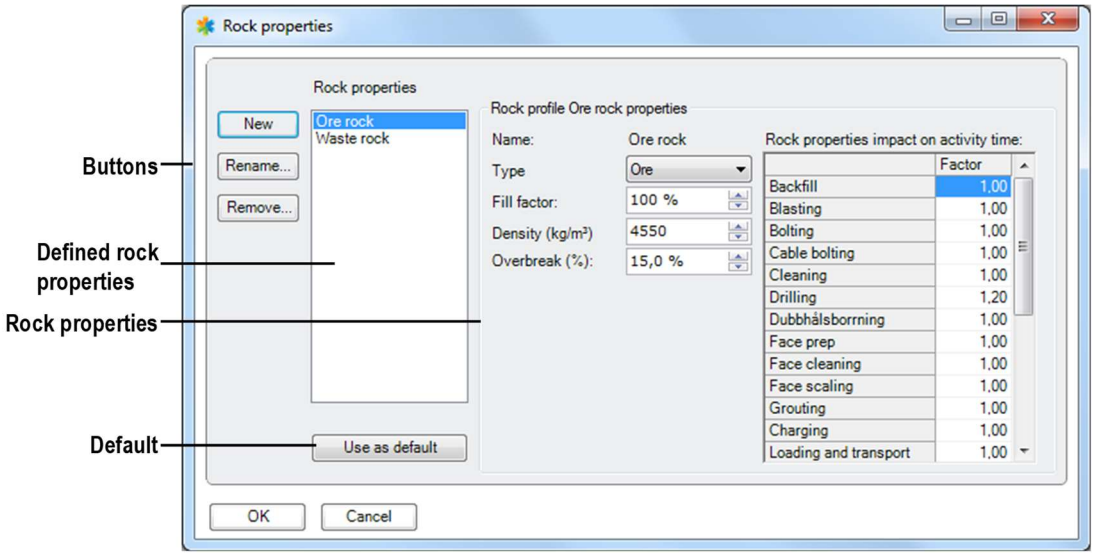


Figure 6-12 - Rock properties

6.6.1.1.1 Change the properties for a rock property

Select the rock property to change from the list. Its properties are shown in the box to the right. Change the properties of your choice. The changed properties are changed instantly – no confirmation is needed. Some properties that can be changed are:

- Rock type – ore or waste
- Fill factor – the normal fill factor on trucks and LHDs
- Density – this determines the density of the solid rock (not the bulk density).
- Overbreak – the overbreak amount in percentage of the normal amount generated.
- Impact factors on activities – how much a rock type affect the work time required for different activity types.

6.6.1.1.2 Change that drilling takes longer time for a rock property

This is about changing the impact factors for different activity types. Select the rock property to change drill affection for in the list (Figure 6-12 - Rock properties). Its properties show to the right. Each defined activity is listed in the "Rock properties affection on activity time" list. Find the row for the drilling activity and change the factor.
A factor of 1 (one) means no affection. A factor of 2 (two) means that the activity takes twice as long as normal to perform, for this rock property.

6.6.1.1.3 Set that a rock property shall be used as default for newly created sections

Highlight the rock property that you want to use as default in the development sections. Click the button "Use as default". The default rock property will be printed in bold. If any other rock property was a default rock property before, it will now become a normal rock property.

6.7 Operator costs

Operator costs are defined costs that define different costs for different days and times during a day. These costs can then be assigned to different entities.

The operator costs are then calculated based on during which times an operator has worked, and the costs during these times.

Note! Operator costs are only used in advanced shift schedule mode, where shift schedules are used. See Set the kind of shift schedule to use on page 79 for more information about using advanced shift schedule mode.

6.7.1 Update exceptions

All changes made here will affect all simulations that use the changed rock properties. No exceptions exist.

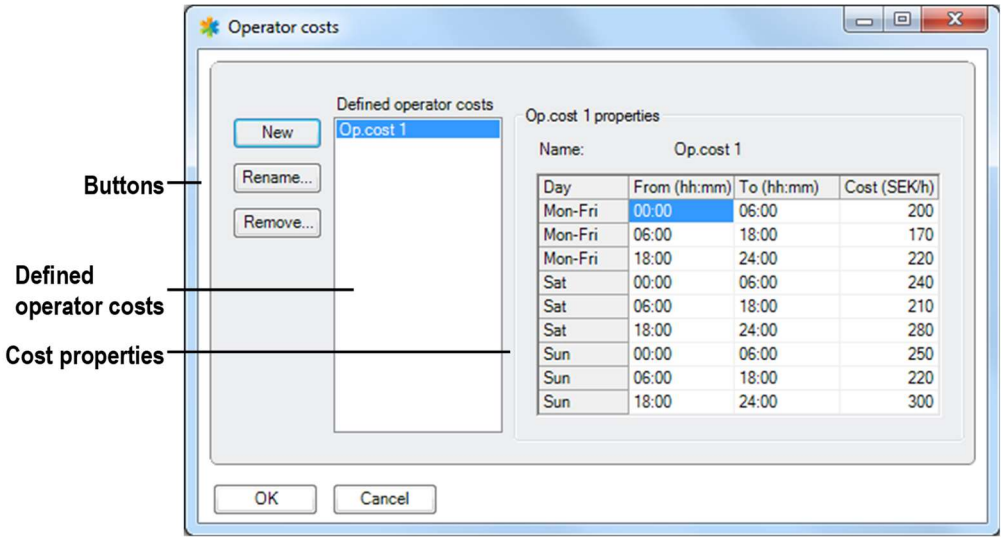


Figure 6-13 - Operator costs

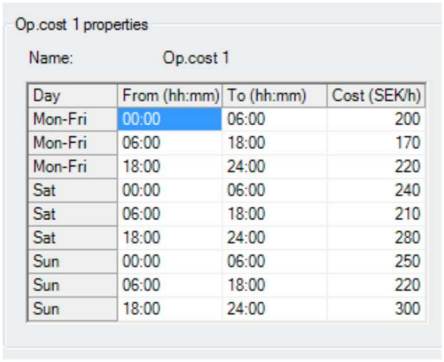
6.7.2 Functionality

6.7.2.1.1 Assign an operator cost to an operator

This is done in the input tabs. It is done for each simulation that will have operator costs. The exact location where to assign it depends on at which level it will be assigned. For example, to assign it to a vehicle to simulate that the operators driving the vehicle have operator costs, it is done in the “Fleet” tab, page 138.

6.7.2.1.2 Modify operator for Saturday between 00:00 and 7:00 AM

Select the operator cost to modify by selecting it from the list of available operator costs. Its properties are seen to the right in the operator cost form.



Day	From (hh:mm)	To (hh:mm)	Cost (SEK/h)
Mon-Fri	00:00	06:00	200
Mon-Fri	06:00	18:00	170
Mon-Fri	18:00	24:00	220
Sat	00:00	06:00	240
Sat	06:00	18:00	210
Sat	18:00	24:00	280
Sun	00:00	06:00	250
Sun	06:00	18:00	220
Sun	18:00	24:00	300

Each time for each period (for example Saturday) begins with the time 00:00. This time cannot be changed.
In the first row for Saturday (5th row from the top), change the “To” time (third column) to 7:00.
The start time for the next period on Saturday is also changed to 7:00.
Change the cost for the first Saturday row to the desired value.

6.8 Materials

Materials are defined as materials that can be assigned a cost at each section. The material cost in SimMine is entered in a simplified way, where you can specify different costs for different materials at different parts of the mine. The costs are per meter (or other unit if imperial system is used) of developed distance. You do not specify cost per piece, or per cubic meter. Materials defined here will show up in the Material cost tab in the main form. See page 148 for more information about Material cost results.

6.8.1 Update exceptions

All changes made here will affect all simulations that use the materials for cost calculation. No exceptions exist.

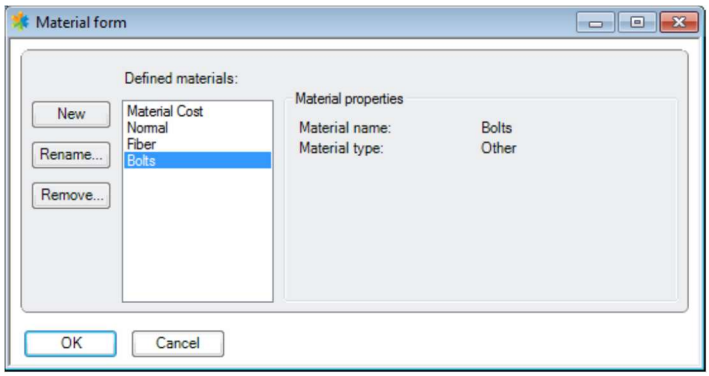


Figure 6-14 - Materials

6.8.2 Functionality

Set costs for a material
Costs for defined materials are set per simulation and is not part of the global data. It is set in the Material costs tab. Further information can be read at Material costs on page 148

6.9 Minerals

Minerals are defined as minerals that can be assigned to different sections and objects in a simulation. To assign a mineral at a section or object, it must first be defined. The minerals are used to specify the mineral type, and value (in the current currency) of each mineral type. When assigning the minerals to sections and objects in the mine layout, you can specify the amount of the different minerals that exist at each section/object. At the end of a simulation, hauled mineral amounts / values are presented in the Minerals output tab.

6.9.1 Update exceptions

All changes made here will affect all simulations that use the mineral for cost calculation. The entered amounts of each mineral are simulation specific and will not be affected. If a mineral is deleted, no results will show for that deleted mineral anymore.

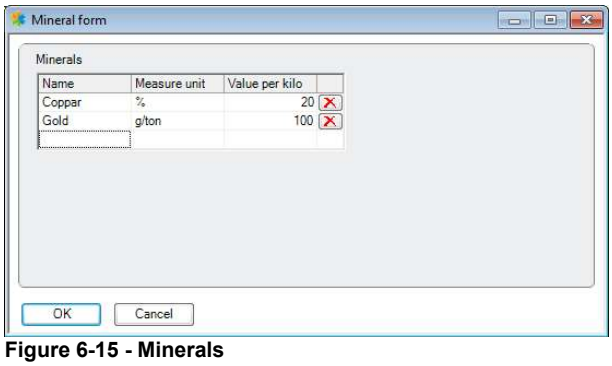


Figure 6-15 - Minerals

The minerals work differently that other global data types in how they are handled.

6.9.2 Functionality

6.9.2.1.1 Create a new mineral

Start to enter a new mineral name in the "Name" column in the last row. When you start entering a new name, a new empty row is added after it.
Fill in the other properties for the mineral (measure unit and Value per kilo)

6.9.2.1.2 Rename a material

Highlight the mineral name cell and start to enter a new name. Double-click in the name cell to enter change mode. When done, just click outside the cell.

6.9.2.1.3 Remove a material

Click the "Delete" button on the row for the mineral to delete.

6.9.2.1.4 Assign a mineral to a section

This is done in the properties for the section, see page 115.

6.10 Light vehicle disturbances

Light vehicle disturbances are defined disturbance data for how frequent and how long disturbances are from vehicles not part of the simulation – i.e. light

vehicles. The light vehicle disturbance is used to simulate disturbances from vehicles that does not take part in a simulation, such as mine taxis, shift boss driving etc. The disturbance configurations defined here can then be assigned to different sections in the mine layout. In this way, different parts of the mine can have different disturbances from light vehicles. A default light vehicle disturbance can be set, which is then valid for the whole mine, if not overridden by the local settings at a section.

6.10.1 Update exceptions

All changes made here will affect all simulations that use the light vehicle disturbances. No exceptions exist.

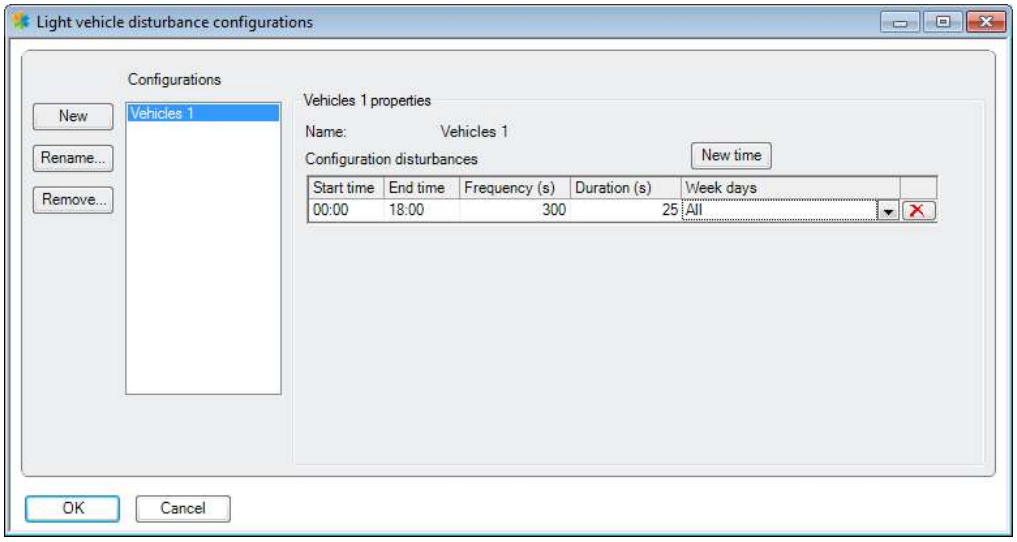
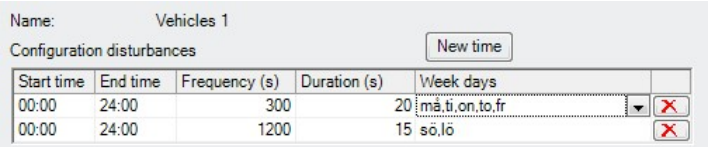


Figure 6-16–Light vehicle disturbance

6.10.2 Functionality

6.10.2.1.1 Specify disturbance data

The data for the disturbance is the data for how frequent and how long a disturbance from light vehicles is. It also contains during which times and days a disturbance can happen.
Example: Assume that we want to simulate that disturbances from light vehicles have a frequency of around 5 minutes (5 minutes between each disturbance). Each disturbance takes around 20 seconds.
On weekends (Saturday and Sundays), the disturbances are much less frequent. During this time, disturbances happen at around 20 minutes, and lasts for 15 seconds.
To configure this, do as:
Create a new configuration by clicking "New" in Figure 6-16–Light vehicle disturbance above. Name the new configuration "Vehicles 1". Click "OK"
When the configuration is created, it is automatically selected in the "Configuration" list. To the right is the selected configuration's data. Click the "New time" button above the table twice. This will add two rows where disturbance times can be entered.



Enter the times as seen above. This specifies that:
Between 00:00 and 24:00 (the whole day), on Monday to Friday, the frequency is 5 minutes (300 seconds) and each disturbance is 20 seconds.
The whole day on Saturday and Sunday, the frequency is 20 minutes (1200 seconds) and each disturbance takes 15 seconds.

The above does just define a disturbance configuration. Next, it has to be assigned to the section / sections for where this disturbance is valid. See page 219 for how to assign a light vehicle disturbance to sections.

6.11 Attributes

Attributes are defined colors assigned to values. These values can then belong to different sections. In this way it is possible to filter and color the layout based on which attribute different sections has.

6.11.1 Update exceptions

All changes made here will affect all simulations that use this global data type. No exceptions exist.

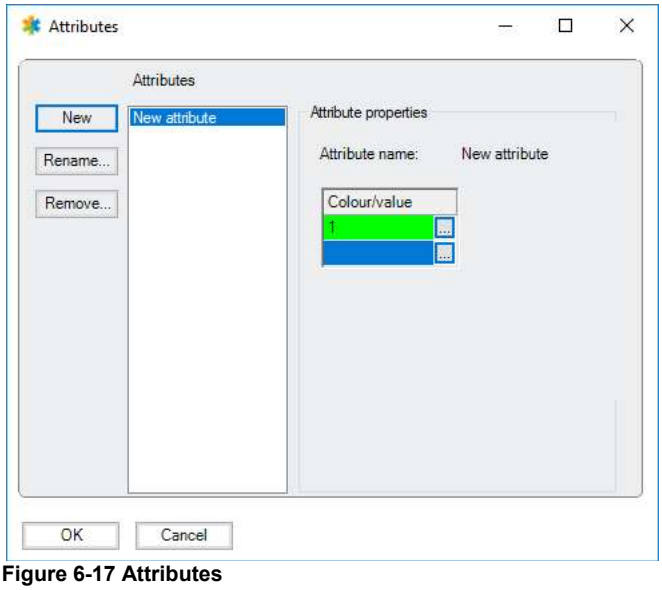


Figure 6-17 Attributes

6.11.2 Functionality

6.11.2.1.1 Assign attributes to sections

The current version of SimMine does not support assigning attributes through a user interface. The assignment must come through an import from a Mine2-4D file, where attributes are present. In a future release, assignments will be possible in SimMine

6.12 Precheck configurations

Precheck configurations are configurations which are used to prioritize certain activities. Different activities can be prioritized differently, for example that we want the drill activity to be highly prioritized in one part of the mine, while the rest of the activities have normal priority since we have enough vehicles to perform them, then precheck configurations is a good tool

6.12.1 Update exceptions

All changes made here will affect all simulations that use this global data type. No exceptions exist.

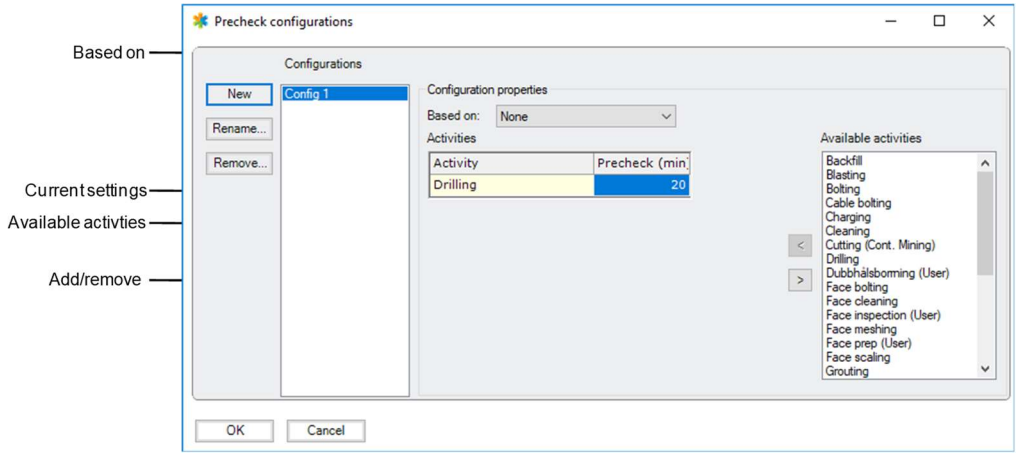


Figure 6-18 Precheck configurations

6.12.2 Functionality

6.12.2.1.1 Set drilling to be a high-priority activity on a section

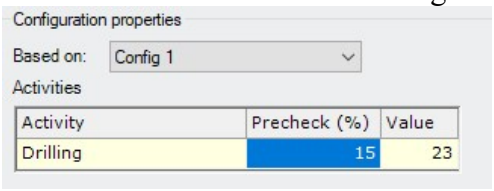
Create a new configuration and select it in the list of available configurations. Its **Current settings** are shown. Select the Drilling activity from the **Available activities** list above, and click the add button (in the **Add/Remove** group in figure above). The drill activity is added to the **Current settings** table.
In the column ***Precheck (min)***, enter a time in minutes. This time, is the time in minutes that the drill activity becomes available for vehicles to be assigned work at. The greater value, the earlier the activity becomes available for work. If a vehicle is assigned work for an activity which isn't the current activity at a face, the vehicle will drive to the face and wait there until it becomes the current activity.
The above has created the configuration. Next it needs to be assigned to the section/sections where this priority shall be used. Open up the properties for the section(s). In the development tab, there is a combo box for which precheck configuration that shall be used. Set this configuration and click OK to save the section properties.

6.12.2.1.2 Set that drilling and bolting shall be priority activities

The setup for this is the save as when setting only drilling as a priority activity, but which the addition that bolting needs to be added as well.

6.12.2.1.3 Do a modification configuration

A modification configuration, which takes the base configuration from one configuration and modifies it with a percentage is done in the same way as a standard configuration. When the properties are shown for a configuration, select a configuration from the **Based-on** dropdown list in Figure 6-18. The grid will then show the activities configured in the based-on configuration as:



In this table, it is possible to change the precheck percentage, which is the amount the value from the based-on configuration shall change. Negative values are also possible. Example: To modify the original configuration "Config 1", so that it is 10 percent less for drilling, create a new configuration and select the "Config 1" in the based-on dropdown list. The table is filled with all activities from config 1 (which is only drilling). In the **precheck (%)** column, enter -10. You can directly watch the resulting precheck value in the **Value** column.

7 Model input interfaces

7.1 Overview

In this section you will learn about the model input interfaces for a simulation and the tools that you use to develop and run simulation models through. In previous section, we looked at global data that can be used in all simulations. This section will focus on setting up simulation data - i.e. data that only belongs to one simulation. It will also be shown how to use the global data from the previous chapter.

All simulation input interfaces can be setup in any order, and can be reviewed and changed by clicking the tab where you wish to review or change data in. However, some tabs are dependent on others, which can cause a tab to show different data depending on what you have done in other tabs.

Through the tabs, you select which kind of data that you want to work with, both input and output tabs exist. Output tabs shows results from the previous simulation run and are marked with a blue arrow. In the chapter, we will focus on the input tabs.

Depending on your license, the number of tabs, and the content of some tabs may differ.

The tabs look as the picture below:

Figure 7-1 - Tabs

There are many tabs of which the most tabs are output (i.e. result tabs), which holds the result from a previous simulation. The input tabs that exist are:

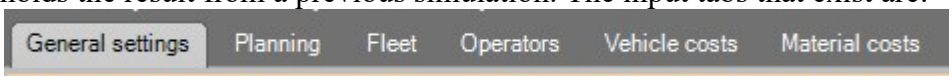


Figure 7-2 Input tabs

The tabs in the figure above shows SimMine development package with operator module.

7.1.1 Tab overview for input data

The tabs for input data hold different kind of data for a simulation, where some tabs are necessary to fill in data for, while others can be left out. The following input tabs exists:

- General settings – contains general settings for the model such as currency, how to setup shifts and availability, run length etc. is contained here. This tab should always be setup to fit the simulation
- Planning – Here is the layout and its properties. It tells what to be done. It also holds rules and settings associated with the layout. It doesn't specify which machines shall perform the work. This tab is required to have a valid layout in.
- Fleet – This handles all the vehicles that take part in a simulation and their properties. If vehicles will be used in a simulation, this is required to have valid vehicle data in.
- Operators – This is used if vehicle operators will be simulated. Vehicle availability and other means can be used to get some effect of simulating operators. An Operator license is required for this to show.
- Vehicle costs – Specified costs for the vehicles that are configured under the Fleet tab. This is only required if costs are part of a simulation. Any configuration in this will not affect any production results – only resulting costs.
- Material costs – Specified costs for materials at sections in the layout and is only required if material costs shall be part of the simulation. This will not affect any production result, only resulting costs

7.2 General settings tab

This tab holds general settings, which can affect how other tabs behave.

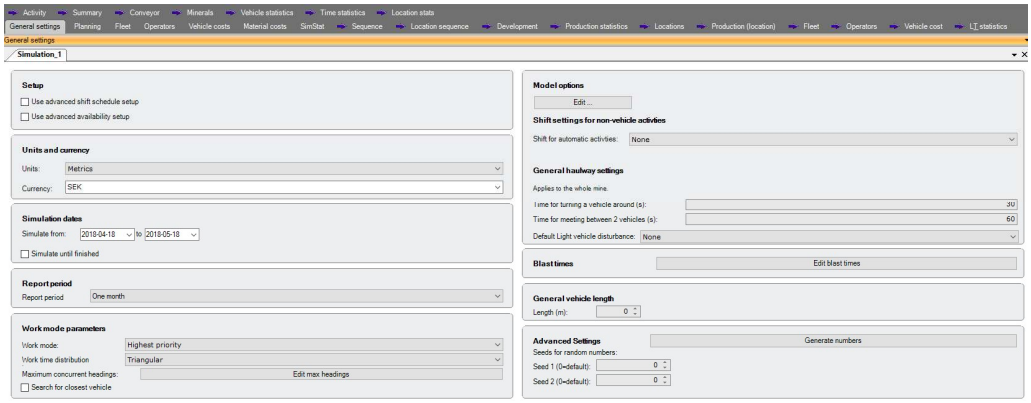


Figure 7-3 - General settings

7.2.1 Functionality

7.2.1.1 Set the kind of shift schedule to use

Check or uncheck the "Use advanced shift schedule setup" checkbox in the ***Setup*** part. When checked, the shift schedules defined in the global data are used. When this checkbox is unchecked, shift scheduling is setup in an easy way, just describing hours per shift, shifts per week, and efficient percentage.

This is visible in the Fleet input tab, when the vehicles are setup and their shifts are assigned.

7.2.1.2 Set that advanced availability shall be used

Check the "Use advanced availability setup" checkbox in the ***Setup*** part. This will allow you to enter more in-depth numbers to control availability for different entities in the simulation. This is visible in the Fleet input tab when assigning mechanical availability to the vehicles.

7.2.1.3 Set unit system to use

Select which unit system to use in the "Units" dropdown box in the ***Units and currency*** part. This affects how you input data is shown (for example distances), and in which unit results are shown.

7.2.1.4 Specify the currency to be used in costs

Select one of the predefined currencies from the "Currency" dropdown list in the ***Units and currency*** part. If your currency is not found in the list, you can type in your currency in this dropdown list.

7.2.1.5 Simulation period

Set the start and end simulation dates to specify from when, and to which date the simulation shall be done. The checkbox "***Simulate until finished***" will cause the simulation to run until all development and production is completed, if it is checked. When it is not checked, the simulation will run until the end date. The ***Simulate until finished*** should be used only when the model is verified to run as it should during a fixed simulation period. The reason is that if the simulation model has been setup so that the simulation will never finish, due to always ongoing loading and transport for example, this will cause it to run forever. If the ***Simulate until finished*** is checked and a simulation model has been configured in such a way that no activities occurs, but it cannot complete the development, the simulation will abort after some month with no activities.

7.2.1.6 Set how frequent output data will be gathered

Select the report period from the dropdown list box in the ***Report period*** part. This is how often output data will be gathered. The data gathering will always occur at a period border. The following periods and period borders exist:

- One day - report border at start of each day
- One week - report border at start of week (Monday 00:00)
- One month - report border at start of month (1st of the month at 00:00)
- Three month - report border at start of January, April, July and October 00:00)
- One year - Report border at start of year (January 1st 00:00)

The first and last periods can start or end in the middle of a report period depending on simulation start time and simulation end time.
Example: If the simulation is set to start at 27th of June, with a report period of 1 month, the first period will only be 4 days (27-30th of June)

7.2.1.7 Set how vehicles search work

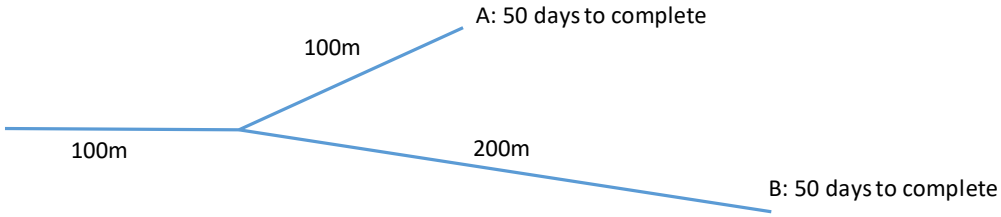
In work mode parameters, there are controls for defining how vehicles will select work, and how the work times are entered into vehicle properties.
Work mode specifies how the vehicle will select work. The possible work modes are:

- Most meters/week - vehicles will select work where the greatest number of meters per week needs to be performed until it must be completed.
- Most meters/week 2 - a variant of the preceding option. This is a more accurate option, but is unsuitable in layouts with many paths between 2 locations, such as in a room and pillar mine.
- Closest - The work locations that require the vehicle to travel as little as possible is selected first.
- User priority - The locations that has the highest set priority will be selected first for working at. The user supplies this priority, see page 116.

A more in-depth description of the most meters / week variants is found below.

7.2.1.7.1 Most meters per day, method 1 and 2

These work modes require a bit more explanation to understand how they work and when each of these can be used.
A requirement for these work modes to be used is that a preferred end date is specified on sections. This can be set in the section properties, under the development tab. If no end date is set, the section will get the lowest possible priority. If no section has a specified end date, all sections will thus get the same priority when most meters/day is used.
In the examples that are given below to explain how these work modes are constructed, the following simple layout is used:



In most meters per day, method 1, the calculation is per path found. The meters per day for path A is 200m/50 days = 4m/day is required. Path B get 300m/50days = 6m/day. The highest found number is used when the priority is assigned to the first common path (6m/day)
For most meters per day, method 2, the calculation is done for all paths that exist from the current development face. In the example above, it calculates that all 400 meters must be done within 50 days, and thus the common path will get the priority of 400m/50=8m/day. This is higher than when method 1 is used. When the development reaches the intersection, the priority for the different paths will be the same as for method 1, since the paths doesn't contain any intersections.

Independent of which work mode is used, the priority is recalculated once in a while to update the current state of the mine.

Which method fits which situation? There is no golden rule for this. Method 2 takes more into account, and will always calculate a higher priority for any

common path before the path splits. This ensures that the development to intersections becomes higher prioritized compared with method 1.
When there are many paths between two points in the mine, method 1 does require a lot less computing power. Method 2 is less consistent when multiple paths exists (such as in a room and pillar layout.

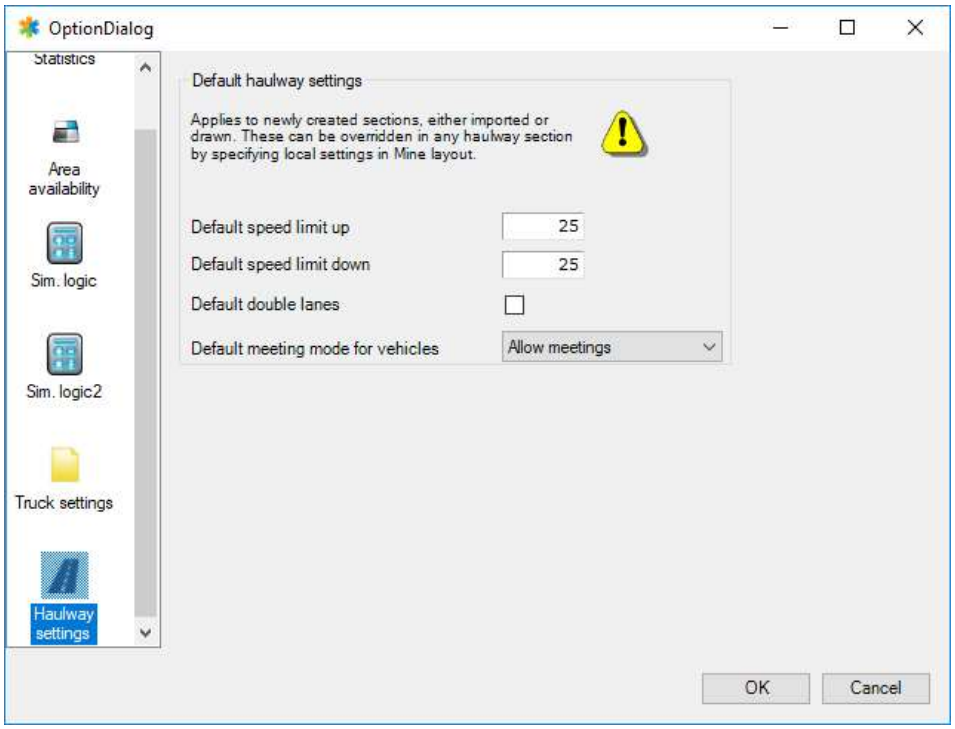
7.2.1.7.2 Work times

The next thing to consider is how the work times for a vehicle is entered. Default, the times are entered in a triangular distribution, with a min, mean, and max value. Change this to enter work times for vehicles in a different distribution.

Set maximum concurrent activities to limit the number of active faces that can be worked at. This setting is at default set to unlimited. To limit the number of ongoing activity cycles, set this to a number greater than 0.
This setting does only limit the maximum number of concurrent activity cycles, and not the maximum number of active faces.
For example, assume that the maximum concurrent activity cycles are set to 1, and there exist 3 faces, A, B and C. When face A is started, the simulation will now have one active activity cycle. No other face can start any activity. However, when the activity cycle is done at face A, and a new activity cycle shall start at the face, the next activity cycle may start at face B, even if face A is already active (it hasn't an active activity cycle though).

7.2.1.8 Set default settings for new sections

When new sections are created in the layout, they are assigned default properties for speed limits, meetings method and if all roads have double lanes. To change the default haul way settings, open up the ***Model options***. It is done by clicking the ***Edit*** button at the ***Model options*** caption. The model options contain several options which can be set. See Model options settings on page 203 for a reference of all model options in the option dialog.
In the opened options, in the left pane, select haul way settings. The settings for the haul way will show in the right pane:



7-4 Model options - haul way settings

These settings will be assigned to any newly created section in the mine. Any existing section in the layout will not be changed when these settings are changed. When a section is created from another section (i.e. a section is split), the settings for the new section is taken from its base section (the split section). All the settings in this form are found in the section properties as well, where they can be set per section.

7.2.1.9 Set time for turn-around and meetings

Each vehicle will turn-around after it has performed its task. The time it takes for a vehicle to turn-around is found in the ***General haul way settings*** part. The setting ***Time for turning a vehicle around*** defines the times this action takes. In the simulation, it is not simulated that a vehicle is turning around. Instead, a vehicle is standing still during the turn-around time when this happens.
Meetings in a mine can occur in two ways

- Simple meeting logic, which causes one of the vehicles to stand still during a specified meeting time. With the simple meeting logic, meetings can occur at any place in the mine.
    - When this mode is selected, each meeting takes the time given in the Time for meeting between 2 vehicles found under ***General haul way settings***.
- Meetings only at intersections, which allows meetings only to occur at intersections and placed locations. This requires the layout to be setup in a more complete way, so it includes the expected intersections.
    - In this meeting mode, each time between vehicle meetings is simulated more realistic. One vehicle needs to wait at the intersection until the meeting vehicle has passed it. This does not use any meeting time number in General settings

- Any location which is placed in the layout can be used as a meeting location. This includes every location from Meeting point to a crusher.

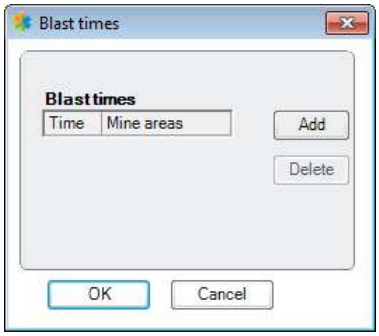
The meeting mode can be set per section, which allows the user to have one part of the mine where meetings can occur in one mode, and another part with another meeting mode.

7.2.1.10 Specify traffic disturbances from other vehicles

Traffic disturbances from vehicle in the simulation are simulated. To include that there are light vehicles, or other vehicles which aren't part of the simulation that needs to be taken into consideration, light vehicle disturbances are used. In General settings, a default light vehicle disturbance configuration can be specified, which can be overridden at each section in the layout. The default light vehicle disturbance configuration is specified by selecting the configuration from the ***Default Light vehicle disturbance*** dropdown list found under ***General haul way settings***.

7.2.1.11 Edit blast time

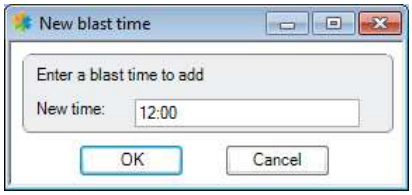
If free blasting is allowed, nothing needs to be done. If blasting can only occur during specific times, these blast times are specified by clicking the "Edit blast times" button in general settings. A dialog shows where you enter times for blasting.



The blast time's table contains valid blast times for each mine area. If a mine area is not shown in the table, or that the table is empty, free blasting in that area is allowed.

7.2.1.12 Add a blast time for all mine areas

Click the "Add" button. A add blast time dialog shows:



Enter the time at which blasting can occur. At this stage, you do not specify where in the mine (mine area) it is allowed, just the time. Click "OK" when done.

The added blast time is shown in the blast time's table as seen in Figure 7-5 - Blast time below.

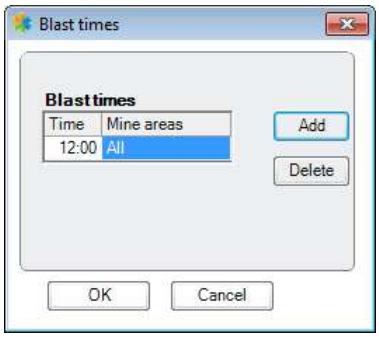


Figure 7-5 - Blast time

As seen above, it is now only possible for blasting to occur at 12:00 in each area.
To specify that blasting be only allowed in one or more specific mine areas, enter a comma-separated list of mine area numbers in the "Mine areas" column. See pages 220 and 295 for more information about mine areas.

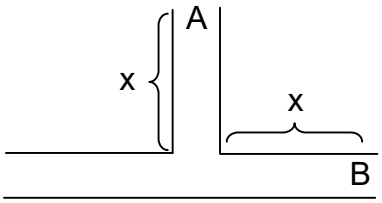
7.2.1.13 Set that free blasting is not allowed during certain times

In the Blast times dialogue, blast times can be set for different mine areas. Any mine area not listed in the blast time dialogue box will have free blasting, which means that whenever the blast activity becomes active, the blast will go off instantly. In some cases, there is a need to prohibit blasts during a specified time period, for example between 1PM and 2PM. This is done by assigning all non-vehicle tasks a shift schedule under Shift settings for non-vehicle activities part. For our example period to prohibit blasts between 1 and 2PM, a shift schedule needs to be created which states that work is scheduled all times except between 1 and 2PM (see Shift schedules on page 64 for information with shift schedules). Next, select the created shift schedule in the ***Shift for automatic activities*** dropdown list.

Note! Be advised that assigning a shift schedule for automatic activities (i.e. non-vehicle activities), will set that shift for all activities which require no vehicle, not only blasting. Further, the assigned shift schedule will be active for all blast activities, even those with set blast times. If the shift schedule prohibits work between 1 and 2PM, and a blast for an area is only allowed at 1:30PM, that blast will never occur.

7.2.1.14 Set that work in intersections cannot occur simultaneously at 2 faces

The setting ***General vehicle length*** in Figure 7-3 - General settings, defines the minimum distance the development has been done from an intersection before work can be started at another face at the same intersection.



For example, suppose that the general vehicle length is set to X meters, and an intersection as above exist. Two vehicles cannot work at the same time at the

faces A and B in the intersection when any of the faces A or B isn't developed at least X meters from the intersection.

7.3 Planning

This tab holds controls to describe the mine that you want to simulate in your model. Through this tab, you can perform most of the tasks associated with the mine layout, such as work sequence, properties for different parts of the mine, production/development methods etc.

A description of all the tools available in the planning tab can be found in the Appendix B.

The planning view holds several subparts. Each subpart has its own tab to the left in the planning tab:

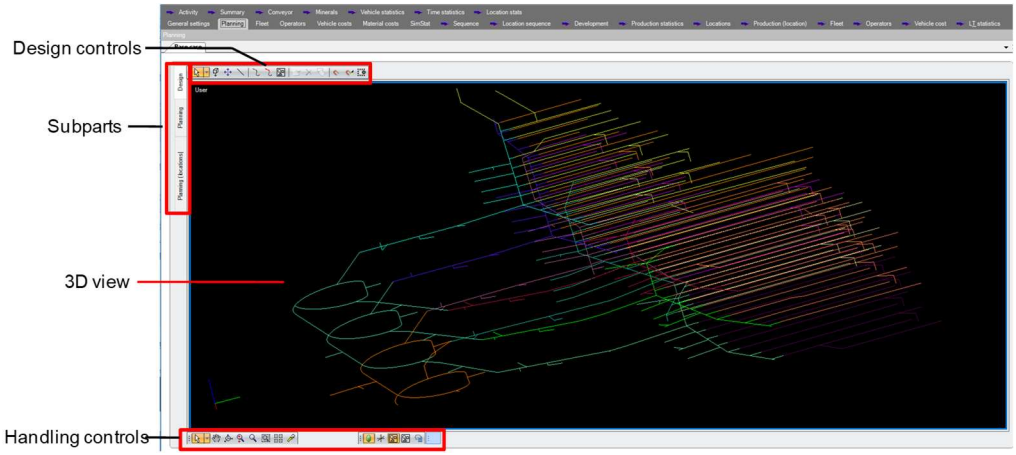


Figure 7-6 Planning tab

Parts in the figure:

Design controls

These allow the user to design the layout. It has controls to add objects, draw sections, divide existing sections etc.

Subparts

The tabs to the left contain subparts in the planning tab. It contains one tab for the design view (seen in figure above), and two or more tabs containing lists of added sections/objects. The number of tabs depends on which types of objects are added to the layout, since a tab is only shown when it has anything to show. In all subparts, the 3D view will be visible together with a list of sections or objects.

3D view

The layout, which can be rotated, zoomed panned etc. In the 3D view, the user can click to select sections and locations. A context menu exist which provides some options for the selected sections and objects.

Handling controls

The handling controls contains camera controls, which allows the user to select, rotate, pan etc. It also contains controls to hide/show different entities in the layout, as well as controls how some things are shown.

Within the planning tab, you control most of the properties associated with the mine layout. The tabs to the left (Design and Planning, plus additional tabs for objects) control which kind of information that is displayed, and what can be done in the layout. The tabs to the left can have the tabs listed below, but any plugin may also make additions to the list of tabs:

1. Design tab - This is when designing the layout. It will display a full 3D design view which shows the current layout
2. Planning tab - This is for planning the development for the designed layout. It contains a list of sections
3. Planning (locations) tab – This displays all added objects.
4. Stopes – Shown when a production location is present (requires the production module license). The production and production plan object types which can be added to the layout does only provide simple functionality and is not part of the production module.

7.3.1 Development functionality

When the license for development exists, it provides these additional functions in the planning tab:

1. Development properties can be set on sections
2. Development direction can be set
3. Dependencies between sections and objects can be specified

7.3.2 Production functionality

When the production module license exists, it provides these additional functions in the planning tab:
Long hole production locations (a primary and secondary location). These locations allow you to setup long hole drilling activities for stope production.

7.3.3 General information

The layout contains sections and objects. Sections define the haul ways, and the distances, while objects define different functionality, such as a crusher, loading bay etc. When loading and transport is used, the transport needs to have a valid destination. A valid destination can only be a placed object within the layout.

As a general guideline, when creating or otherwise modifying objects and sections from within a 3D view, you confirm your actions with the right mouse button. For example, when placing a new object, you place it with the left mouse button, and confirm by clicking the right mouse button. Before the right mouse button is clicked, you can left-click on another spot to place the object there instead.

7.3.3.1 Layout part description

This part gives a short overview of how the layout is divided into smaller parts. The layout contains sections, which are user-defined parts of the layout. A layout can contain a single section if desired. One section contains one or more segments, which is a part of the layout without any intersections. A segment contains one or more lines and points, which are the smallest building blocks to create a segment.

Each section can be assigned unique properties to. This means that if two parts of the mine need to have different properties, the mine layout needs to be split up in at least two sections.
Some properties can be unique on each segment, such as priority, start activity and length done.
Lines and points cannot have properties which can be reached through a property box. The have properties for their coordinates and length, but all properties are set through sections, or in some cases the segments.

As an example, see picture below:

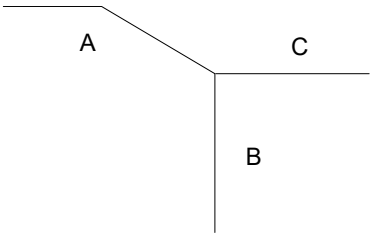


Figure 7-7

In the picture above, one section exists and 3 segments – A, B and C. Segment B and C does only contain one line each, while segment A contains 2 lines.

7.3.3.2 Layout objects

Objects do add functionality to the mine layout. Different types of objects can be added to the mine layout. An object can be the only possible destination for rock transport. There also exist objects which do not have any rock functionality, such as meeting points, which only allows 2 vehicles to meet each other. Objects can only be added to an existing section. The type of objects that can be added depends on your SimMine license.

7.3.4 Design view

The design part under the main planning tab shows controls, which allows you to design your mine layout. See Figure 7-6 Planning tab

This view consists of tools to create or modify the layout, place objects, and to control the camera.

7.3.5 Planning tab for sections

The planning part under the main planning tab show controls which allows you to see and plan how the mine shall be developed. Its main interface is seen in Figure 7-8 – planning below.

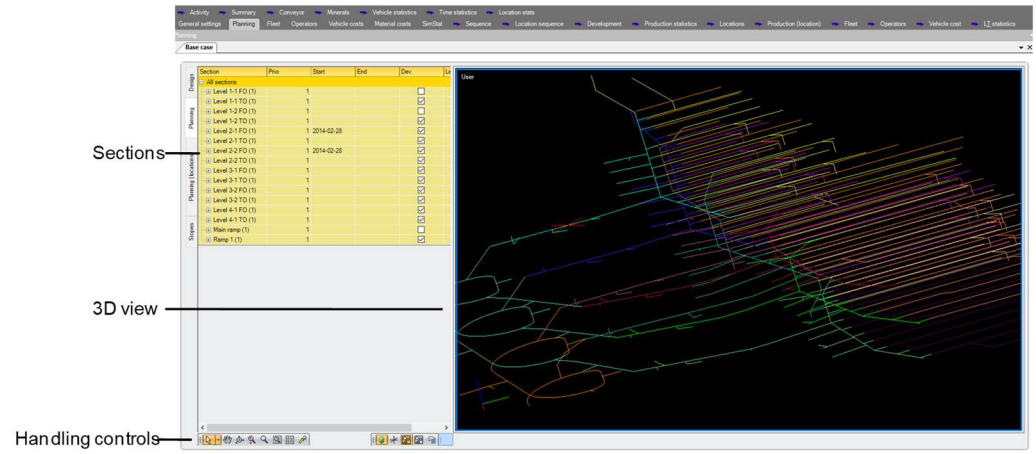


Figure 7-8 – planning for sections

The planning for section subpart consists of two parts:

1. Sections*1 - The section list shows each main section that exists in the layout. Each main section's name has its mine area within parenthesis. Each section can be expanded to show all its segments.
    - The list contains a number of columns, which can be modified by the user. These columns show information for the sections in this list.
2. 3D view - This shows the 3D layout, and let you select sections or objects to set its properties. Here you can also use tools to rotate, move or other ways to see the layout from different angles.

*1 See Section list on page 201 for more information of the section list and its information

7.3.6 Planning tab for locations

This works in a similar way as for the planning tab for sections, with the difference that this contains a list of objects which have been placed in the layout. It looks like the picture below.

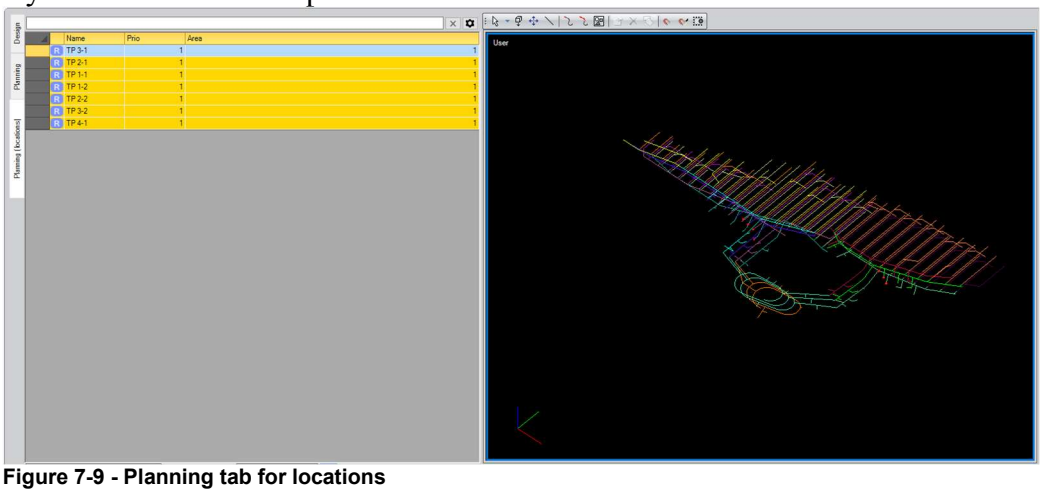


Figure 7-9 - Planning tab for locations

7.3.7 Steps to create a mine layout

A mine layout is needed to describe the mine that shall be simulated. The mine layout is not needed to look like the real mine layout. The most important is that the travel distances between the faces and locations (crushers, loading bays etc.),

are correct and consistent with the real mine. However, having a mine layout which reminds or is exactly as the real mine layout has its advantages:

3. Less prone to human errors in bigger layouts, when the user does not need to set any layout values manually in a real mine layout
4. Easier to believe the results when the model mine layout looks like the real layout.
5. Easier to communicate ideas in a real layout

The steps required to setup and configure the layout:

6. Create the mine layout, either by drawing the mine layout in SimMine, or by importing a CAD drawing of the mine design. When the mine layout is drawn in SimMine, the correct distances are hard to get correct since SimMine is not a CAD program and thus it lacks functionality to place locations and sections at precise locations. In this scenario, the distances between the locations and faces can be set manually, after the mine layout is drawn.
7. Verify that the mine layout does not contain any gaps. If it has gaps, it can prohibit vehicles to travel, and thus unexpected behavior as a result.
8. Divide the mine layout into sections based on the purpose and needs of the simulation.
9. Place all the locations needed. Locations can be crushers, loading bays, cement stations etc.
10. Set properties for sections and locations in the mine layout for how the work shall be done.

The above is a very brief description of the process to create a mine layout. It doesn't cover any work with specifying the development sections and flow of rock within the mine. These steps are described in the functionality descriptions below.

7.3.8 Functionality for planning tasks

The design part is the part where the design of a mine layout is meant to happen. With the design, things like dividing the layout into smaller parts, placing locations, and setting properties for how the development shall be performed and specifying transportation description, shall be done. Setting properties for sections and objects can be done from the subtabs for sections or locations as well, but the design and dividing the layout can only be done in the design view.

7.3.8.1.1 Import mine layout from a file

Note! Importing a drawing from a file requires that the file contain a center line, which represents the haul ways where development and transport will take place. Importing a file which does not contain a center line will have undocumented behavior since all lines are treated as center lines.

To import a drawing as a center line, click the ***Import*** button in the ***Import/Export*** group in the ***Settings/Data*** tab

Figure 7-10 Import button

The import wizard will show:

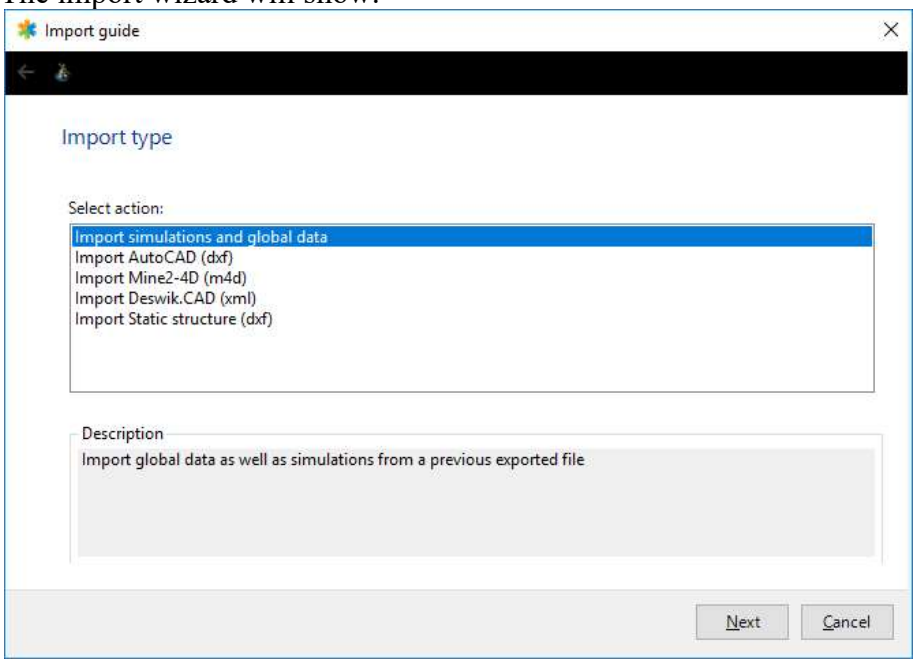
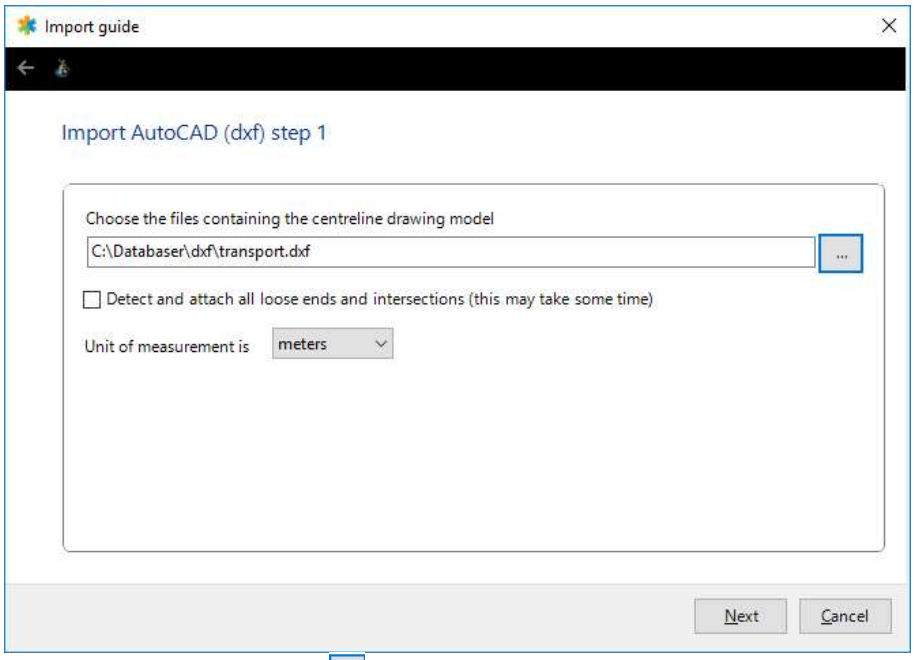


Figure 7-11 Import wizard

Note! The options available in the import wizard depends on the license.

Select Import AutoCAD (dxf), and then click ***Next***



Click the browse button (...). This will open up a file selection dialog box which allows you to browse for a file containing the center line file to import. If a layout already exists in SimMine, there will be a checkbox in this step which allows you to specify if the current layout shall be cleared before importing a new one.

The checkbox ***Detect and attach all loose end and intersections*** will perform an automatic gap detection and gap connect process, which will try to connect gaps in the imported layout. This can be done after the layout is imported with greater control. It is recommended that this is left unchecked and instead done later.

The measurement option tells if the import file is drawn in meters or any other unit.

Click Next when done. The next step will show:

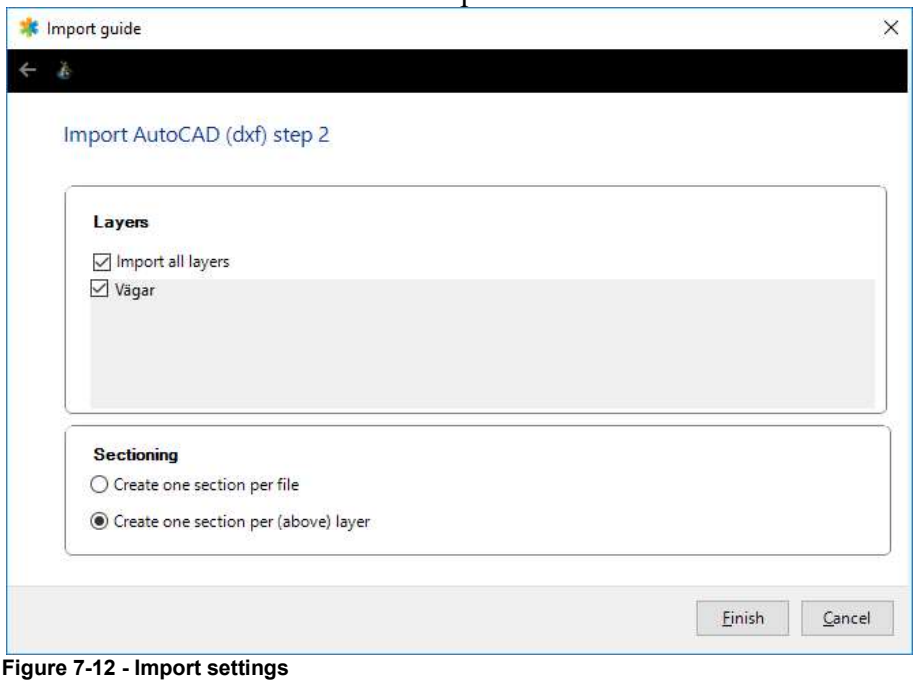


Figure 7-12 - Import settings

The import step 2 dialog lists all layers that were found in the drawing file. Select the layers you which to import. In the sectioning part, you tell how the imported parts will be sectioned:

11. Create one section per file – this will create one section per import file, which in this case will create one section from all imported layers.
12. Create one section per above layer – This will create one section from each found layer. The layers are listed in the Layers box in the screenshot above.

Click ***Finish*** to do the import. The imported layout is now visible in the 3D model area.

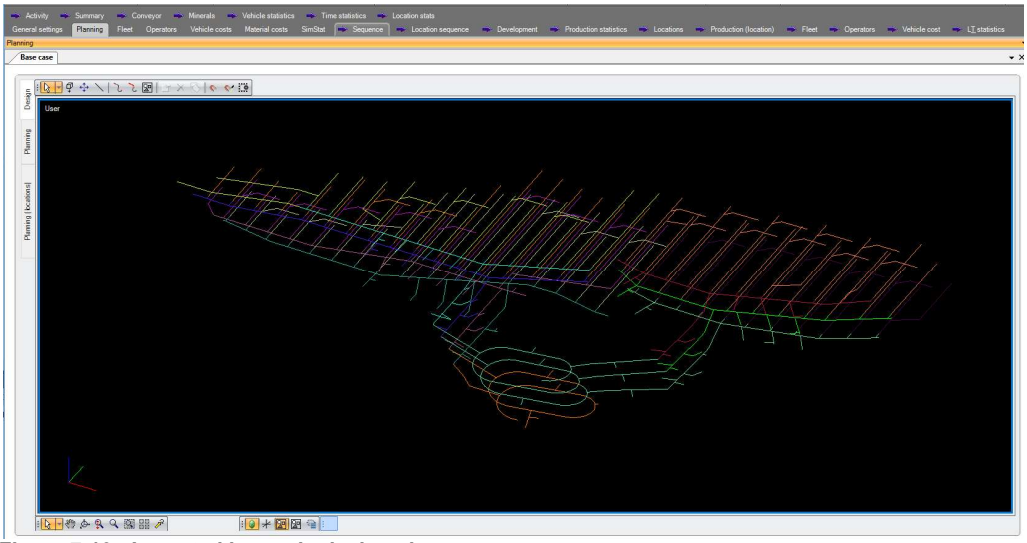


Figure 7-13 - Imported layout in design view

If you switch over to planning view (the planning tab found in the **subparts** in Figure 7-6 Planning tab on page 86), you will see each section contained in the imported layout (Figure 7-14 - Imported layout in planning view).

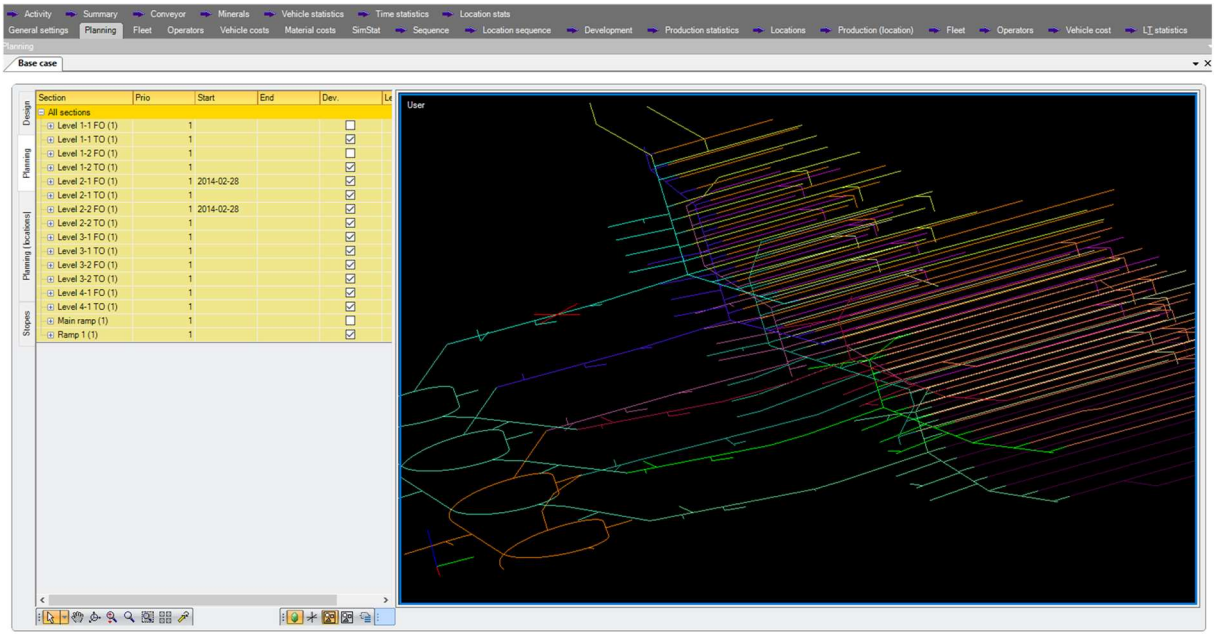


Figure 7-14 - Imported layout in planning view

A layout in SimMine must have all its haul ways connected. If a layout contains gaps, vehicle cannot travel to all placed in the layout when needed. This can cause vehicles to jump to their destinations (see Vehicle cannot find a path between two locations on page 191 for how to discover if any vehicle has jumped). To complete and verify the imported layout - look further into the following parts:
Verify that all paths in the layout are connected on page 99
Place an object in the layout on page 112

7.3.8.1.2 Update the layout with additional haul ways

To add more haul ways, a new import is done. The process of adding more sections (or haul ways) is exactly the same as when importing a new mine layout (see Import mine layout from a file on page 90). The only difference is in the import wizard, at the first step, which can look as figure below:

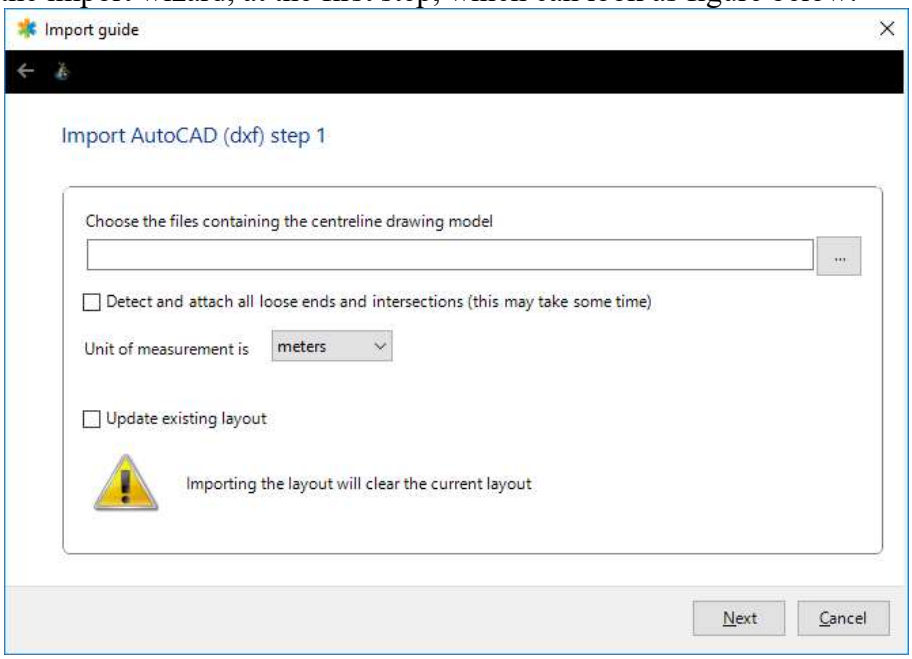


Figure 7-15 Update layout wizard

In the lower part is a checkbox which must be checked to update the layout. If this checkbox is left unchecked, the existing layout will be removed before importing the new layout.
The rest of the wizard is equal to the normal import process described above.

Note! An update will not import lines that already exist in the mine layout. However, even though two dxf files contain the same layout, but created from different exports, the points can differ in their coordinates, even though it is only by a fraction, they are still treated as different points, and therefore, this can create lines which are almost on top of each other. Of this reason, it is recommended that an update file only contain the parts that shall actually be added, and not an already existing layout

An update of the layout can also be done by copying and paste from another layout. See Copy a layout from another model on page 114 for information on this

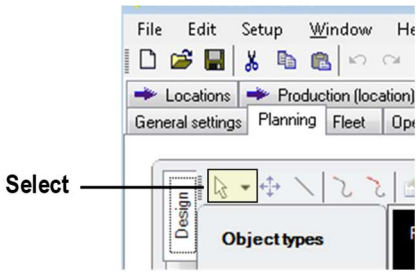
7.3.8.1.3 Modify sections or objects - general info

To modify sections or objects, the section or object must first be selected. When items are selected, modification can then be done on the selected items, such as altering their properties, merge sections etc.

All of these modifications that can be done for a section or object are listed under other captions in this chapter. For a reference manual of each function available, see Appendix B– Interfaces.

7.3.8.1.4 Select a section or part thereof

Click on the "select" button. It is located above the 3D layout view in design mode. It can also be found in the camera controls below the 3D layout view.



The select tool has three modes. These three modes can be selected by clicking the small arrow beside the select tool.

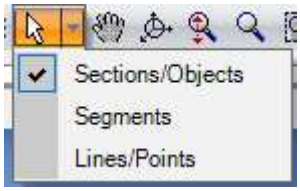


Figure 7-16 Select modes

The three select modes are:

Sections/objects

This will select complete sections or objects. This is the tool you will use when selecting sections and objects to display their properties. Properties can in most cases only be set on complete sections and objects.

Segments

This will select a section segment (a segment is between intersections). No properties can be assigned to segments. Segment selection is useful for other means

Lines/points

This will select the individual lines or points.

Segment selection and lines/points selections cannot change any properties for them. These select modes are instead useful for other things, such as:

13. Creating a new section from the currently selected segments/lines. This is done by right-clicking somewhere in the 3D view and select ***Set as new section*** from the context menu
14. Assigning selected segments/lines to a layer. Layers are used to hide/show parts of the layout to show other parts, which may be behind

other segments/lines. This is to clean up the layout when editing it/moving its parts.

Each select mode allows selecting one or more object by using the CTRL key, or window selection.
Selections by using CTRL key is done by selecting one item, and then holding down the CTRL key and select the next item.
Window selection is done by clicking at an empty space in the 3D world and then dragging the mouse while holding the left mouse button. This will select all items within the selection window.
Only items of the same type can be selected at the same time. You can for example not select a section, and a placed object, such as a crusher. Window selection will always select sections, segments or lines depending on the selection mode - never objects (crushers etc.).

Example: To select two different sections, select the complete select tool, and click on the first section. After it has been selected, hold the CTRL key and click on the next section. This other section is now added to the current selection.

7.3.8.1.5 Navigate in the 3D world

Navigation means to rotate, pan and zoom, so the viewed layout can be seen from an angle of your choice. The navigation controls can be found under the 3D window.

Figure 7-17 - 3D navigation tools

These controls allow you to select a 3D navigation tool, and then by using the mouse inside a 3D view you can pan, rotate etc.
The tools to use from Figure 7-17 - 3D navigation tools are:

Select tool
This is not a 3D navigation tool and is described in Select a section or part thereof above.

Pan
This allows you to pan the camera. Click and hold the left mouse button while dragging will cause the camera to move.

3D rotate
This allows you to rotate a view in 3 dimensions. Click and hold the left mouse button while dragging to rotate.

2D rotate
This allows you to rotate a view in 2 dimensions. The view's Z-axis is used for rotation. Click and hold the left mouse button while dragging to rotate.

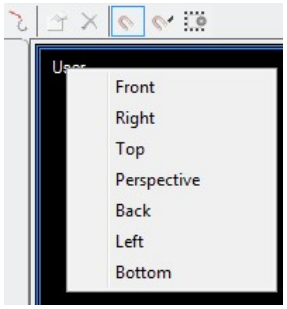
Zoom discrete steps
This will zoom in or out in a view. Left-click to zoom in, and right-click to zoom out. The zoom is done in discrete steps.

Zoom
This allows you to zoom a view in or out. Click and hold the left mouse button while dragging to zoom.

Zoom window

This will allow you to zoom to view what is inside a window drawn in the view. Click and hold the left mouse button while dragging to create the zoom window. When the mouse button is released, the drawn window will be the current view.
View All. This will zoom and pan all views so that any existing layout is fully visible within every 3D view.

A view can also be set to show one of several pre-defined views, such as a top view and front view. Right-clicking the top-left label in the view to change does this. A popup menu shows the different views that can be selected:



All views except "Perspective" are orthogonal views.

7.3.8.1.6 Move an item

Click the move tool. It is located in the tool bar above the 3D layout window in design mode. This works as a select and move tool - that is, you select the item (section, segment, line, point or object), and then move it with the same tool.
The selection mode used when selecting an item with the move tool is the same mode as the last selected selection mode. See: Select a section or part thereof above for more information about selection modes.

Example: To move a complete section, select the "Sections/objects" select tool, and then click the move tool. You do not need to click the select tool before moving an item if the last select mode used is the correct one you wish to use.

7.3.8.1.7 Delete an item

Select the item to remove by selecting the correct select mode tool button. Press the "Delete" key or click the delete button in the toolbar:

7.3.8.1.8 Create a new section from existing parts in the layout

A section is a user-defined part of the mine. The mine consists of one or more sections. Creating new sections should be done based on model requirements. Each section can hold unique properties. If two parts of the layout need to have different properties, the layout needs to be divided into two sections.
Click the "Begin a new section" ( ) tool to start creating a new section. A "New section" window will appear. This window shows information about the new section. The new section will not be created until you click the "OK" button in this window. Click cancel to abort the section creation anytime.

Figure 7-18 - New section window

Note! This will create the new section from one or more existing sections. It will not create new lines to be included in the new section.

15. Select a start point for the new section by clicking on a point in a 3D view. The selected point will show as a selection box. The selected point can be placed or moved to somewhere else by left-click again on the new location.
16. When you are satisfied with your start point selection, right-click to confirm the selection. When you have confirmed your selection, the point cannot be moved.
17. Select another point that will become a limit of the new section. Right-click to confirm your selection.
18. Repeat the above step to place other limits on the new section's boundaries.
19. When two or more points have been selected and confirmed, the route between these points is shown in the new section window. The length of the route will show as well. The route will also be highlighted in the 3D view. (See example in Figure 7-19 - Section started)
20. Click "OK" to create a new section that contains the selected routes.

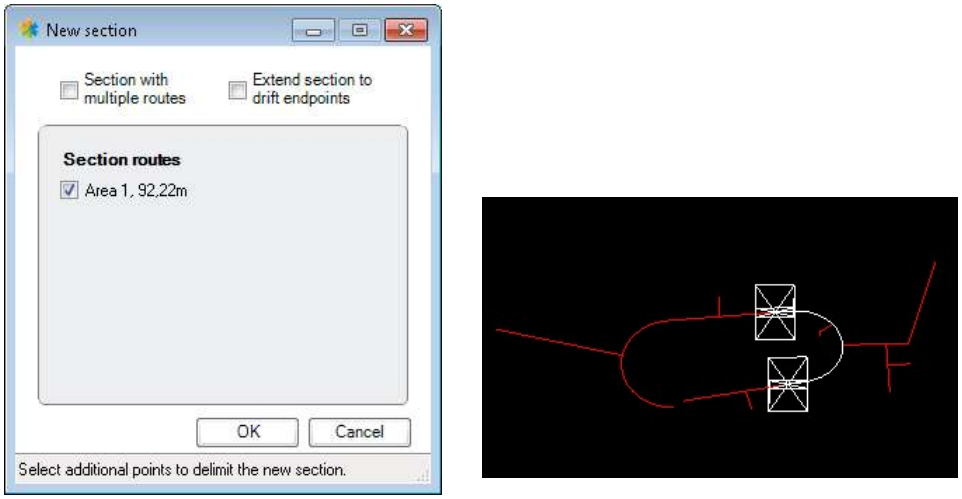


Figure 7-19 - Section started

When there is at least two points placed for a new section, you can use other options to extend and create the new section. These options are the two checkboxes in the top of the new section dialog box:

21. Section with multiple routes: This will calculate every route between the selected points. These routes will show up in the new section window where you can check which routes that shall become the new section.

Note that for a complex layout with several routes between each point, this operation will take a substantial amount of time.

22. Extend section to drift endpoints: This checkbox will select all paths that begin between the placed points, and extend that selection to the end of each path, even if it includes the full layout. For example, if you have several small loading bays placed between the start and end points, and you wish all those loading bays to be part of the new section, this checkbox will select those loading bays as well.

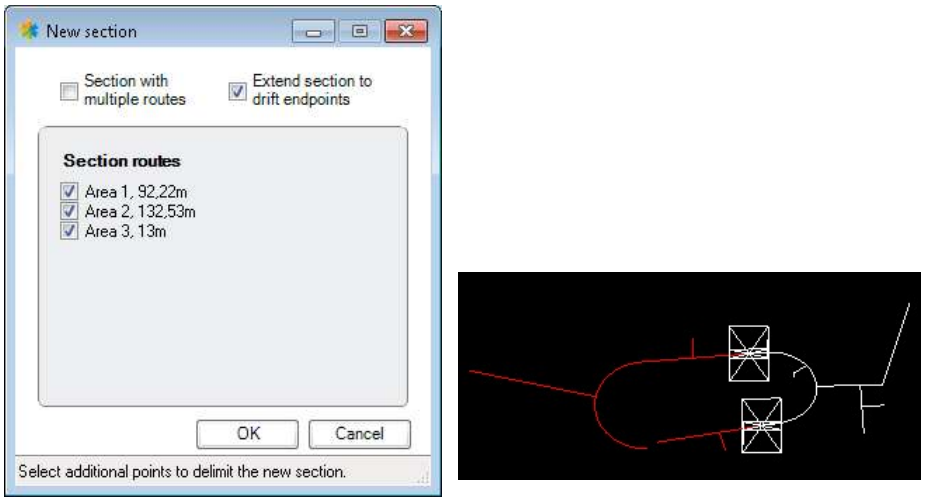


Figure 7-20 - New section with endpoints

In the same way as for multiple paths, you can select which parts that you want to include in the new section. Uncheck or check the checkboxes for the parts to include in the new section. You will see which parts are highlighted in the 3D layout.

Click ***OK*** to create a new section from the highlighted parts in the 3D layout. The newly created section will have the same properties as the section where the start point was placed, and will appear in the section list (see Figure 7-8 – planning). The name of the new section is a default name.

7.3.8.1.9 Verify that all paths in the layout are connected

It is important to verify that there are no gaps in the layout. Gaps means that vehicles may not find a path between two points. In these cases, the vehicles will “jump” to the destination, causing the time to reach the end point to be instant. These events will cause a warning in the SimMine log window (see Vehicle cannot find a path between two locations on page 191 for how to check the log window).

The layout consists of one or more fragments, where each fragment is one part of the layout which isn’t connected to any other part. Therefore, in most mine layouts, only one fragment should exist. The number of fragments is checked in the attach dialog.

As an example of a layout with several fragments, another layout is used to visualize fragments

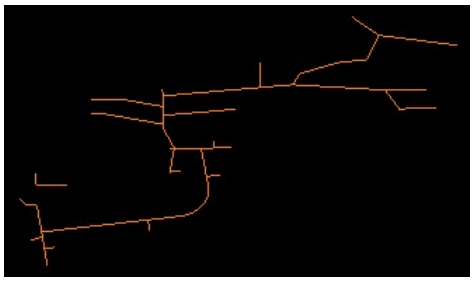


Figure 7-21 – Layout with multiple fragments

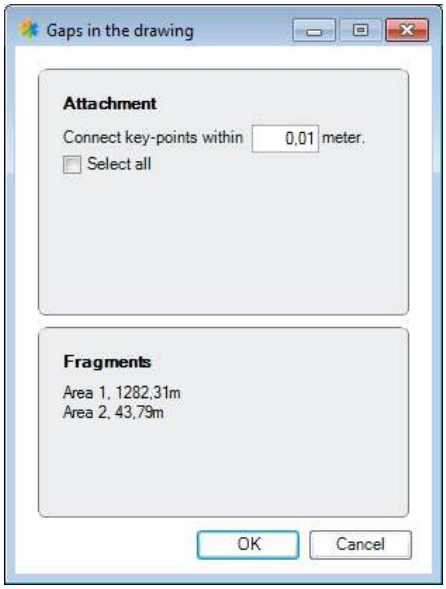
As can be seen in the layout above, it consists of two visible fragments (to the lower right in the picture).

Note! In the above layout, the fragments are clearly visible. It exists many layouts where the gaps in the layout between fragments are very small and cannot be seen by the user unless zooming in. A gap can also be invisible due to that two points are at the same coordinates, but aren't connected to each other.

Open the attach dialog by clicking ***Attach*** in the Visualization group in the Start tab in the SimMine application

Figure 7-22 - Attach button

The attach dialog from the Visualization menu look as below



In the bottom part of this dialog, there are two fragments (as seen in the example layout). In the above layout, the gap is clearly visible, so it is not necessary to check where this gap is. However, the process of discovering these gaps will be performed here to show which steps are done to see where gaps are:

23. Click on one of the fragments in the fragment part of the dialog box. The selected fragment is selected in the 3D view. The smaller length of the fragment which is selected, the easier it is to discover the point where the gap is, since large fragments may have multiple gaps to surrounding parts of the layout.
24. You can see where the selection stops in the 3D view (i.e. which part of the layout is selected, and colored white. In there, it is also visible which parts that are not selected. The gap is therefore where the selection ends, and the unselected layout begins.
25. In cases when the layout is big, and the fragments are small, it may be hard to exactly spot the selected or unselected parts. In those cases, right-click on a small fragment. Select ***Zoom to*** from the popup menu. The 3D view is zoomed to the selected fragment.

When the gap is identified, it can be connected to the rest of the layout. See Connect broken paths on page 104 for information how to connect parts in the layout.

7.3.8.1.10 Verify that a path exists between two locations

It is important to verify that different paths can be used in a mine layout. If a path cannot be used, the vehicle "jumps" to its destination, and thus will create unexpected results.

The attach dialog is a good place to check how many fragments the layout consists of. A fragment is one part that is not connected to any other part. For a typical mine, it shall only consist of one fragment, meaning that each haul way is connected to at least another haul way, and that vehicles can find a travel route when it will travel. See Verify that all paths in the layout are connected above for information how to check number of fragments.

Note! Even if the mine only consists of one fragment, it doesn't necessary mean that the mine layout is ok. It may exist 2 routes between 2 locations. If one of these routes is broken (a vehicle cannot travel there), all vehicles travelling between these 2 locations must choose the second route, which might be a longer route.

The verification process of verifying that a path exist is only necessary in layout where there are multiple paths between two locations. To correct the layout when it contains several fragments is described in Verify that all paths in the layout are connected above.

When the layout does only contain one fragment, the next thing to check is if all major paths are correct.
This is easiest done with the ***New section*** tool found in the tools above the 3D layout view. See further page 97. To use this tool to check routes, do as described below:

1. Select the ***New section*** tool.
2. Start the new section at a location from where to check if a route exists.
3. Place the second point at the location to which the route shall be checked. The shortest path between these locations is now highlighted in the 3D layout.

4. If the shortest path isn't highlighted, it means that the path is broken somewhere between the two locations. To further pinpoint where the gap is in the path, you can add more points along the path. The path shall be highlighted. When a path isn't highlighted, it means that the gap is between the closest selected point and the newly placed point.
5. When a gap is discovered and found, you can close the gap. See Attach points in the layout manually on page 107 to see how to connect a broken path.
6. When you have verified that a path exists (or not exist) by using the ***New section*** tool, click ***Cancel*** to close the new section window. The new section tool was only used to verify if a path exists between the placed points.

7.3.8.1.11 Create a section

Creating a section does not include adding parts in the layout. It is simply a matter of creating a new section from already existing parts in the layout. Remember, a section is a user defined part of the layout, which can be as large as the full layout, or as small as a single line.
To create a section, there are multiple ways it can be done.

7.3.8.1.11.1 Method 1: New section tool

26. Select the ***Begin a new section*** tool ( )
27. Check the ***Snap to all points in the drawing*** tool( ) This will cause the cursor to snap to points in the layout, which gives you the opportunity to start a new section at the end of a line. This step is not required but can be a good help, especially if the new section shall start at the end of a line.
28. Start a new section by clicking at that point. When you move the cursor close to the end point it will turn green if snap is used, which tells you that it has found a point. Confirm the selection by right-clicking.

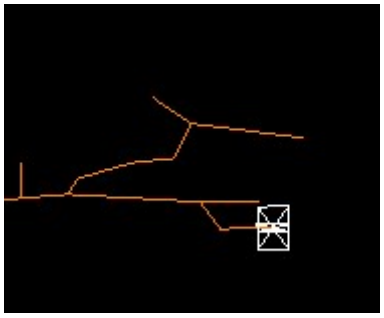


Figure 7-23 - End point selected

29. Select the next point of the new section at another point, just as under the previous bullet point. Right-click to confirm the selection. The line between the two selected points is now highlighted in the layout as seen below.

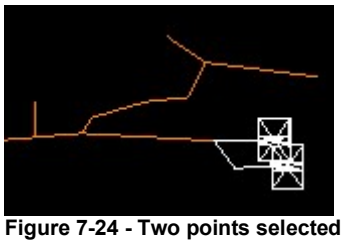


Figure 7-24 - Two points selected

30. You can continue to select points to extend the section.
31. When you are satisfied with the section, click ***OK*** in the ***New Section*** tool window. This will create the section.

7.3.8.1.11.2 *Method 2: Define the section by selecting parts of the layout*

32. This method will create a section based on a selection in the mine layout. You can select parts of the layout by either doing section selection, segment selection, or line selection (see Select a section or part thereof on page 95 for the differences between these selection modes). This example uses segment select.
33. Start by selecting the segment selection tool ( ). Click the down arrow and select Segments.
34. In the 3D view, select the segments that will make up the new section. You can either select by clicking and dragging to select all segments contained within the selection window, or by clicking one and one and holding down CTRL key to select multiple segments.
35. When you have selected all segments, which will be the new section, right-click and chose ***Set as new section*** from the dropdown menu. The selected parts will now become the new section

Create a section which contains every side road

This example uses the same layout as in Method 1: New section tool above. This is good if you have a part of the layout where you want to create a new section and include all loading bays along the way between the start and end point.

36. When at least two end points for the new section are specified, and the ***New section*** tool window is still open (i.e. the new section is ongoing), check the ***Extend section to drift end points*** checkbox.

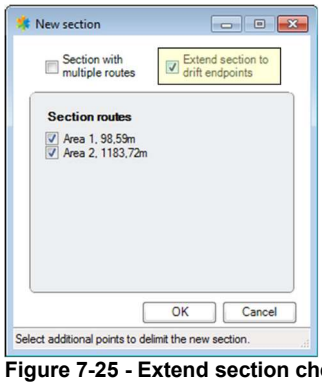


Figure 7-25 - Extend section checkbox

37. This setting will cause the selected section to extend itself to all end points, starting from each intersection it will find within the selected section. As seen in Figure 7-24 above, an intersection exists between the two selected points. When the checkbox to extend the section is checked,

the section is extended, starting from that intersection. Due to that the path from the intersection has more intersections; it will expand to the whole layout if no gaps are found.

38. The highlighted section in the layout now shows which lines that are connected to each other. The only part that is not selected is the separate small brown part seen below.

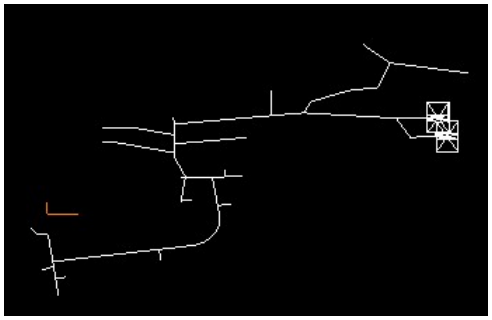


Figure 7-26 - Found gap

39. To exclude some parts from the section which will be created, those parts can be unchecked from the New section tool window (see Figure 7-25 - Extend section checkbox)

7.3.8.1.12 Connect broken paths

When a gap is found in the layout, it can be connected by using one of the following methods (or a combination of them).

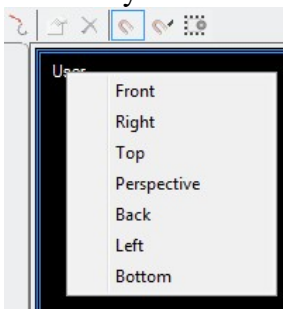
1. Connect it by drawing a new line between two points in the drawing
2. Connect it by moving a point so that it will connect.
3. Connect them by attaching them (this connects them without modifying the layout)

Each of the above methods is outlined here.

7.3.8.1.12.1 Connect it by drawing a new line

To be able to draw anything in the layout, an orthogonal view must be used. In perspective, no lines can be drawn.
Follow these steps to draw a line between two points:

1. Switch to a suitable orthogonal view by right-click on the top-left label in the layout view. A context menu appears:



7-27 - view context menu

2. Select a suitable orthogonal view (all except Perspective)
3. When the view is in an orthogonal view, select the Begin a new section tool
4. Select the Snap to section end point . This will ensure that when the mouse cursor comes close to an end point, it will snap to it. The snap is also

placing the marker at the level of the snapped point. If the snap function isn't activated, the start point of the line will be placed on the ground level (at z elevation 0 if using top view).

5. Start a new line by clicking the first point to connect, and then on the second point. Right-click to confirm that you are done with the new line.
6. The gap is now filled

7.3.8.1.12.2 Connect by moving a point

The function to move points can only be done in an orthogonal view. Right-click on the label in the top-left corner of the view. A menu shows which let you set which view to show. Select ***Top*** view to show the layout from the top.

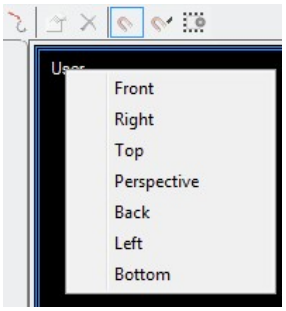


Figure 7-28 - View context menu

It is recommended to zoom in as much as possible so the point to move, and the location where the point will be moved to, are clearly visible. Select any of the zoom functions, or zoom in by scrolling the mouse wheel. When the view is zoomed as desired, it is easier to move the point.
An example is shown below, where point A will be moved and connected to point B in the layout.

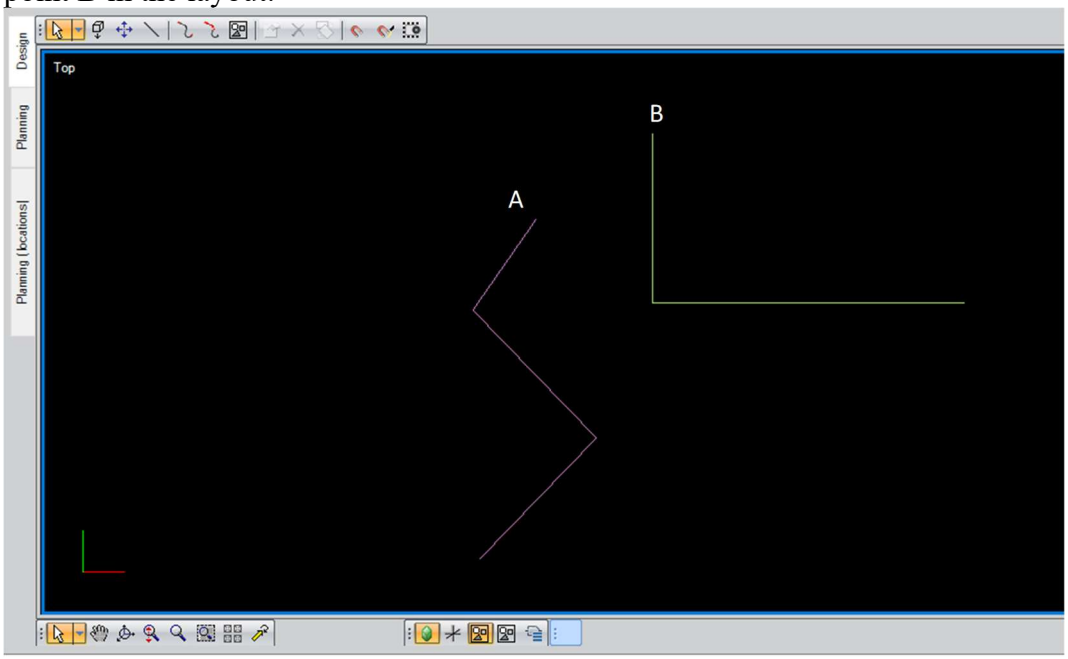
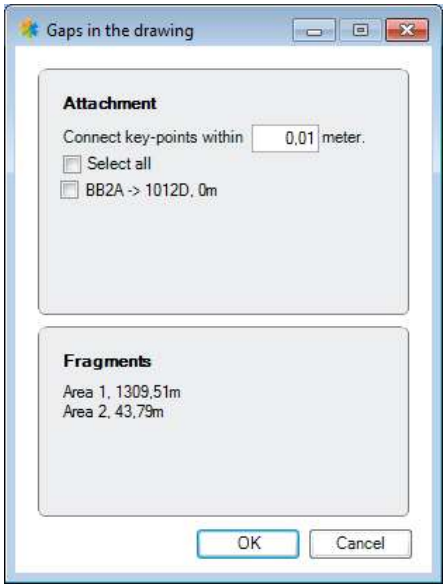


Figure 7-29 – Example layout for moving points

Move point A to point B by performing the following steps:

1. Select the ***Select Lines/Point*** tool from the selection dropdown control ( ). This selection mode allows the user to select a single point in the layout. An example view is seen above, where the A and B are not visible in SimMine - they are just used in this example.
2. Select the snap tool ***Snap to all points in the drawing*** to assist when moving the point. The snap function is advised to use since it will help to move the point exactly at point B's position. If snap is not used, the move may require additional moves if the two shapes are at different levels (i.e. Z elevation if the view is seen from the top). You cannot see if they are at different levels in the Figure 7-29 – Example layout for moving points due to that the view is from the top. If you don't use snap, the move will occur at the same level as the point was from the beginning - then, if the two shapes are at different levels, you might have to show a front view to move the same point up or down so it will be close to the 'B' point.
3. Select the ***Move*** tool . The move tool operates in the same mode as the last selected selection mode. In this case, it will operate in points/lines mode.
4. Move the cursor to point 'A'. The cross will turn green when it snaps to that point. Click and hold the left mouse button. Drag it to point 'B'. It will snap to that point (but without the green cross).
5. Release the mouse button when the move has completed
6. The two points are not connected, they are just moved on top of each other. To connect these locations, open up the attach window (from Visualization menu).



7. In the top part, all points that are closer to each other than 0.01 meter are shown. Check the only entry here. This is the 'A' and 'B' point, and they are 0 meter from each other (i.e. at the exact same location).
8. To verify that the shown points are the 'A' and 'B' location, click the label for the checkbox. The points are highlighted in the 3D layout. There you will see that it is the newly dragged point.

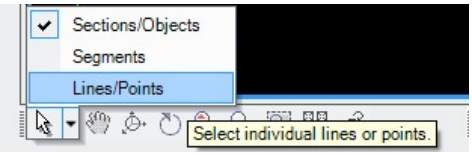
9. When you check the checkbox, you will notice that the number of fragments in the lower part will decrease. This is also a way to determine that the attach was as expected (to bind the two fragments together in this example)
10. Click ***OK*** to confirm.

7.3.8.1.12.3 Attach points in the layout manually

In the attach windows (accessed from Visualization group under the Start tab), a list of non-connected layout parts is listed at the bottom (fragments). These fragments are not connected to each other, and thus no traffic or material can flow between these fragments. In Verify that all paths in the layout are connected on page 99, a description how to attach these fragments with a different method exist.
In some cases, it can be easier to simply select the points that shall be attached, and then attach them. This method is shown here. As an example, the same layout as in Figure 7-21 – Layout with multiple fragments is used

In this example, the points A and B shall be attached to each other. There is a visible gap in the example, and the attach shouldn't be done when the gap is too large. Then it is better to move the points closer to each other, or to draw a connection line between the points. Attach will simply attach points with a 0-length path.
To attach the points manually, perform the following steps:

1. Select the Lines/points tool from the select tool splitter



2. Enable snap functionality to assist.
3. Next, select the points to attach to each other, either by dragging a selection window which covers both the points to attach, or by manual selecting one of the points, and then additional point while holding down the CTRL key. The selection should look like below (zoomed in)

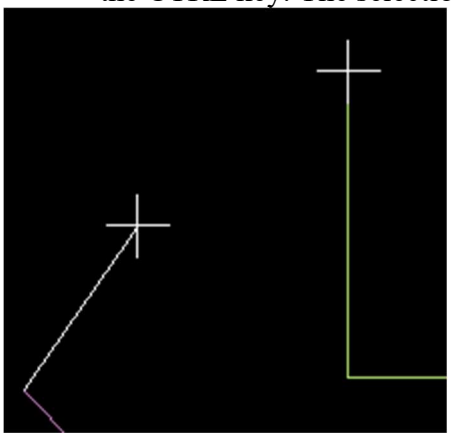
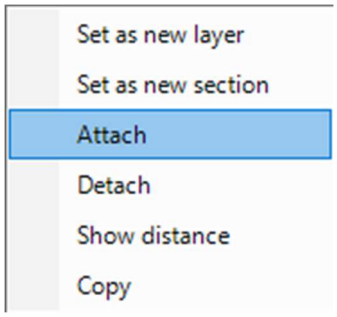
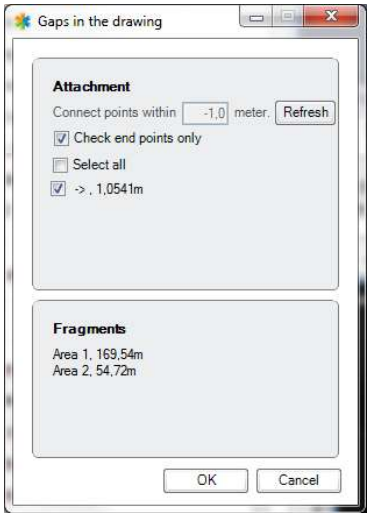


Figure 7-30 - Selected points to attach

4. Right-click anywhere in the 3D layout area and select "Attach" from the pop-up menu.



5. The attach dialog will show with only the selected points in the list of points that can be attached. Click to check the checkbox next to it.



6. Click ***OK***. The points will now attach to each other.

Note! The above steps to attach points will also work if lines are selected. The closest distance between the selected lines (or between a line and a selected point) will show up in the attach dialog.

All attach method will attach points to each other without moving the points that are attached. They will be attached with a 0-length connection. After an attach is completed, it can now be tested if the layout has been connected. This is described in Verify that a path exists between two locations on page 101.

7.3.8.1.13 Draw your own path

Click on the line tool. A draw line tool window shows. This tool will allow you to draw your own line, which will be treated as a path in the layout. Drawing lines can only be done in orthogonal views.
Two methods exist when drawing a line, either by entering its coordinates, or by drawing it in a 3D view.

7.3.8.1.13.1 *Draw a line by entering its coordinates*

1. Entering the line's start and end coordinates in the draw line window

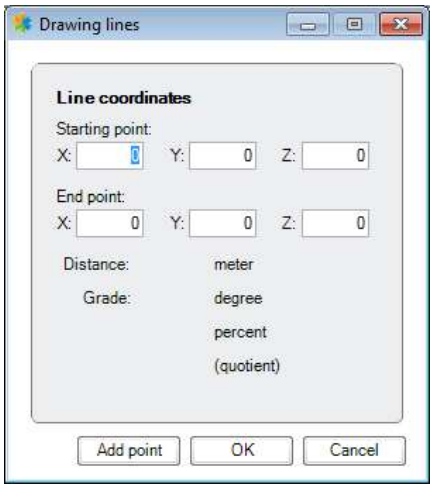


Figure 7-31 - Draw line window

2. If the line will only contain 2 points, jump to step 5.
3. Click ***Add point*** to add another point along the line. The previous end coordinates will now become the start point coordinates for the next line.
4. Repeat step 2 for each point along the line to create.
5. Click ***OK*** when done. The line is created and shows in the 3D views.

7.3.8.1.13.2 *Draw a line in a 3D view*

1. Activate the 3D view where the line will be drawn in. If there is only one 3D view, skip this step
2. Start a new line by left-click in the view to start creating the line. The draw line window will show information about the drawn line.
3. Move the mouse to where you wish to set another point for the line and left-click.
4. Repeat step 3 for each point along the line you wish to create.
5. When done, right-click to confirm. The line is now created.
6. Repeat step 1 to 5 to create additional lines. When done, click ***Cancel*** in the ***New line window*** or select another tool. This will end the new line tool.

When snap is used, the point will be at the same location as any point it snaps to when left-clicking. When snap is not used, each point is created in the ground plane for the view that you are drawing in.

Note! The line is always created in the view's ground-plane when no snap is used. This might have an undesired effect when drawing new lines. For example, if you are viewing a layout which has all its lines at Z level (height from the ground) set to 200, and you are drawing a line in the top view (which has Z level 0 as its ground plane), the new lines will be drawn at Z = 0. You must then move the lines to Z=200.

7.3.8.1.14 Check development direction

In the visualization menu, click the ***Show direction***. Red arrows in the 3D layout show in which direction the development will be done. Click "Show directions" again to hide the arrows.

7.3.8.1.15 Change development direction

Select the section or segments you wish to change the development direction for. Right-click in the 3D layout area and select "Change direction" from the context menu. You can also right click the section in the sections list (see Section list on page 201**Fel! Hittar inte referenskälla.**) and click the "Change direction" from the popup menu there. This is only valid when the development license exists.

7.3.8.1.16 Set development direction

Set development direction can be used if there are multiple segments which need to have their development directions changed.
To check current development direction, check the “Show direction” in visualization menu. This shows the current development direction for all segments. An example can be seen in picture below.

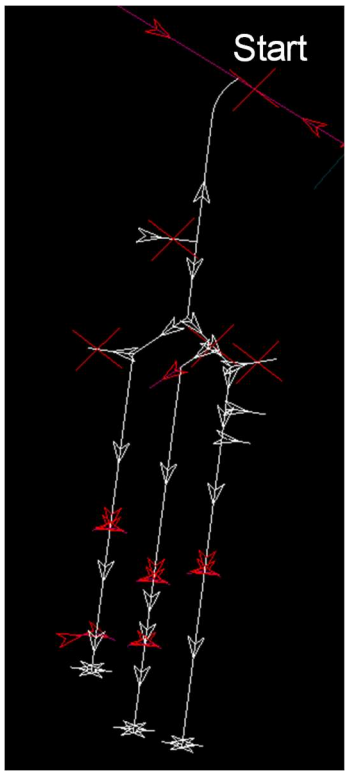


Figure 7-32 - Development direction

In this example, the development direction will go from the point marked as “Start”. As seen, the direction is currently not set as desired. There are two options for specifying the development direction:

1. Manually, on each segment. This is described in Change development direction above. This could involve a lot of changes in sections where the development direction is wrong on many segments.

2. Based on start point; This method does fit when the development direction will be done from a specific point in the mine. The point from where

the development direction will start does not need to be within the section itself, and can thus be outside of the section whose development direction you wish to set.

In the example picture above, the direction will start at the point marked “Start”. This fits into method 2.
Note! There are only two segments with wrong direction in the picture above, so method 1 can be used as well. However, method 2 will be shown here.

To set the development direction by specifying a start point for the development, do as follows:

1. Select the section to set direction for (the white section in Figure 7-32 - Development direction)
2. Right-click and select “Set start point” from the context menu. The start points dialog shows:

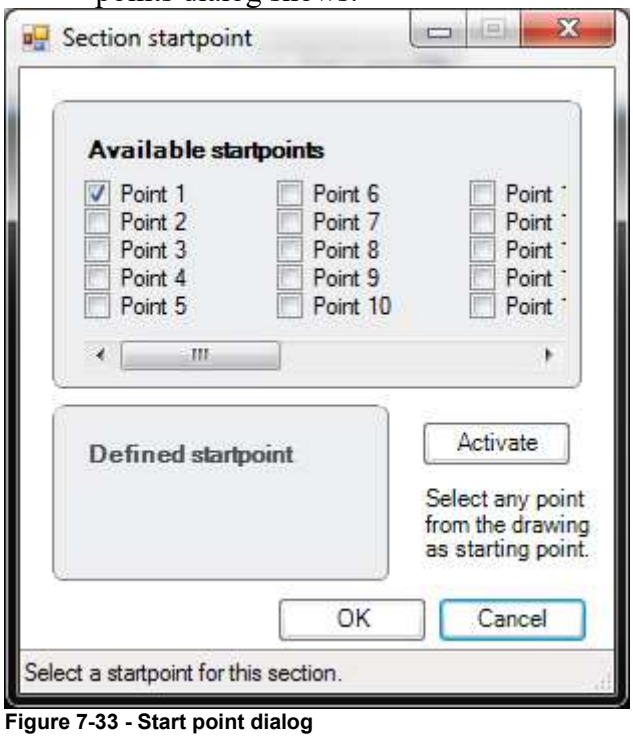


Figure 7-33 - Start point dialog

3. Select the point you wish to have as the start point for development from the list of available start points.
   a. Method 1: Select it from the “Available start points” list. The selection shows in the 3D layout. Make sure that the correct point is selected. This can be a hard task if there are many points in the section.
   b. Method 2: Click the “Activate” button and then click on a point in the 3D layout. You can click any point, even outside the current section. The development direction will then be calculated from the placed start point.
4. Click “OK” to accept your choice. The development direction is now set according to your selected point. If the direction is in the wrong direction now, you only need to change the development direction for the whole

section (not the individual segments). Do this by selecting the section, right-click and select “Change direction” from the context menu.

7.3.8.1.17 Place an object in the layout

Objects are used to handle rock, or act as a recipient, meeting point etc. Many objects are recipients which are the only locations in the layout which can receive rock.
Objects (i.e. locations) are placed with the help of the Place object tool found in the toolbar in the planning view ( ). See Figure 7-6 Planning tab on page 86 for more info of the planning tab and its tools.
To place locations, do as:

1. Open the ***New object*** tool:

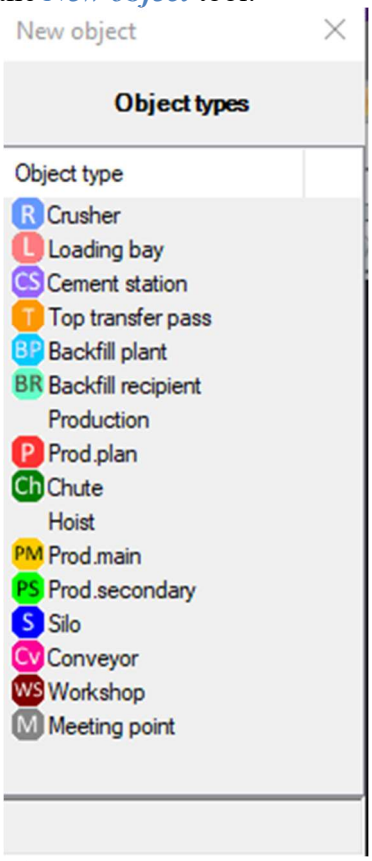


Figure 7-34 - Objects

2. Select the object you want to place in the layout from the ***New Object tool*** window. Note that some objects might not exist in your version of SimMine since your license might not allow some object types.
3. Next, place the selected object in the 3D layout by clicking on the section where you wish to place it. If you are not happy with the location, just left-click again somewhere else.
4. When you are happy with the location of the new object, right-click to confirm its location. The placed object is now part of the layout and can be used in the simulation.
5. Repeat step 2 to 4 if more objects will be placed in the layout.
   a. If multiple instances of the same object type shall be placed, there is no need to select the object again from the ***New object*** window, just continue from point 3 instead.

6. Close the ***New object*** window when done.

7.3.8.1.18 Dependency between two sections/objects

A dependency means that one section or object must have reached a certain state before the second section or object can commence.

Terms: **Master** section/object is the section/object which has dependent sections or objects bound to it - it does not depend on other sections/objects.
Slave section/object is the section or object that depends on other sections/objects.

Note! A section or object may be both master and slave

The dependencies are set in the property window for a section or object

In the description below, a section object is used, but the same apply when setting dependencies for objects.

Open the properties for the section, and switch to the Depends on, or Dependent objects tabs:

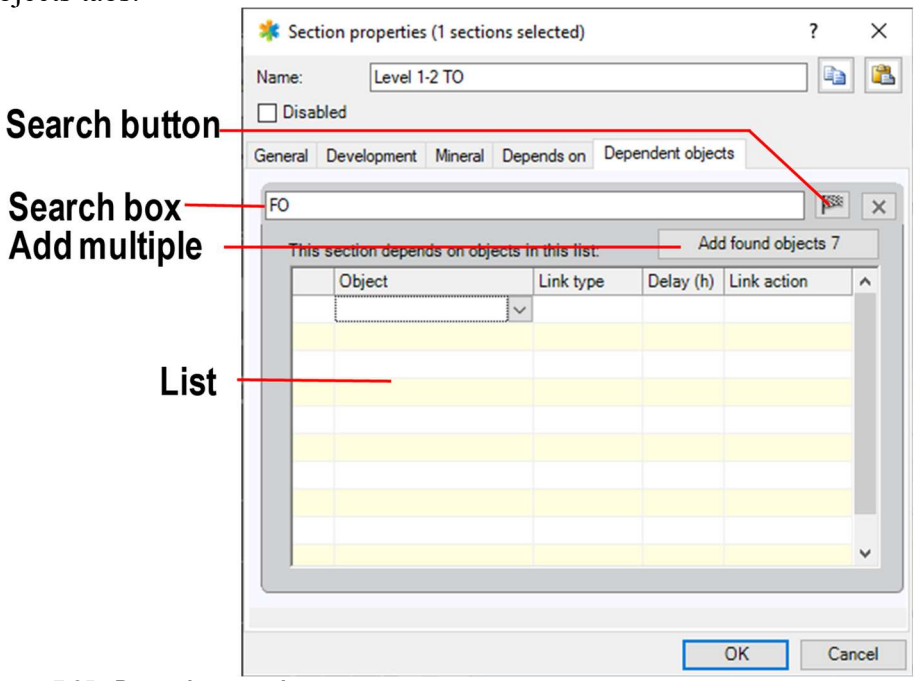


Figure 7-35 - Depends on settings

If the section shall become a master (i.e. other sections or objects will depend on it), use the ***Dependent objects*** tab. This is where all sections/objects which depend on the current section is listed and set.
In the ***object*** column, expand the dropdown list (which is visible when you have the cursor in the object column), select which section/object that will depend on the current section which properties are open. In cases when the list of objects in the dropdown list is long, you can filter it by specifying a filter string (***Search box*** in picture above) in the textbox above the list of dependent objects, and then click the flag button (***Search button*** in Figure 7-35 - Depends on settings above)

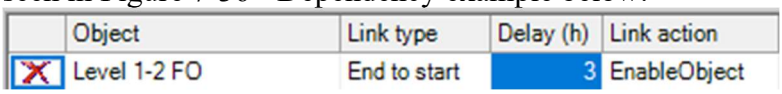
to filter. The next time you expand the dropdown list for the objects to select among, only the filtered sections/objects are shown. In cases when you need to add multiple dependent objects, and all dependent objects can be filtered out, you can first enter a search criterion in ***Search box***, click the ***Search button***, and then click the button ***Add multiple*** to add all found sections/object. The button text for the ***Add multiple*** button shows the number of found sections/objects.

There are a couple of different dependency types:

- End to Start, which sets that the slave cannot commence until this has been completely done.
- Start to Start, which sets that the dependent slave may commence at the same time that this commences.

Set the dependency type in the link type column dropdown list.

A delay and an action can also be specified for dependencies. An example is seen in Figure 7-36 - Dependency example below:



	Object	Link type	Delay (h)	Link action
	Level 1-2 FO	End to start	3	EnableObject

Figure 7-36 - Dependency example

The delay sets how many hours which will pass from the point when the dependency triggers, and until the action is performed. The action is set in the last column under ***Link action*** column. In the example above, Level 1-2 FO section will become enabled after 3 hours after the current section (which the properties are shown for) become finished.
In most cases, the link action has only one option to enable the object.

When a dependent slave is set as in the above example, the properties for the slave will show the master section in the ***Dependent on*** tab in its properties.

7.3.8.1.19 Copy a layout from another model

Adding parts to a layout can also be done by copying required sections from another layout, in another simulation model. This is useful when only parts of a layout have changed. A new import can be done, but this is a bit risky if multiple parts not known about have also been changed, in which case these changed sections are imported. If the change is very small, the new section will be imported on top of the already existing section. Their coordinates will be almost the same, but for the end user, it is very hard to discover these sections which are on top of each other, with almost the same coordinates. Therefore, a good solution to import only knows parts of a layout is done by copying missing parts from another layout. This can be done as:

1. Open the simulation model which shall receive new sections (destination layout)
2. Create a new simulation model. Its name is not important. This will open up as a new model tab in SimMine and you can switch between the two models.
3. In the new model (source model), import the layout.
4. After the import is done, switch to the Planning tab and find and select the sections that shall be copied to the destination layout.
5. Right-click and select ***Copy*** from the context menu

6. Switch to the destination model. Paste the copied sections by right-clicking and select Paste.
7. The copied sections do now exist in the destination layout.
8. Repeat steps 4 to 6 until all required sections have been copied
9. Attach the newly copied sections so they are connected with the already existing layout.

7.3.8.2 Tasks for sections

In a layout in SimMine, there can be both sections and objects (i.e. locations). Some tasks are specific for sections, while some are specific for objects. This part lists some tasks which are section specific.

7.3.8.2.1 Change properties for a section

The properties for a section can be changed from both the section list (see Figure 7-8 – planning for sections on page 89), or from the property window for sections. The section list itself does only contain some properties, while the property window contains most of the properties applicable to sections.

7.3.8.2.1.1 Change section properties from the section list

In the section list, some of the properties are visible and can be changed:

Section	Dev.	Face profile	Act.cycle	Length (m)	Rock type	Current activ
All sections						
Level 1-1 FO (1)	☐	Main drift		687	None	
Level 1-1 TO (1)	☑	Drift	Easy cycle	1601,9	None	
Level 1-2 FO (1)	☐	Main drift		638,4	None	
Level 1-2 TO (1)	☑	Drift	Easy cycle	1502,8	None	
Level 2-1 FO (1)	☑	Main drift	Easy cycle	806,7	None	
Level 2-1 TO (1)	☑	Drift	Easy cycle	1751,8	None	
Level 2-2 FO (1)	☑	Main drift	Easy cycle	680,4	None	
Level 2-2 TO (1)	☑	Drift	Easy cycle	1662,2	None	
Level 3-1 FO (1)	☑	Main drift	Easy cycle	932	None	
Level 3-1 TO (1)	☑	Drift	Easy cycle	1851,4	None	
Level 3-2 FO (1)	☑	Main drift	Easy cycle	663,9	None	
Level 3-2 TO (1)	☑	Drift	Easy cycle	1589,1	None	
Level 4-1 FO (1)	☑	Main drift	Easy cycle	948,1	None	
Level 4-1 TO (1)	☑	Drift	Easy cycle	1968,5	None	
Main ramp (1)	☐	None		1062,4	Waste rock	
Ramp 1 (1)	☑	Decline	Easy cycle	628,7	None	

Figure 7-37 - Section list

For each section, a number of different properties are shown on the same row. Change a value by entering a new value in the cell which contain the value to change. If multiple sections are selected, the changed property will be changed on all selected sections.
Each section contains one or more segments. To show the segments for a section, expand the section by clicking the plus sign to the left of its name. For segments, only a limited set of properties can be changed.

Note! The columns shown in the section list is configurable by the user. See Section list on page 201 to see how the columns may be changed.

7.3.8.2.1.2 Change section properties from property window

To open up the property window, select the section, and then right-click. Select ***Show properties*** from the context menu. The section can be selected either in the 3D layout view, or in the section list. If multiple sections are selected, the property window will show the properties for the first selected section, and show which properties differ between the selected sections.

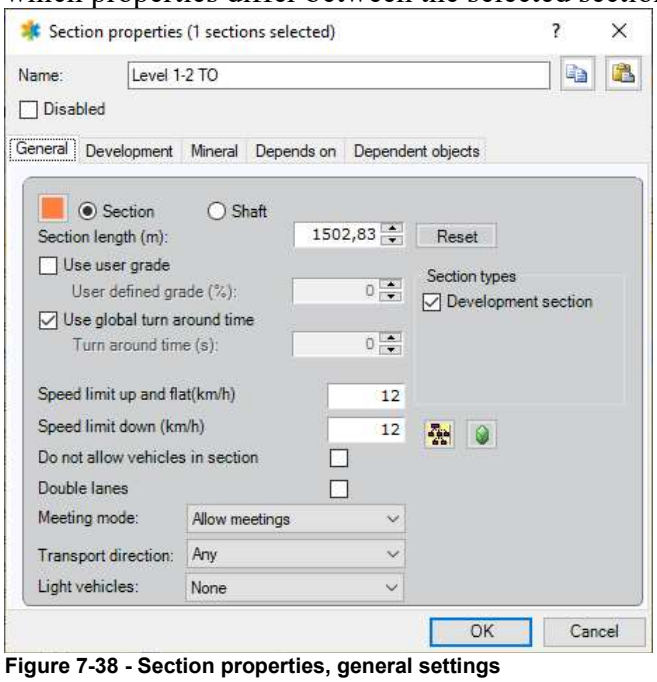


Figure 7-38 - Section properties, general settings

When the section's properties are shown, the properties can be changed. Click OK when done to save your changes. If multiple sections were selected, all changed properties are assigned to each selected section.

Note! If a single property is changed for an activity, the whole activity is set as changed, and will thus replace the whole activity on all selected sections.

To select more than one section from the sections list, first select one section, and the hold CTRL or shift key and click another section. This method is also available in the 3D layout view. All the selected sections will be highlighted. Independent of which way a section is selected, the selected section or sections will be highlighted in the sections list and the Layout view.

7.3.8.2.2 Development priority for a section

The priority to develop a certain section depends on a couple of settings. There are several priority modes, where only one mode will use the user supplied section priority. All other priority modes calculate the priority based on meters left to do, distance etc.

The user priority is possible to change even if priority mode isn't set to Highest Priority (which will use the user assigned priority). Check that work mode (i.e. priority mode) is set to ***Highest priority*** in the ***General settings tab***. See: Set how vehicles search work on page 81.

Change the value in the priority column for the sections that you wish to set priority for. A lower number means higher priority. A priority number itself is only meaningful when it is compared with another priority.
If the priority column isn't visible, see Change columns on page 202 for how to show it
The priority can also be set on segments, independent on the section they belong to.

7.3.9 Tasks for production

This part covers tasks which are only available if the license allows production.

7.3.9.1.1 Setup stope drilling for production

Stope drilling (or any other production method which requires long hole drilling) is setup with a main and secondary production location. For stope drilling, there are often 2 locations connected to each other – one location where drilling, charging etc. is done at, and one location where the blasted ore exists, which is below the stope.

Start by adding two locations to the layout, a production main and secondary by selecting them from the ***New object*** tool ( ).

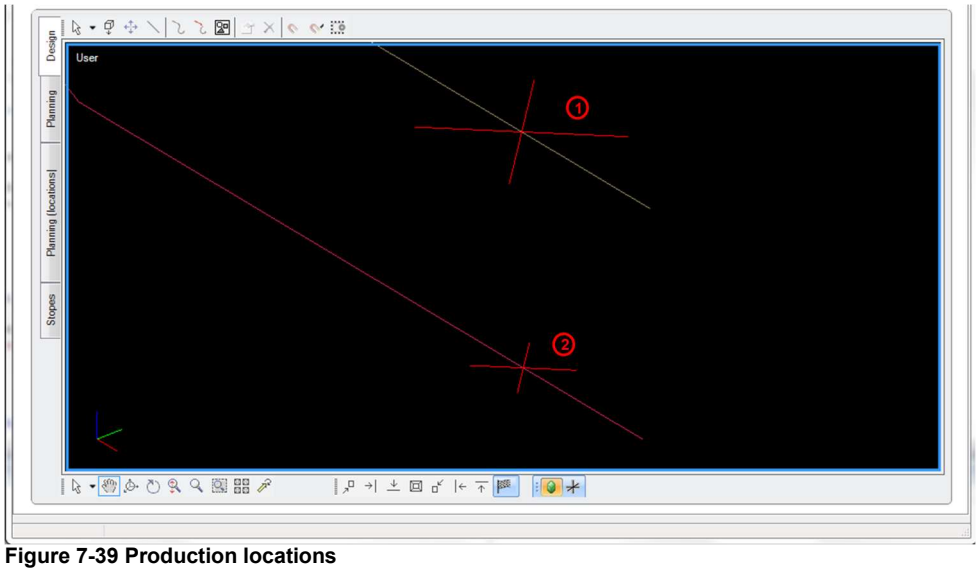


Figure 7-39 Production locations

In the example layout above, a production main (1), and a production secondary (2) are placed in the layout. They are placed on different levels, on top of each other.

Note! These locations can be placed anywhere – there is no control that they must be on top of each other.

After the objects have been placed in the layout, perform the following steps to setup the stope production:

1. Connect the production main and secondary points to each other by opening up the properties for the main production location, and select the secondary location from the ***Connected location*** dropdown list.

a. This is done so that one set of activities can be performed on both locations. The secondary production point cannot have any activity cycles associated directly to it – all properties are set on the main production location. In the activity cycle properties, a decision is made where each activity will be performed.

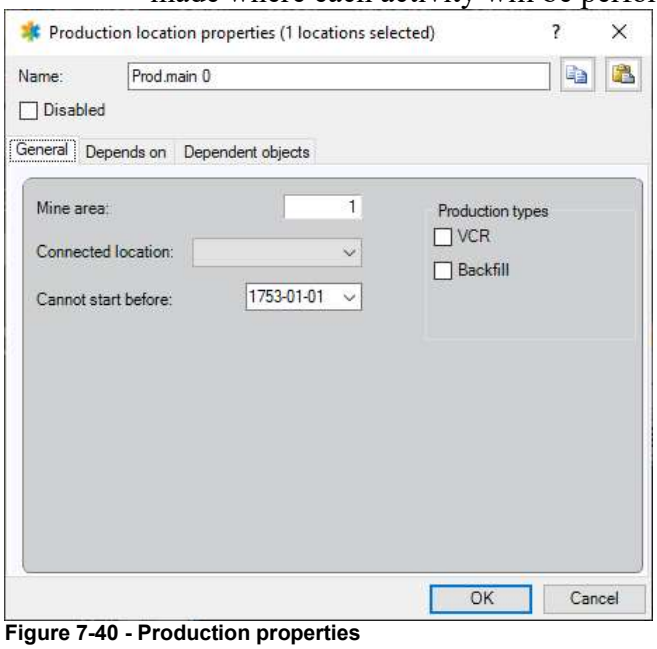


Figure 7-40 - Production properties

2. Set that the location shall be a production location for long hole drilling by checking the checkbox ***VCR*** (Vertical Crater Retreat) in the general tab above. When ***VCR*** checkbox is checked, the VCR tab will become visible, where all properties for the long hole drilling is set.
3. Switch to the ***VCR Data*** tab to set long hole drilling properties.

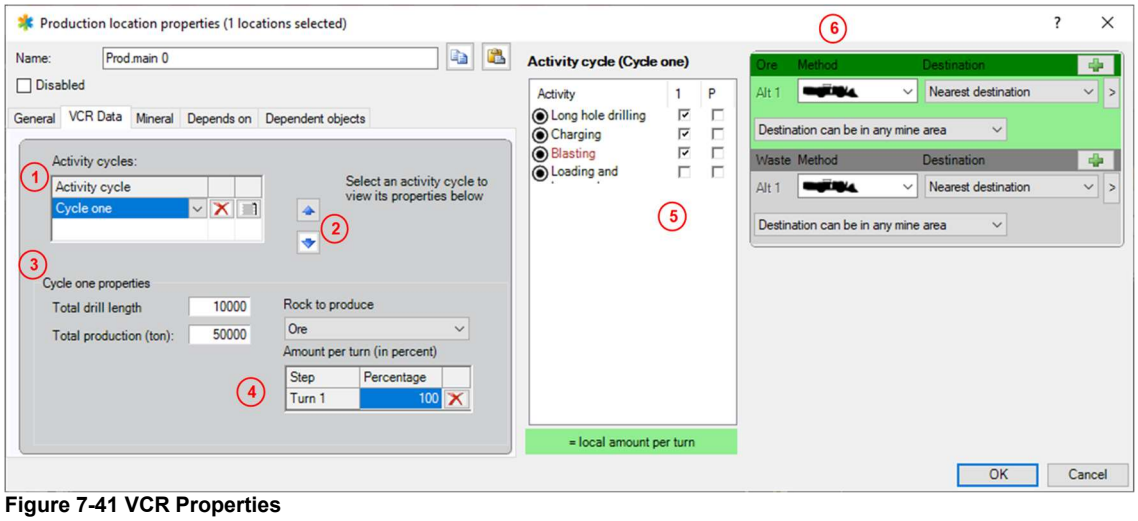


Figure 7-41 VCR Properties

4. The VCR properties has the following parts:
   a. 1: Activity cycles which shall be performed at the main or secondary locations. Click on the edit button ( ) in the last column to show/hide the activities contained in a cycle. Each cycle is performed in sequence. When one is completed, the next is started.
   b. 2: Move A selected activity cycle up or down

c. 3: The properties for the selected activity cycle, which contains the total number of meters to drill for the stope, and the total tonnage in the stope. The meters and tonnage are what the current cycle will do. Some activity cycles may not require any meters or tonnage if they do not have any long hole drilling activity.
d. 4: This controls in how many iterations the activity cycle shall be done, and how much of the full cycle which will be done during each iteration.
e. 5: The activities in the selected activity cycle. This holds two columns which controls how activities can be performed. The column "1" is the primary/secondary settings, which, when checked, will have the activity performed at the main production location. The "P" column is if the activity can be done in parallel (at the same time) as the previous activity in the cycle. This can exist for an activity after the loading and transport activity, which may be performed at the same time as the loading and transport, but at the main location, while the loading and transport is done at the secondary location.
f. 6: The loading and transport settings, if loading and transport exist in the cycle

Basic example of setting up a VCR production, when the production method is already set: The points in this description refers to points in Figure 7-41 VCR Properties.

1. Select the activity cycle to use (1). The activity cycles shown here are activity cycles for production (See Create a development or production cycle on page 61 for how to create production activity cycles)
2. In the properties for that activity cycle (3), specify the total drill meters and tonnage that will be produced when the activity cycle is completely done. Also specify the rock type of the produced rock. Leave Amount per turn-table (4) as it is.

In the example above (Figure 7-41 VCR Properties), there is one activity cycle, which has 4 activities. The long hole drilling will do 10000 meters of drilling, and when blasted, 50000 tonnes of ore will be created.

7.3.9.1.2 Use of only a secondary production location

This is not possible. A secondary production location cannot be used by itself – it must be connected main production location. It can however be setup so all activities will be performed at a secondary production location, but in this case, it is better to only use a main production location and use that without a secondary production location. A main production location can work without a secondary production location.

7.3.9.1.3 Set that loading and transport shall be done at the secondary location

In a long hole drilling setup, a main and secondary production location can be connected and used together as one production location. If a main production location is used without any connected secondary production location, all activities will be performed at that location.

To set which activity will be performed where, open up the properties for the production location and select the VCR tab.

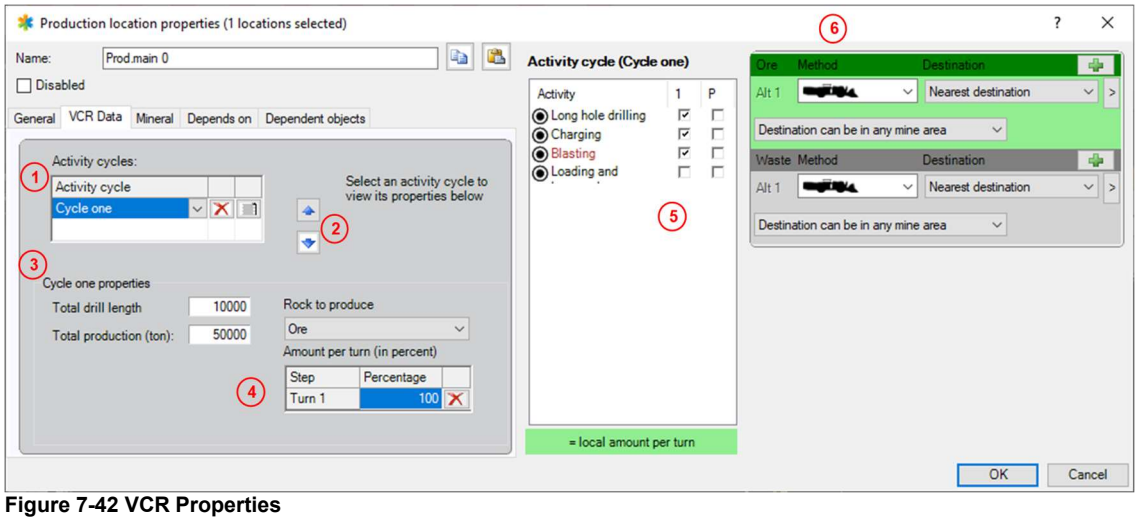


Figure 7-42 VCR Properties

In part (5), all activities in the selected activity cycle (1) are shown. The extra columns, named "1" and "P" exist. Column "1" specified where the activity shall be performed. If this is checked, it will be performed at the main location, otherwise at the secondary location.

7.3.9.1.4 Set that an activity will be done in parallel

When setting up a long hole drilling production location, with a main and secondary location, some activities may be possible to perform in parallel, so that work is done both at the main and secondary locations at the same time. To do this, the same procedure as when specifying where an activity shall be performed is done. See: Set that loading and transport shall be done at the secondary location above

The difference is that it is the "P" column (point (5)) that sets the parallel activity. Only activities after each other that are performed at different locations (main or secondary) can be done in parallel. In Figure 7-42 VCR Properties above it means that only Blasting and loading and transport can be done in parallel with each other due to that they are done at different locations (column "1") and they are after each other. Loading and transport and long hole drilling cannot be parallel – they are not counted as after each other, even if the activity cycle will be done during several rounds.

7.3.9.1.5 A stope shall be done in 3 rounds

In cases when a stope is done in several rounds (i.e. the whole stope is not drilled and blasted at once), additional settings must be done. These are done in the ***VCR Data*** tab in the property form for the production location (see Figure 7-42 VCR Properties above).

Table (4) holds the percentage of the complete round that shall be done. As default, this table holds one row with the value 100. This means that the cycle will be done at once.

Example: The cycle is setup as above, with total drill meters equal 10000 and total tonnage set to 50000.

If table (4) is set as one row with 100%, the following will happen:
When drilling starts, it will drill all 10000 meters before charging commences.
After drilling, the whole stope is charged, and then blasted.
When the blast happens, 50000 tonnes are blasted for the haulage fleet to haul.

Example2: The cycle looks as in the Figure 7-42 VCR Properties on page 120, point (5). The drilling is done in 3 rounds. These are:
Drill: 2000m, Charge, Blast and haul
Drill 4000m, charge, blast and haul
Drill 4000m, charge, blast and haul
This means that 20% of the full round is done during 1st round, then 40% and last is the remaining 40%. Enter 20 in table (4). A new row will be created. Enter 40 in the second row, and 40 in the last row.
This will cause the cycle to be done during 3 rounds

7.3.10 Section properties

This section describes some of the properties that can be set on sections, with some examples. Most of the section properties are accessed through the section property window (see Figure 7-43 - General section properties), while other properties can be set directly in the section list under the planning tab (see Figure 7-37 - Section list on page 115). See page 217 for more information about all the settings in the property window.

The section properties are shown by selecting one or more sections, either from the section list, or from the 3D layout. Right-click and select ***Show properties*** from the context menu.
The general properties for a section can be seen in the figure below:

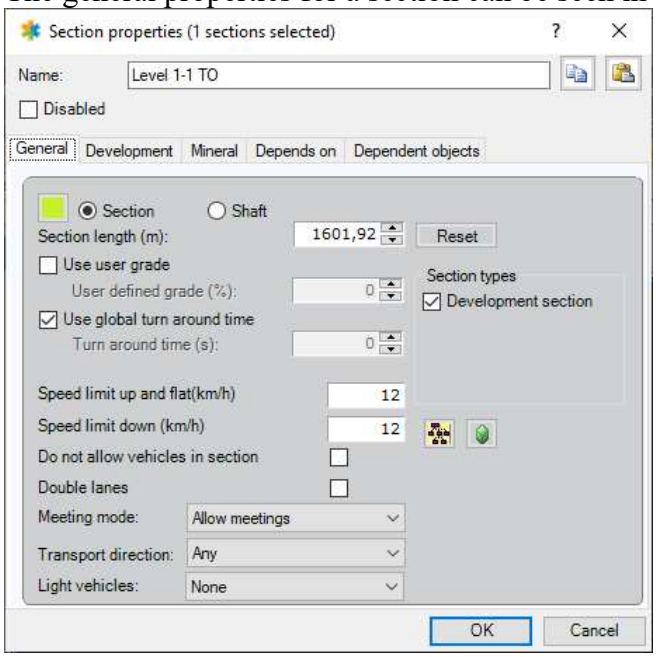


Figure 7-43 - General section properties

7.3.10.1 General section functionality

This allows the user to set common properties which are valid both for sections that shall be developed, and for already existing sections. They are found under

the general tab in the property window. The general settings allow the user to control and set:

- Section name. The name which is displayed in the user interface. All the segments which a section consists of, will get the same name, plus an index (- 1, - 2 etc.)
- Section type. This can be either shaft or normal. The only difference is in the 3D layout, where a section, which filled, will have a face profile, while a shaft will have a round profile.
- Set if the section is already developed or not. A check mark in the ***Development section*** checkbox will mark the section as a section to be developed during simulation.
    - When a section is set as a development section, more tabs will show which allows the user to specify additional properties from the development.
- Maximum allowed speed limits
- Method for how meetings between vehicles are simulated. The following methods exist:
    - Allow meetings – this adds a time one of the vehicles will wait for the other vehicle. The vehicle can meet with other vehicles even if no meeting spot or intersections exist. See Set time for turn-around and meetings on page 83 for more information for how to specify and setup meeting time)
    - Meeting at intersections – Meetings can only occur at intersections or placed objects. A vehicle which will meet another vehicle, will wait in the closest intersection until the other vehicle has passed. This require that intersections or objects are placed in the layout.
    - Only one vehicle – Only one vehicle at a time is allowed in the section. This require that there will be no activities in the section that require two vehicles (such as shotcreting), since only one is allowed.
- Other vehicle disturbances. This is disturbances in traffic from other vehicles, which doesn't take part in the simulation. It is named Light vehicles in the properties, but can handle all disturbances from vehicles not part in the simulation. See Light vehicle disturbances on page 74 for how to setup light vehicle disturbances)

7.3.10.2 Development functionality

A section which is marked as a development section has additional properties which controls how the development is done. Most of these properties exist in the property window for sections, with some properties also exists in the section list in the planning tab.
The most important development properties are found under the ***Development tab*** in the property window.

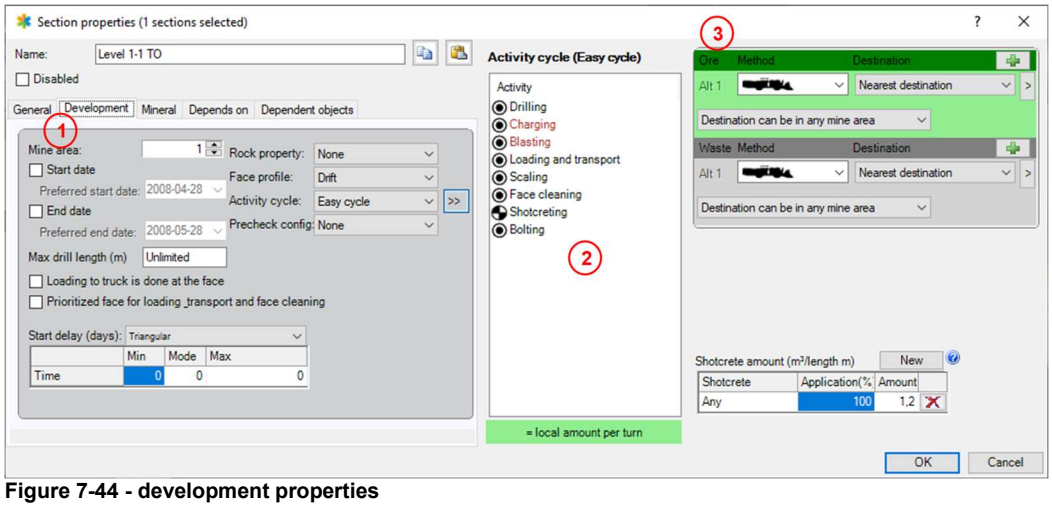


Figure 7-44 - development properties

The properties which can be set for development are:

- Which mine area a section belongs to. The mine area controls a number of things, such as where vehicles are allowed to work, blast properties, statistic grouping etc. See page 295 for a description of mine areas.
- Preferred start and end dates when the development should commence and end.
- Start delay, which is the time from when the section is allowed to commence until it will commence. This time will be in addition to any other time set, such as any time for a dependency that this cannot start until another section is completed.
- Assign rock properties. The rock properties are defined in a global list and only assigned here. See Rock properties on page 70 for how to define rock properties.
    - **Note!** If no rock property is assigned to a section, waste with a density of 2000 kilo per cubic meter is used.
- Assign a face profile, which sets the area of a face among others. The face profiles are defined globally and only assigned here. See Face profiles on page 59 for how face profiles are defined.
- Activity cycle to use, which describes the activities that must be done in the development process. Activity cycles are defined elsewhere, and assigned here. See Activity cycles on page 60 for how to define activity cycles)
    - To show the activities within an activity cycle, click the expand button ( ) next to the activity cycle dropdown list. The activities in an assigned activity cycle can be set properties only valid for the current section.

7.3.10.2.1 Destination for blasted rock

In the development tab, the left-most part (3 in Figure 7-44 - development properties) contains basic settings for the loading and transport activity. If there is no loading and transport activity in the currently assigned activity cycle, this does not contain any loading and transport settings.
In the loading & transport properties, set the method and destination for the rock type in question (ore or waste in the gray or green parts depending on the type of rock the section contains).
The above will cause ore or waste to be transported to the destination set in the loading & transport activity. The rock type that the section contains is set in its rock property dropdown list.

Note! If the development tab isn't visible, the part with loading and transport properties is not visible either.

See Loading and transport on page 288for a more in-depth description of how loading and transport is setup and works.

7.3.10.2.2 Set which cement type is used for shotcreting

When a shotcrete activity is part of the assigned activity cycle, shotcrete properties are shown in the lower part of point (3) in Figure 7-44 - development properties.

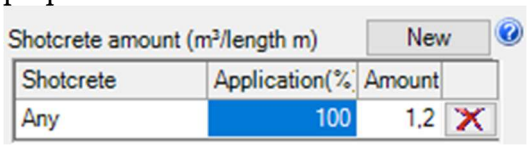


Figure 7-45 - Cement data

This holds one row for each cement type that can be used to shotcrete in the section. In most of the cases, this can be set as show in picture above.
What this tells us is that Any cement type is used (i.e. it doesn't matter what is used), and it is used 100% of the times that shotcreting shall be done. When shotcreting is done, it requires 1.2m^3 of shotcrete for every length meter of the section.
In more advanced simulations, multiple rows can be added for different cement data. At every occasion when shotcrete shall take place, the cement type is randomly selected based on the percentage of use in the Application column. The cement truck which can take work at the section must then either be empty (and will go to refill), or have the correct cement type in its blender.

7.3.10.2.3 Minerals a section contains

The minerals a section contain results in minerals hauled results. The results for how much of each mineral are hauled can be seen at the Minerals output tab.
The mineral types are assigned in the ***Mineral*** tab in the section property window:

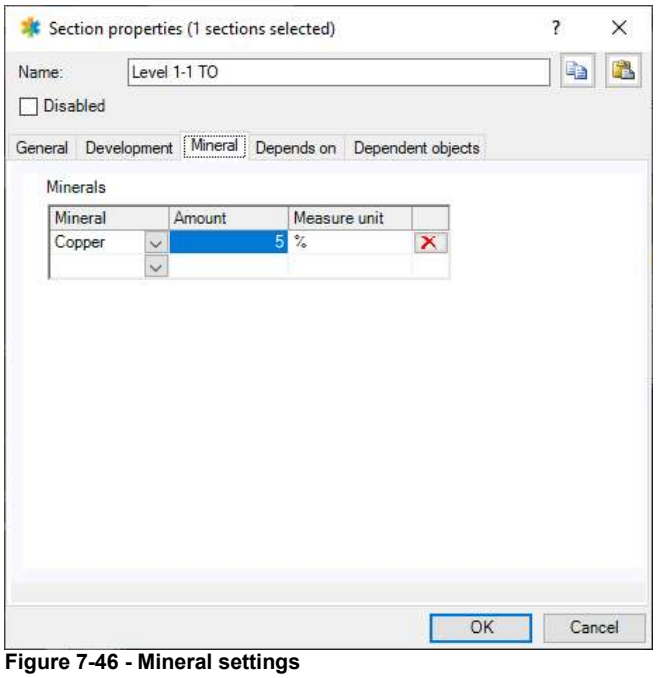


Figure 7-46 - Mineral settings

In the list of minerals, at the last row, drop down the mineral drop down list in the first column and select the mineral to assign. This dropdown list contains the globally defined minerals. See Minerals on page 74 for more information of how to define new minerals.
When a mineral is assigned, its measure unit is automatically filled based on the defined measure unit for the selected mineral.
Fill in the amount of the mineral at the section.

7.3.11 Objects properties

In SimMine, there are multiple types of objects which can be placed in the layout. Each different object type has different properties. Some properties can be found in several different objects. This lists some of the common properties found, as well as an overview for each object type.
See Object Properties on page 227 for information of all object properties.
The properties for objects are changed through the object property window. It can either be shown by selecting an object from the object list (see Planning tab for locations on page 89), or by selecting the object from the 3D layout.
Multiple objects can be selected and shown properties for at once. However, if multiple objects of different types are shown, only the first selected object type's properties are shown.
A typical property window can be seen below:

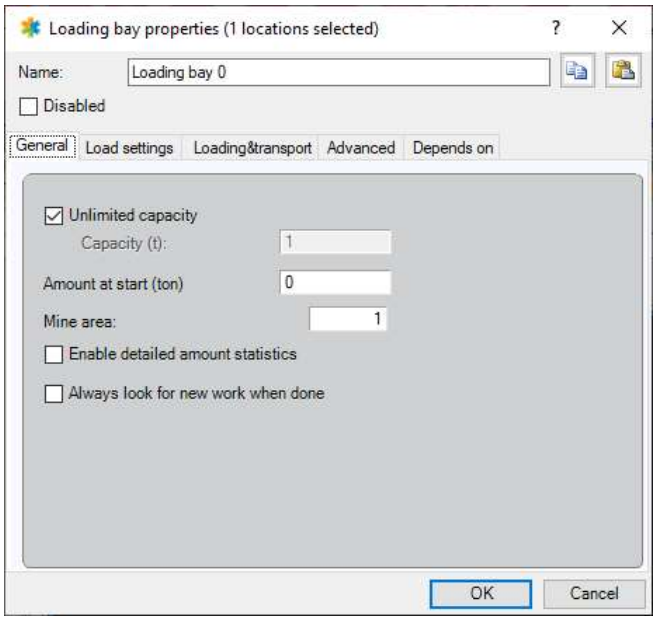


Figure 7-47 - General settings for a loading bay

7.3.11.1.1 Mine area

Each object which supports rock handling in some way, has a mine area setting. It controls several things, such as which vehicles can work at the object, statistic grouping etc. The mine area is any user supplied number.

7.3.11.1.2 Maximum capacity

Objects which can hold rock, can have a maximum capacity setting. For some objects, it is also possible to specify that the object has unlimited capacity. In those cases, it will never become full. When unlimited capacity is not set, a textbox allows the user to enter the maximum tonnage allowed at the object. The maximum amount can be exceeded in some cases, for example if a truck holds 50 tonnes, and the amount left is 40 tonnes. Additional trucks will not be able to dump into the location, if they are not already travelling towards the object.

7.3.11.2 Crusher object

The crusher object is a recipient. It has functionality to process incoming rock and allow it to continue throughout the mine. Crushers which do not allow the rock to be further processed will only register the incoming amount. The rock will not continue to be transported in the mine. When rock material is dumped into the crusher, the flow for the rock material will stop if not configured otherwise. Statistics for received amount and type will be saved.
A crusher can represent many objects in a mine simulation. Due to the reason that rock material flow can stop here, it can be used for all situations where the simulation will not simulate any rock material flow beyond a specific point. For example, this crusher object may be placed as a fill station to a conveyor, if the flow beyond that conveyor will not be simulated.

7.3.11.2.1 Functionality

A crusher has functionality for:

- Breakdowns

- Delay in availability - from the time it becomes available in the layout, it may still take some time until the crusher can be used to dump rock into it.
- Work shift schedule - Which times it is operational.
- A buffer in front of it, which can fill up and stop further transports to it.
- Receive schema - A limited amount that it can receive can be set up.
- Continued flow parameters, which includes crushing speed, and outgoing buffer size, as well as which object to put the crushed rock into.

7.3.11.2.2 Specify that a crusher may only receive 1000 tons each 24 hours

In the crusher properties:

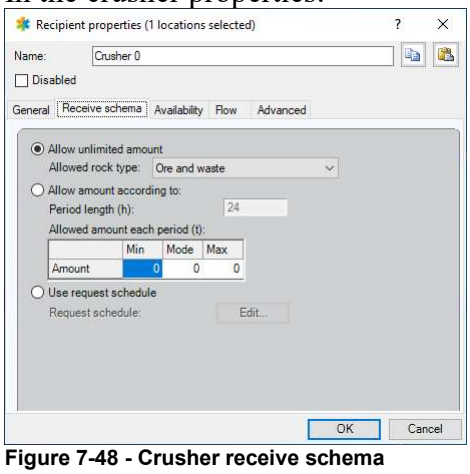


Figure 7-48 - Crusher receive schema

In the tab ***Receive schema***, Check the radio button ***Allow amount according to***.
Set period length to 24 hours
In the amount grid, set 1000 for min, average and max.
The above will cause it to allow exactly 1000 tons each 24 hours. If you wish to have some variance in the amount it is allowed to receive, set different values in the min, average and max grid cells. The function to generate is triangular distribution. This is not changeable.

7.3.11.3 Loading bay object

The loading bay object can receive and store rock, until it is transported further. It can be set to hold an unlimited amount or a limited amount.

7.3.11.3.1 Functionality

A crusher has functionality for:

- Limited capacity
- Only one rock type at a time can exist in a loading bay
- Advanced loading and transport control, which includes:
  - Only certain locations can have this as its destination
  - Time with no activity until vehicles will try to empty this
- Can hold backfill material.

7.3.11.3.2 Specify that a loading bay may only receive rock from shaft development

The particular scenario can be configured in several ways, where one way which includes setting properties for the shaft development sections.
This requires some configuration for the shafts as well. Shaft development can be set up as normal development, if desired. The important setting is to assign a unique mine area for the shafts, so that all shafts share one mine area. This is the mine area that will then be allowed to haul its rock to the loading bay. The description below covers the settings for the loading bay.
To assign properties for the shaft development section, see Activity properties on page 217

Go to ***Load settings*** tab

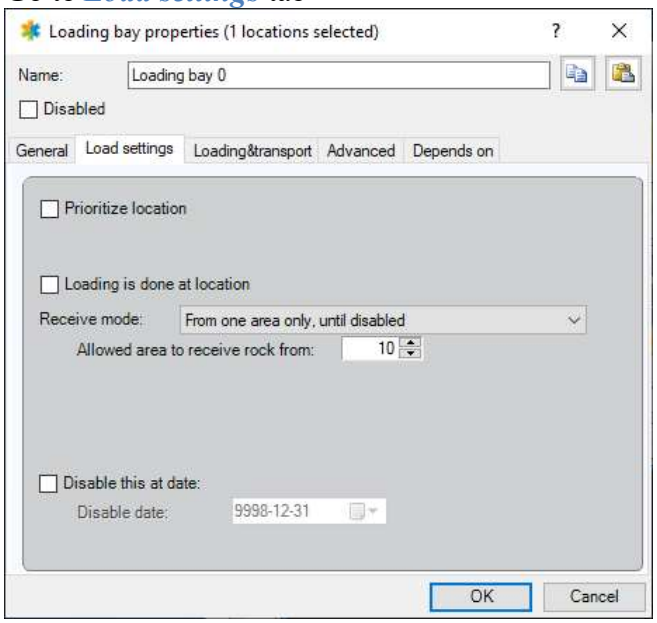


Figure 7-49 - Load settings for loading bay

Select ***From one area only, until disabled*** from the ***Receive mode*** dropdown list and set the mine area to the mine area to which the shafts belong to.

The above will cause it to only accept rock from one mine area, which is the mine area to which all shafts belong. All other sections or objects should belong to another mine area, which is not allowed to haul rock to this location.

7.3.11.4 Cement station object

The cement station object is a location where cement truck (agitators) goes when they need to be refilled. It is only needed when it exists at least one cement truck which hasn't an unlimited capacity. This cannot receive any rock.

7.3.11.4.1 Functionality

A cement station has functionality for:

- Breakdowns
- Simple work schedule.
- Fill speed when filling trucks.
- Support for several types of cement.

7.3.11.4.2 Set that it has two different fill speeds for different cement types

As default, two cement types exist. More can be added through defined materials under global settings (See Materials on page 73)
In the cement station properties:

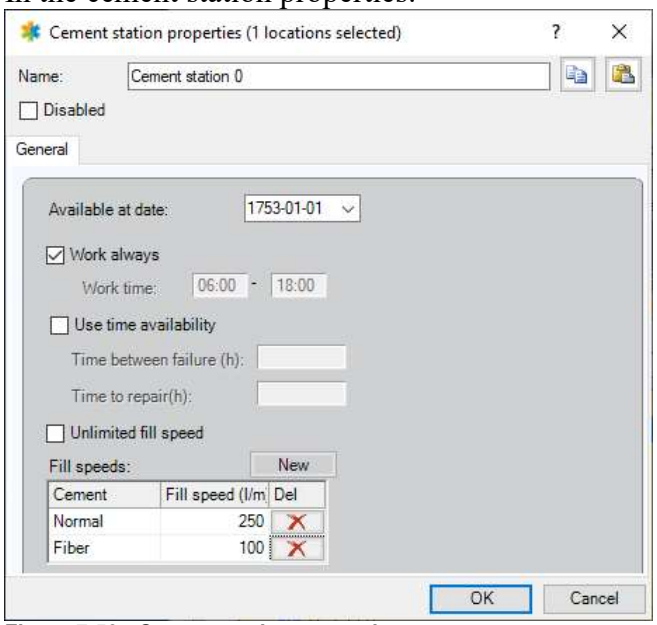


Figure 7-50 - Cement station properties

- Uncheck the ***Unlimited fill speed*** checkbox. This will enable the fill speed table.
- Click the "New" button above the table. This will add a new fill speed row.
- Set the cement type in the "Cement" column for which to set the fill speed. This combo list will enumerate all cement types defined.
- Set the fill speed in the "Fill speed" column.
- Repeat the previous 3 points to add another cement type and set the fill speed for that cement type.

Note! The "Any" type of cement is used when no exact match for a cement type is found. If a cement type is used within a mine, and that cement type or the "Any" type exist in the fill speed table, unlimited fill speed is used for that cement type.

7.3.11.5 Top transfer object

The top transfer object is a dump point for vehicles, to dump rock into a transfer pass (for either ore or waste). It can only receive rock and must always be connected with an end location. The end location for a top transfer pass object can be any object which can receive rock, and also chutes. The connected end location is set in the properties for the top transfer pass object.

7.3.11.6 Backfill plant object

The backfill plant generates backfill to be filled at backfill recipients or other locations that accept backfill. This is the only object in the simulation that generates backfill. If any backfill functionality will be part of a simulation, this object needs to be part of it.

7.3.11.6.1 Functionality

A backfill plant has functionality for:

- Breakdowns
- Automatic fill mode where backfill recipients can be filled automatically, without the need of any truck.
- Unlimited / limited production of backfill material

7.3.11.7 Backfill recipient object

7.3.11.7.1 Overview

This object can receive backfill from a backfill plant. It cannot receive any ore or waste – only backfill material produced at a backfill plant.
Use this to simulate that a backfill process shall take place.

7.3.11.7.2 Functionality

This object has functionality for:

- Amount to backfill at the location
- Delay in start of backfilling from the time the location becomes available.

7.3.11.7.3 Specify that a backfill recipient shall use backfill material from a specific backfill plant

This setup requires at least 2 backfill plants in the layout. Assume that these backfill plants are named Plant 1 and Plant 2.
Open up the properties for the backfill recipient.
Select which rock type the backfill plant is allowed to receive. For example – Waste rock as the picture below:

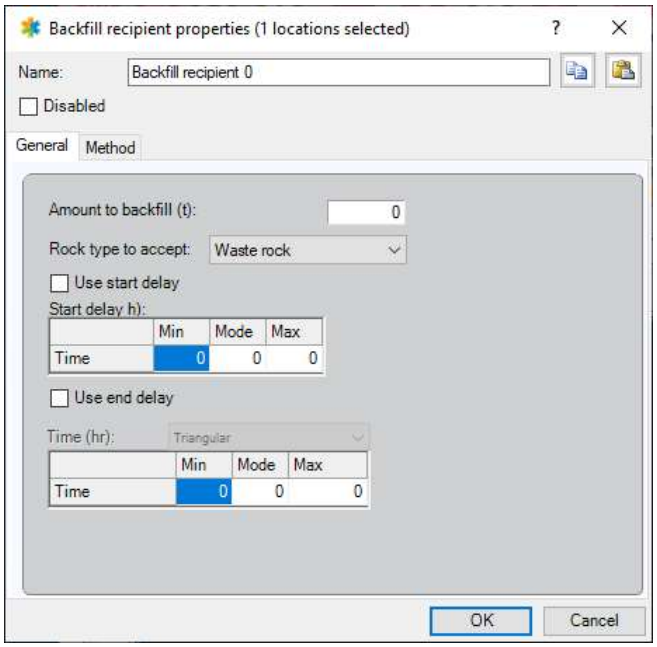


Figure 7-51 - Backfill recipient

Note! Waste rock is a user defined rock type. Even if this is waste, it is used in the backfilling logic to differentiate backfills generated by different plats. The material is still treated as backfill, even if ore type will be assigned. See Rock properties on page 70 for how to define rock types.

Click "OK" to accept and close the properties for the backfill recipient.
Open up the properties for backfill plant "Plant 1"

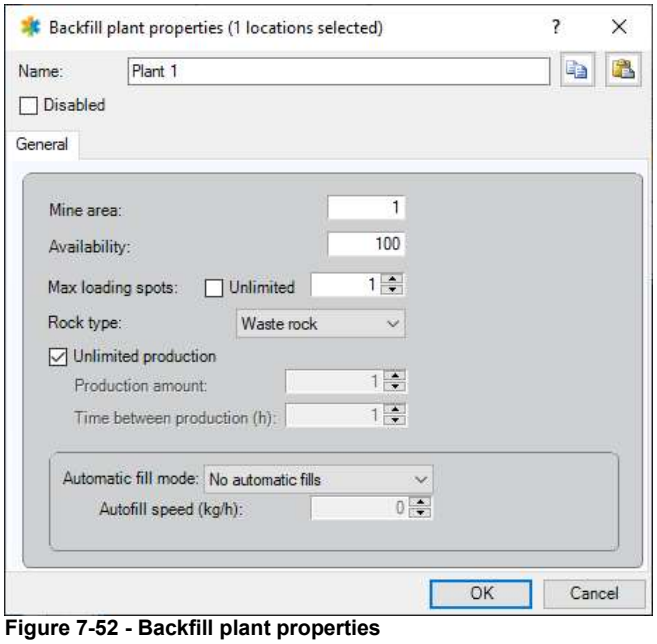


Figure 7-52 - Backfill plant properties

Set that Plant 1 will produce Waste rock (the same rock type as you assigned for the backfill recipient to receive).
Click "OK" to accept and close the properties.
Open up the properties for backfill plant "Plant 2".
Set that Plant 2 will produce another rock type, other than “Waste rock”. This rock type differs from the rock type that the backfill recipient can receive, and thus it will not be transported or filled to the backfill recipient.

The above specifies that the backfill recipient can only receive one specific rock type. The two existing backfill plants produces different rock types, where only one backfill plant produces the rock type which the backfill recipient can receive. In this way, backfill recipient will not receive any backfill from Plant 2.

Note! Even though that the rock types are set to Waste rock, the rock created by a backfill plant will always be treated as backfill. It is the mechanism used to differentiate rocks from different plats.

7.3.11.8 Production object

The production object is a simple production location, which can produce a user defined rock type. It is very limited in how it can produce the rock – it hasn't any production schedule. This can be used to generate some rock which can be used in the simulation. It should not be used to accurately simulate a real production plan.

7.3.11.8.1 Functionality

This object has functionality for:

- Set a rock type to produce
- Unlimited / limited production.

    - The limited production only allows a user-defined amount each time period. The user can set the amount and time period.
- Set loading and transport settings for how to transport any produced rock from the location
- No production plans

7.3.11.8.2 Set that the production object shall produce 1000 tonnes of rock each 24 hour.

Open the properties for the production object.

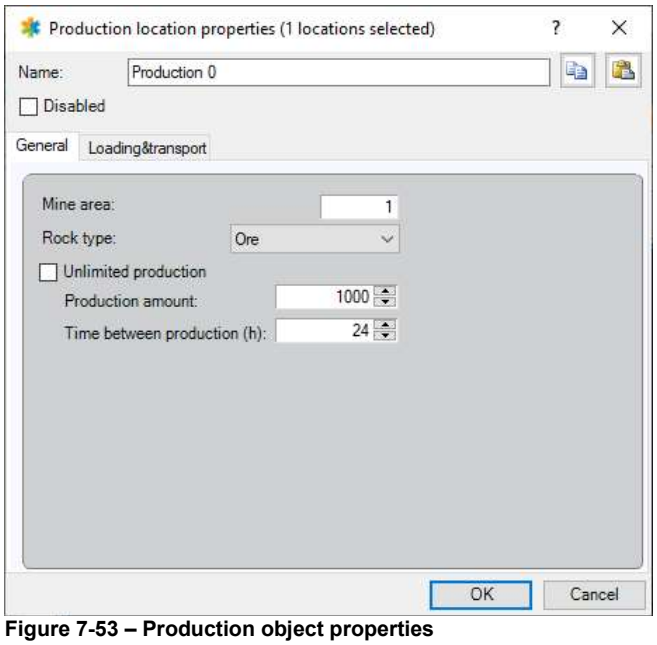


Figure 7-53 – Production object properties

Select which rock type to produce.
Uncheck "Unlimited production" checkbox. This allows you to set an amount and time period. Set those to 1000 and 24 respectively.

7.3.11.9 Production plan object

The object simulates ore or waste production at the location where it is placed in the layout. The object has an advanced production plan, which allows the user to specify in more detail the amount to produce, what to produce and when to produce it.

7.3.11.9.1 Functionality

A production plan has functionality for:

- Loading properties for how the rock is loaded.
- Where the rock will be loaded onto a truck, if a truck is used (at the location or nearest intersection)
- Production plan functionality:
    - Set which rock type shall be produced
    - Set when the rock shall be produced
    - Set the amount of rock to be produced
    - Set exceptions, when no rock shall be produced.

The production plan functionality is similar to the receive plan functionality and described in more detail on page **Fel! Bokmärket är inte definierat.**. Instead of receive functionality, this part handles produce functionality.

7.3.11.9.2 Set that the production shall be 10000 tonnes each month

The properties for the production plan object are seen below:

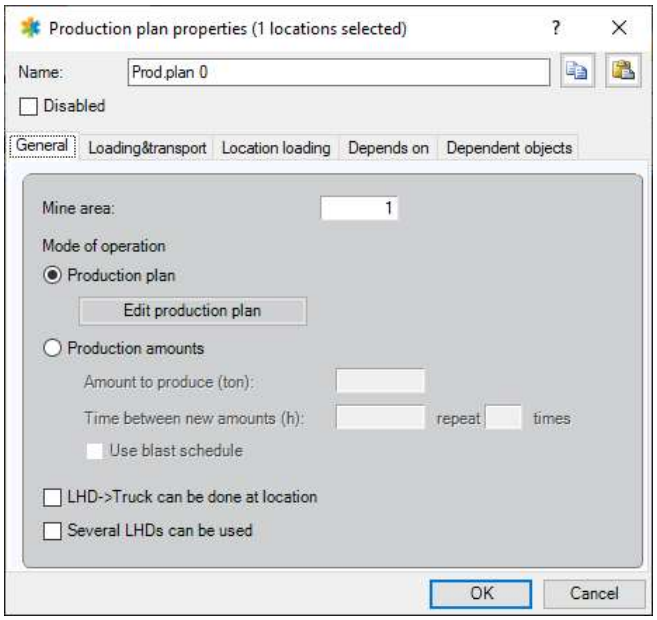
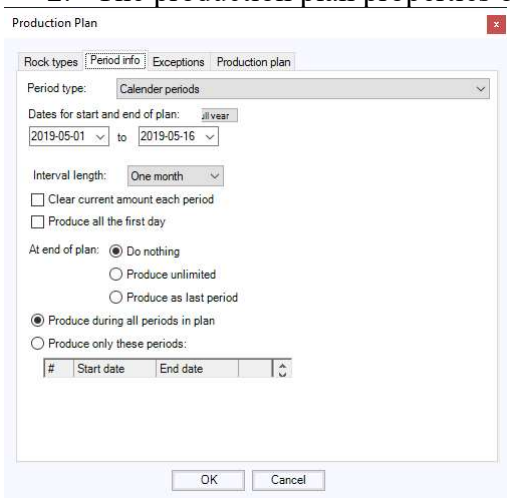


Figure 7-54 - Production plan properties

1. Verify that the ***Production plan*** radio button is checked. Click the ***Edit production plan*** button.
2. The production plan properties open. Select the ***Period info*** tab:



3. Set that the productions plan will be valid from 1st of May to 31st of June. This period can be a period of your choice and is the period during which the production plan will produce rock.
4. Switch to Production plan tab. Fill in the production in the production table. In this case – 10000 tonnes of ore each month.
5. Click "OK" to accept and close the production plan. Do this for the production plan object property windows as well.

The above example will produce the easy rock type "Ore" for 2 months. User defined rock types can also be produced by settings this mode in the ***Rock types*** tab in the production plan properties. The production plan tab will then allow the user to specify which rock types that shall be produced.

7.3.11.10 Chute object

A chute is an object which cannot receive any rock from a vehicle and can be loaded to trucks without any loader. The chute will get its rock from other locations which are connected with it, such as top transfer pass objects.

7.3.11.10.1 Functionality

A chute has functionality for:

- Break downs
- Shift schedule during which it is operational
- Receive plan for how much and what type it is allowed to receive.

7.3.11.11 Main production object

This object is a production location object and is only available when the production module license is active. The main production object provides functionality to perform production long hole drilling methods, such as VCR, open stoping and other production methods that involve long hole drilling.
It is normally connected with a Secondary production object.

7.3.11.11.1 Functionality

This object has functionality for:

- Perform VCR production method
    - This involves running according to an activity cycle, which can have several activities
- Perform backfill operation
- Several activity cycles can be used, where each activity cycle is performed in sequence when the preceding one is completed.
- Two activities can be performed simultaneously at the main and secondary production objects within the same activity cycle.

The main production object can be connected with a secondary production object. In this case, the activities that shall be performed can either be performed at the main or secondary production object. This is configurable by the user.

7.3.11.11.2 Connect a main and secondary production objects

For this to work, it is required that at least one main production and one secondary production object exist in the mine layout.

The connection between the main production object and the secondary production object is done from the main production object's properties

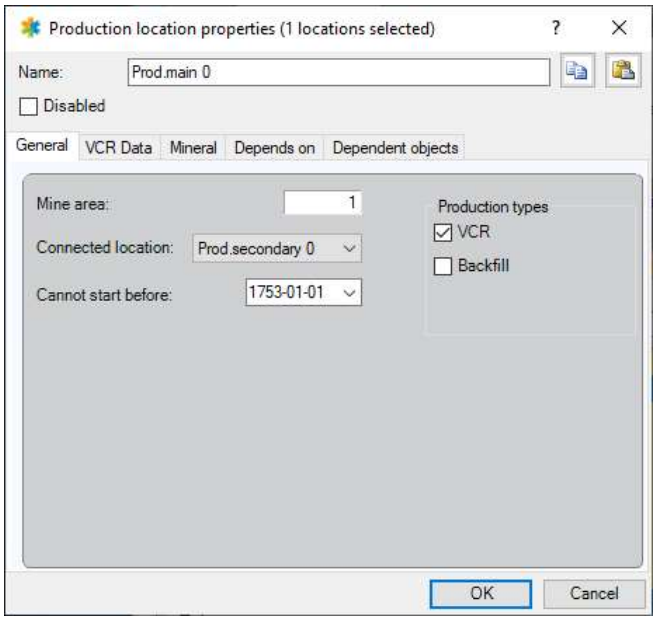


Figure 7-55 - Production main properties

Select the secondary production location from the ***Connected location*** dropdown list. This list does show all existing secondary production objects.

Note! The newly connected secondary production object will be renamed so its name is adapted to the name of its connected main production object. Any earlier connection with the secondary production object is removed when connecting it to another main production object. When properties are shown for the secondary production object, the same properties as for its main production object is shown.

7.3.11.12 Secondary production object

This object is a secondary production object and cannot act on its own. It must always be connected to a main production object. The activities assigned to the main production object can then be performed both at the main and secondary production objects. When opening up the properties for this object, its connected main production object's properties are shown. It doesn't have any properties on its own.

7.3.11.12.1 Functionality

It is solely dependent on a connected main production object. Its functionality is the same as for the main production object it is connected to.

7.3.11.13 Silo object

This object acts as a silo, which can receive and store rock. It can then be served by an LHD to be emptied. It reassembles to the loading bay, even though it has some extra functionality not found at a loading bay.

7.3.11.13.1 Functionality

This object has functionality for:

- Transport method for rock transported from this can be directly connected to another object, without any required vehicle.
- Loading properties for how the rock is loaded and transported from it, if this object isn't connected directly to any other object.
- Limited / unlimited capacity

- Start time
- Unlimited empty speed (affects the time it takes to get a scoop or box from it)

7.3.11.14 Conveyor object

This object is either the end location at a conveyor, or a spot along the conveyor where new rock can be loaded onto it (either the conveyor's start location, or a location in the middle of the conveyor). The conveyor's end location can be connected directly to other recipients, like another conveyor or a crusher.
The end location may also receive rock from vehicles, but the start locations can never transfer any rock further – only at the end location it can be transferred to another object.

7.3.11.14.1 Functionality

A conveyor object has functionality for:

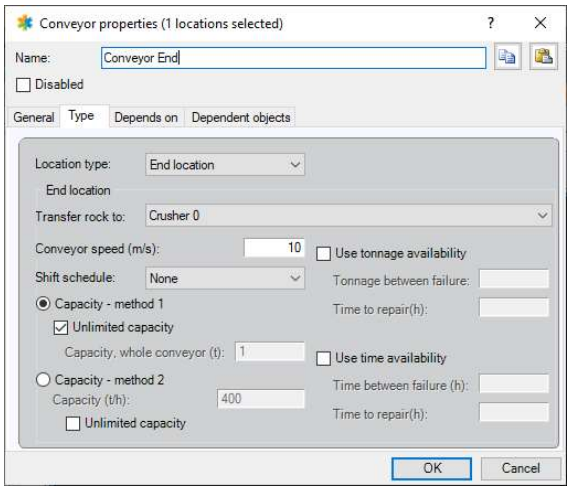
- Unlimited / limited capacity in form of amount of rock at the conveyor
- Shift schedule for work hours of the conveyor
- Set which object will receive the transported rock when it comes to the end of the conveyor.
- Speed settings for conveyor belt.
- Availability
- Maximum number of vehicles which may dump into it at the same time.

7.3.11.14.2 Setup a conveyor with one start location and one end location

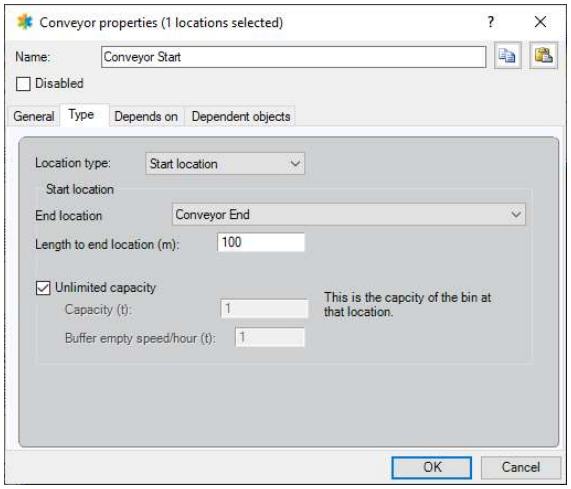
This scenario sets up a basic conveyor with just one start location (the location where new rock can be added to the conveyor), and one end location. The end location will be connected to a crusher.
The following example requires that a mine layout exist in SimMine.

Perform the following steps to configure a conveyor:

1. Add 3 locations to the mine layout: A crusher (recipient), and 2 conveyor objects. It doesn't matter where in the mine these objects are placed. SimMine doesn't check if the locations are feasible or not.
2. Select one of the conveyor objects which will become the end location, and open its properties. We start with the end location since the start location requires that there exists a start location so it can be completely configured.



3. Go to the ***Type*** tab, and set it as End location in the ***Location type*** dropdown list. Set other properties according to your needs.
4. Set the ***Transfer rock to*** value to the Crusher object. This will cause any rock which is received by this end location will be transferred to the crusher.
5. Click ***OK*** to confirm the settings.
6. Select the second conveyor locations which will become the start location. Open its properties:



7. In the ***Type*** tab, set its ***Location type*** to Start location
8. In the ***End location*** dropdown list, select the placed and configured end location. If the end conveyor location wasn't configured before the start location, this list would have been empty. Enter the distance to the end location. This affects the time it takes to transport material from this location to the end location.
9. Click OK to save your settings

The above example didn't discuss any length or speed of the conveyor. The conveyor is also operating at all times and never breaks. It can also hold an unlimited amount of rock.

7.3.11.15 Work shop object

This object does not have any functionality other than it is the location to where vehicles will go to when they need to be repaired in a work shop. This setting exists for each vehicle. See REPAIR IN WORK SHOP CHANCE on page 264 for work shop settings for a vehicle.

7.3.11.16 Meeting point object

This object acts as a meeting point where vehicles may meet with each other in a ramp. It doesn't have any specific properties other than a mine area setting. A meeting point object is only used for meetings if the meeting mode for a section is set to ***Only at intersections***. This also include placed objects, such as meeting points. In other cases, the vehicles may meet anywhere.
It can also act as a point where trucks can wait to get its box filled. See Truck loading on page 290 for information how truck loading is handled and how meeting points are used in this case.

7.4 Fleet

In a simulation, one or more vehicles can be used to perform the tasks assigned in the layout. The fleet tab is the place where vehicles that will participate in a simulation are managed. Here their availability, shift and other properties are set. New vehicles cannot be created here, instead you can assign already created vehicles to the simulation. New vehicles are created in the global settings (see Vehicles on page 58).

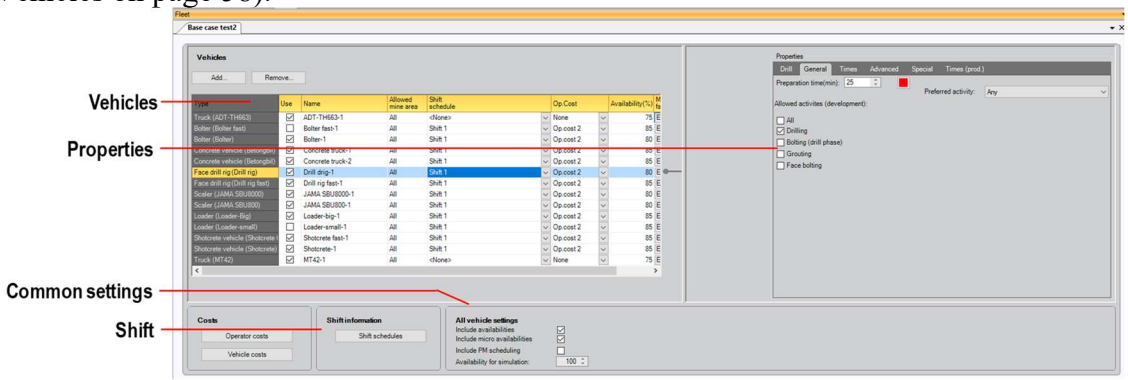


Figure 7-56 - Fleet

7.4.1 Functionality

7.4.1.1 Add a vehicle

Click ***Add...*** button above the vehicle list. (Figure 7-56 - Fleet above). The add vehicle dialog bow shows:

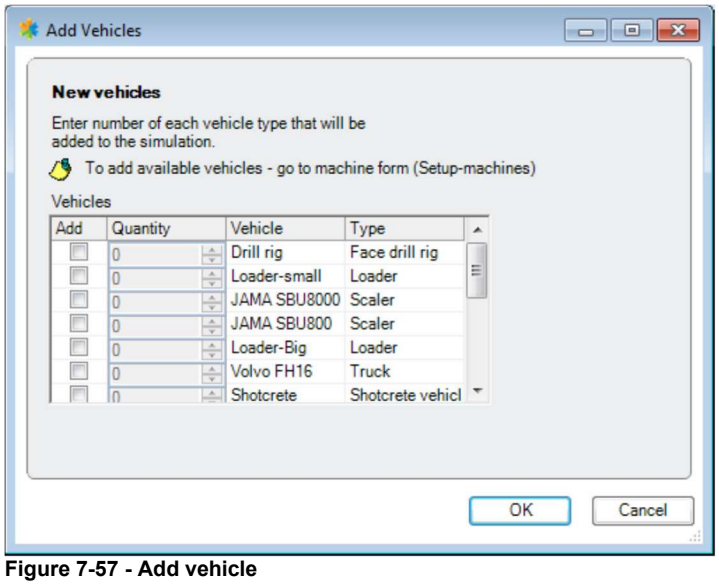


Figure 7-57 - Add vehicle

Check the checkboxes for the vehicles to include in the simulation. You can add more than one type of vehicle at once, and by changing the "Quantity" settings for the checked vehicles, more than one vehicle of the same type can be added at once.
If multiple vehicles of the same type shall be added, it is often simpler to add one vehicle, and configure it. Then you can duplicate that vehicle so all the vehicles get configured at once.
Click "OK" to add the selected vehicles to the simulation. The added vehicles will show up in the "Vehicles" list in Figure 7-56 - Fleet above.

7.4.1.2 Remove a vehicle from the simulation

A vehicle can be removed from the simulation, without removing the vehicle from the vehicles list. This is useful when testing with a number of vehicles. Instead of removing a vehicle and later add it and re-enter all its properties, it is possible to exclude it from the simulation by unchecking the ***Use*** checkbox for the vehicle in the Vehicle list in Figure 7-56 - Fleet

7.4.1.3 Remove a vehicle

To completely remove a vehicle, not just exclude it from the simulation, select the vehicle to remove from the "***Vehicles***" list. You can see which vehicle is selected by looking at the property marker at the right border of the vehicle table:

Multiple vehicles can be selected at the same time by first selecting one vehicle, and then hold down CTRL key and select additional vehicles.

Click ***Remove*** button to remove the selected vehicles. A control question asks if you are sure to remove them.

7.4.1.4 Change a name of a vehicle

Go the "Name" cell for the vehicle to change the name for in the "Vehicles" list in Figure 7-56 - Fleet. Enter a new name, or press F2 to start edit the existing name.

7.4.1.5 Change basic properties for a vehicle

Basic properties are shown in the Vehicles table in Figure 7-56 - Fleet. To change any of these properties, just go to the cell to change and enter or select a new value. The following values exist in the table:

- Use – marks if the vehicle shall be used in the simulation or not
- Name – the vehicle name
- Allowed mine area. All, or a comma separated list of mine areas where the vehicle is allowed to work. This corresponds to the mine areas assigned to sections and locations.
- Shift schedule or shift information
- Operator costs
- Availability

7.4.1.6 Change properties for a vehicle

The grid in the fleet form contains basic properties, which are visible for all vehicle the whole time. When a vehicle in the grid is selected, its properties are shown in the Vehicle properties control to the right (see Figure 7-56 - Fleet, Properties). These properties have multiple tabs which shows different properties. Any changes here will instantly be saved to the vehicle. Multiple vehicle may be selected to change properties for several vehicles at once. When multiple vehicles are selected, the first vehicle selected (shown by a grey marker) has its properties shown in the property control. Only properties which are changed, will be saved to selected vehicles.

7.4.1.7 Shift schedule information for a vehicle

SimMine supports two modes of shift scheduling – basic and advanced. The shift mode is specified in general settings (see Set the kind of shift schedule to use on page 79).
Shift schedule modes:

- Basic shift scheduling: When basic shift mode is used, the shift column holds shift utilization, which is a percentage between 1 and 100%. This is the percentage of a full shift when the vehicle can do useful work. The shifts used in basic shift scheduling mode is set in the Shift info part in Figure 7-56 - Fleet above.
- Advanced shift mode: In this mode, the shift column holds a dropdown list which contains all defined shift schedules. Select a shift to be used by selecting it. The shifts are defined in global settings (see Shift schedules on page 64)
    - When this mode is used, and the shift schedule says ***None*** in the user interface, it means that the vehicle is scheduled to work 24 hours per day.

In basic shift schedule mode, the user doesn't have any control over when during a day or week that work is done. Therefore, this mode should be used

when the exact work time during a day isn't important or during test phase before a complete model is done.

In basic shift mode, when the user enters shift information in a basic way, the resulting work time is according to:
If the hours per shift are set to 8 hours, and shift utilization is set to 75%, then the vehicle can do 6 hours of useful work every shift. The rest is meal breaks, meetings, fuel refill etc. Repair time, or preventive maintenance is not included in the rest 25%.

7.4.1.8 Availability for a vehicle

Availability for vehicles has two values – Availability and Micro availability. In availability, when the vehicle breaks down in availability, it may go to a workshop to get repaired (controlled by the setting **REPAIR IN WORK SHOP CHANCE** on page 264). When it breaks down in micro availability mode, it will always break down at the face during work (never during travel). It will lock the face until it is repaired.
Availability information can be entered in easy or advanced setting, depending on which availability mode is selected in general settings (see Set that advanced availability shall be used on page 80).
Availability is set in the "Availability" column in the vehicles fleet.

Easy availability	The availability is a percentage, which is how many percentages of the total work time it will be broken. Example: A 80% availability means it is on average broken 2 hours for every 8 hours of work time. It is still random the intervals between each breakdown.
Advanced availability	The availability contains a button. Clicking it opens up the availability settings for the vehicle. In these settings, mean time between failure, mean time to repair, different availabilities for different ages of the vehicle etc. can be entered. See below for more information of advanced availability setup.

For availability to work, the ***Include availabilities*** under ***Common Settings*** Figure 7-56 - Fleet above must be checked.

7.4.1.8.1.1 Advanced availability:

Click the "Edit..." button in the "Availability" column for the vehicle to open up its availability settings.

Note! If the availability column doesn't contain an edit button, you must switch to advanced availability in general settings tab.

An availability window opens:

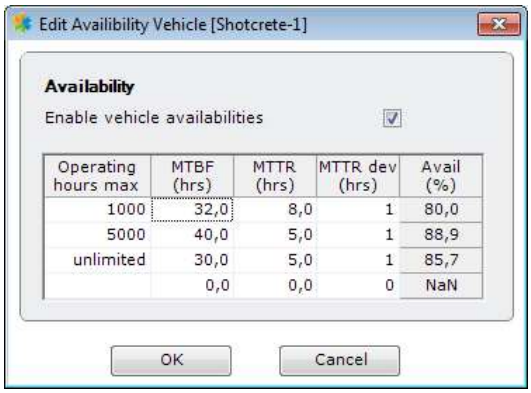


Figure 7-58 - Advanced availability

These settings allow you to specify different availability for different operating hours for the vehicle.
Set the maximum limit for the operating hours in the left column. The settings entered on this row are used as long as the vehicle's operating hours is between the "Operating hours max" on the previous row, and the current row.
Also enter the mean time between failure and mean time to repair (and a deviation).
Each row that contains values must have its operating hours max set to a greater value than the preceding row's value. Enter 'u' to specify unlimited.

Example: In the Figure 7-58 the vehicle will have 80% availability up to 1000 operating hours. When going above 1000, it will have 88,9& availability, and above 5000 hours it will have 85,7% availability.
Note! If no unlimited exist as the last row, the vehicle will have 100% availability when the vehicle's operating hours gets greater than the last maximum number entered here.

Info: The distribution functions used for availability are exponential for mean time between failures, and lognormal for mean time to repair.

7.4.1.9 Set which tasks a vehicle can perform

Each vehicle type has a pre-determines set of activities it can perform. Some vehicles can also perform user defined activities, which allows the user to create new activities, and add them to a vehicle’s list of possible activities.
In the Properties part, the currently selected vehicle(s) properties are shown. In the General tab, there is a list for which activities the vehicle can perform:

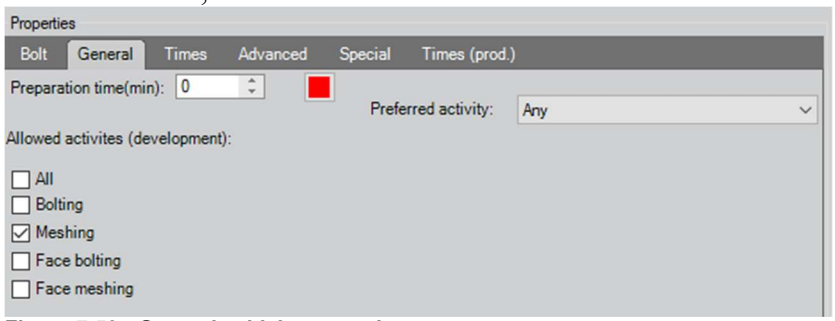


Figure 7-59 - General vehicle properties

In the above screen shot, the vehicle has the possibility to perform Bolting, Meshing, Face bolting and face meshing. Only Meshing is set for the vehicle.
The activity times, i.e. how fast the vehicle can perform its activities is found under the Times tab. See Change time to perform a task for a vehicle below.

7.4.1.10 Change time to perform a task for a vehicle

Most of the activities a vehicle can perform will take some time to be performed. For a drill rig, it can be drilling or bolt drilling. Some vehicles do not have any time to perform a task, such as the agitator, which depends on a shotcrete rig.
To change the times, it takes to perform a task, select the vehicle from the vehicles list. The selected vehicle's properties are shown to the right of the vehicles list. Switch to the Times tab. In this tab, there is one section for each activity type the vehicle can perform. As for the vehicle shown in Figure 7-59 - General vehicle properties, it may look as seen below:

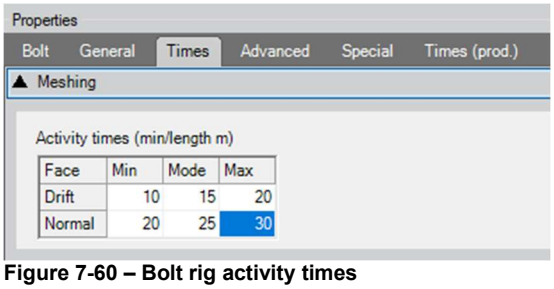


Figure 7-60 – Bolt rig activity times

In the times properties seen above, only Meshing is displayed. It has two rows in the times table. The times are entered and read as:

- For each row, the left-most column contains the faces. Each face corresponds to one defined face profile (see Face profiles on page 59 for face profile description)
- For each face, the work time can then be entered for that face.

The face information is for which face the entered work times are valid for. In the above table, when the vehicle comes at a work location in the mine which has the Drift face profile assigned, it will use the work times at that row.

Note! Some activity times are per length meter, while some activity times are independent of length meter. Keep an eye on this when entering work times. Example: In the above table, the title holds the minute per length meter caption. It means that the entered times are per length meter. When this vehicle will come to a face with the Drift face profile where a 5-meter blast has occurred, the total work time will be between 5*10 minutes and 5*20 minutes.

Some vehicles do not have a work time which depend on any face profile, such as loaders and trucks when they are loading and transporting rock.

7.4.1.11 Set that a vehicle performs other, non-simulated tasks

A vehicle which is part of a simulation, will work as much as possible. In situations where a vehicle also performs other tasks, which are not simulated, the general availability of a vehicle will become too high. This can for example be when a vehicle is used for production work as well as development work. If a simulation will only simulate the activities for development, any time the vehicle is performing production work, it should be available for development. In the simulation however, when no production is simulated, the vehicle will be available for development work its full scheduled time. To simulate that

vehicles are doing other work, not part of the simulation, there exist a setting ***Available for simulation***:

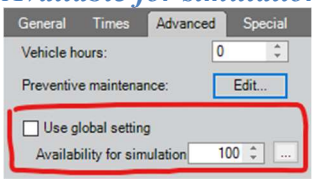


Figure 7-61 - Availability for simulation

This setting exists in the ***Advanced*** tab for the vehicle properties (in the ***Fleet*** input form).
This setting can either use the global setting for Availability for simulation found in the fleet form, at the bottom of the screen, or by unchecking the checkbox for Use global value and specify a setting only for this vehicle.
When the availability for simulation is set to a value lower than 100, it will be times when the vehicle is unavailable for work. The time when a vehicle is not available for simulation can occur at any time, even during off shift periods. When it triggers that the vehicle will not be available for simulation, it will never abort any ongoing work.

7.5 Operators

The operators tab is used for defining which operators that exist, their skills, how they work, which work team they belong to etc.

Note! The operators tab is only available is the correct license exist in the license key. Otherwise there will be no operator tab in the application

Each work team, called an operator pool in SimMine, can contain one or more operators. For each operator, you can select which activities that operator can be used for. One or more operator pools can be assigned to a vehicle (see ** for more information)

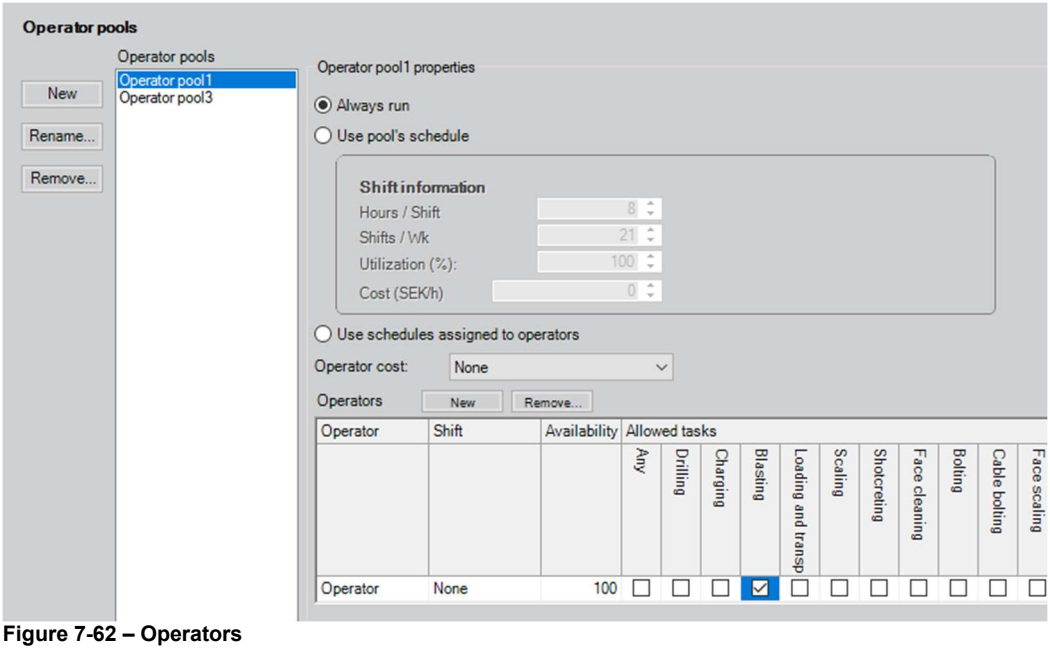


Figure 7-62 – Operators

Parts in the figure:
Operator pool list

This list shows all defined operator pools. Add, remove or rename a pool with the buttons to the left.

Add, rename and remove buttons

With these buttons, you add, rename and remove operator pools from the simulation model. When an operator pool is removed, it is also removed from any vehicle which was configured to use that operator pool.

7.5.1 Operator pool properties

When an operator pool is selected in the list of operator pools, its properties are shown to the right. These properties are shown in the figure above and contains the following fields:

Always run radio button

When checked, it means that the operators in the pool will always work (never goes off shift or take a meal break)

Use pool's schedule radio button

When checked, the shift control below it will become enabled. In here, you specify according to which shift all the operators that belong to the current pool will work according to.

Use schedule assigned to operators radio button

When this is checked, each operator can have their own shift schedule. You assign the shift the operators will use in the table at the bottom, showing all operators part in the operator pool

Operator cost list

Select which operator cost configuration to use to calculate the cost for operators. See ** for more information of operator costs.

Operators table

This table lists all operators that belong to the current selected pool. You can add/remove operators by using the NEW and REMOVE buttons above the table. The table contains a number of columns:

- Operator name
- Shift schedule the operator will work according to. This shift is only used if the Use schedule assigned to operators radio button is checked.
- Availability – the availability for the operator. The availability for an operator works a bit different than the availability for a vehicle in that sense that when an operator becomes unavailable, it will still work until the shift ends, and only be back to work at the next shift start after it becomes available again. If an assigned shift does not have any off shift periods, the operator's availability behaves like a vehicle's availability in that it becomes instant unavailable/available.
- A column for each defined activity. In these columns, you can select which activities the operator can be assigned to. All is the default setting which means that the operator can be assigned to any activity.

7.5.2 Functionality

7.5.2.1.1 Assign operators to a vehicle

The assignment of operators to a vehicle cannot be done in this form. Here you can only define the operator pools, which later on can be assigned to vehicles.

To assign operators to a vehicle, go to the **FLEET** tab, and select the vehicle(s) to assign operators to. In its properties, go to the **ADVANCED** tab:

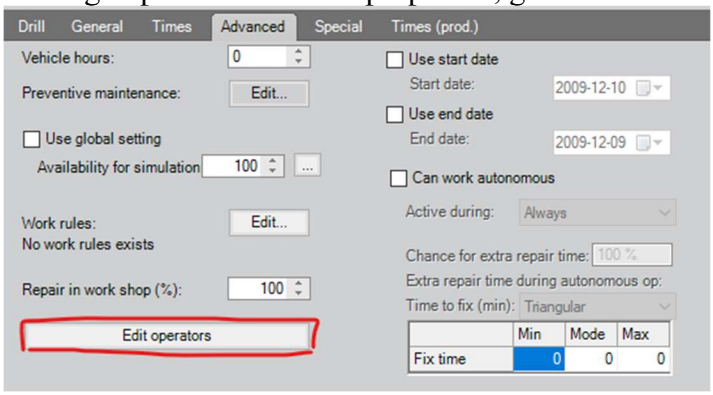


Figure 7-63 - Vehicle properties with operator option

Click on the **EDIT OPERATORS** button. This button will be green if any operators are configured for the vehicle. The edit operators dialog opens:

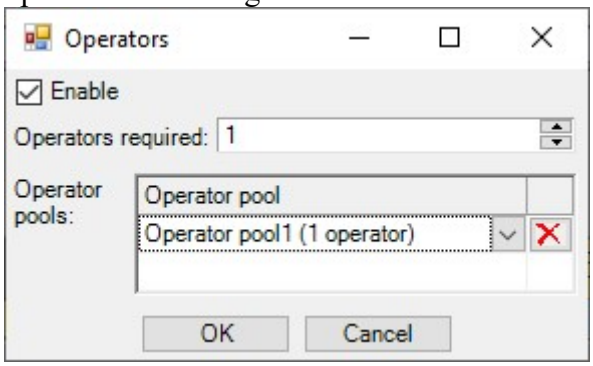


Figure 7-64 - Edit operators for a vehicle

In this dialog do the following:

- Check the Enable checkbox to enable operator functionality for the vehicle. With this checkbox unchecked, the vehicle will not require any operators.
- Next, set how many operators the vehicle will require
- In the table, select one or more operator pools defined.
- Click OK.

The vehicle will now require operators.

7.5.2.1.2 Rules for which operator is selected

When operators are used in a simulation and a vehicle requests operators for an activity, the operator is selected as:

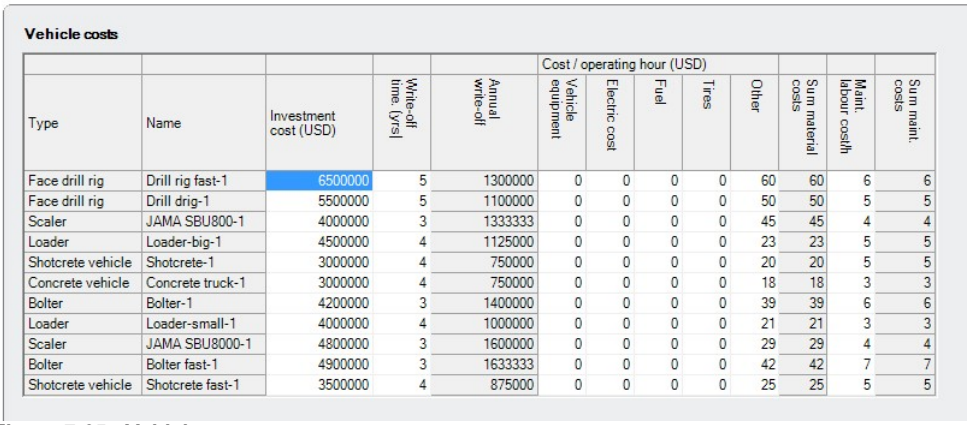
- The operator pools are checked from top to bottom, which means that if there are free operators from the first operator pool, it will be used. This has no effect if only one operator pool is used for the vehicle.
- Any previously used operator is selected first. When the vehicle starts using an operator, that operator will always be used, until someone else requests it.
- A specialized operator is selected before any generic operator. This means if the vehicle requests an operator for face drilling, an operator which has the face drill activity among its allowed activities is selected before an operator which knows ALL activities. The exception is if a generic operator has previously been used by the vehicle, and the vehicle

is about to perform another activity – then the previous operator is selected (as described in the previous bullet)

- A vehicle which cannot claim any operator goes into Wait for operator state, which can be seen in the Fleet results (see ** for more information on this)

7.6 Vehicle costs

The vehicle cost tab is used to specify costs for the vehicles that exist in the fleet tab. Here it is possible to add investment cost, which can be spread across a number of years, running costs and costs for maintenance labor. Figure 7-65 - Vehicle costs shows an example.
The costs set here does not affect the simulation productivity result, only the resulting costs.



Vehicle costs

					Cost / operating hour (USD)							
Type	Name	Investment cost (USD)	Write-off time [yrs]	Annual write-off	Vehicle equipment	Electric cost	Fuel	Tires	Other	Sum material costs	Maint. labour cost/h	Sum maint. costs
Face drill rig	Drill rig fast-1	6500000	5	1300000	0	0	0	0	60	60	6	6
Face drill rig	Drill drig-1	5500000	5	1100000	0	0	0	0	50	50	5	5
Scaler	JAMA SBU800-1	4000000	3	1333333	0	0	0	0	45	45	4	4
Loader	Loader-big-1	4500000	4	1125000	0	0	0	0	23	23	5	5
Shotcrete vehicle	Shotcrete-1	3000000	4	750000	0	0	0	0	20	20	5	5
Concrete vehicle	Concrete truck-1	3000000	4	750000	0	0	0	0	18	18	3	3
Bolter	Bolter-1	4200000	3	1400000	0	0	0	0	39	39	6	6
Loader	Loader-small-1	4000000	4	1000000	0	0	0	0	21	21	3	3
Scaler	JAMA SBU8000-1	4800000	3	1600000	0	0	0	0	29	29	4	4
Bolter	Bolter fast-1	4900000	3	1633333	0	0	0	0	42	42	7	7
Shotcrete vehicle	Shotcrete fast-1	3500000	4	875000	0	0	0	0	25	25	5	5

Figure 7-65 - Vehicle costs

- The cost entered in the investment cost is spread evenly across the entered write-off period.
- The costs under the main ***Cost/operating hour*** column will count for each work hour the vehicle has done.
- The cost under the ***Maint.labour cost/s*** will count for each repair and preventive maintenance hour.

7.6.1 Functionality

7.6.1.1.1 Specify costs for a vehicle that lasts 3 years

In this form, specify the total investment costs and running costs. Set that Write-off period is 3 years. This will cause the vehicle to cost 1/3 of the total investment cost each simulation year. After year 3, it will cost nothing when looking at the investment costs.

Important! If you wish to limit a vehicle's cost to the total lifetime of a vehicle (for example 3 years), it is also important to remove the vehicle from the simulation when its lifetime ends. Otherwise the vehicle will still perform work, but will not cost anything in terms of investment costs. It will still have running costs. In vehicle properties, check the "Use end date" checkbox under advanced tab in vehicle properties and set the desired end date for that vehicle.

Tip! If the vehicle will be replaced by another similar vehicle after 3 years, instead of having the vehicle replaced in the simulation, the same vehicle can be used throughout the whole simulation. In that case, set the investment cost for

the vehicle very high together with a high write-off period so the Annual write-off sum becomes the expected annual cost for the investments.

7.7 Material costs

Material costs allow you to set a cost for each defined material for different parts of the mine. See: Materials on page 73 for information how to define materials.

All defined materials are listed in this form. The costs are defined as a cost per meter of development per section in the mine. It is not possible to specify a cost per piece, like per bolt.

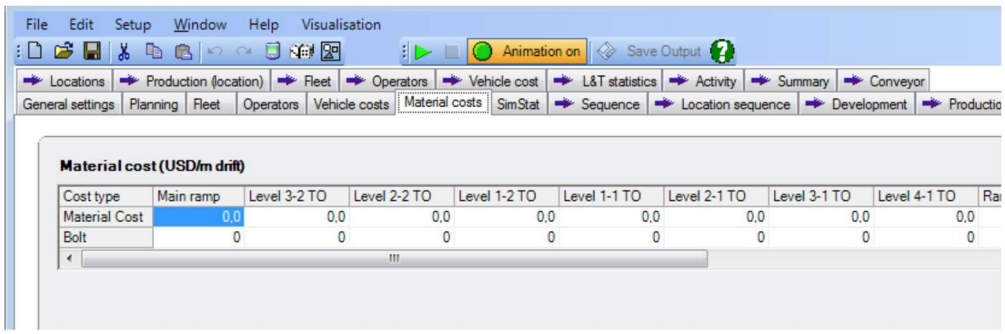


Figure 7-66 - Material costs

7.7.1 Functionality

7.7.1.1.1 Specify costs for bolts

First, define the bolt material if not already defined. See Materials on page 73 for information how to create a new material. When the material is created, it will show as one row in the cost table.

Enter a cost for each section in the row which contains the newly created bolt material.

7.7.1.1.2 Define higher bolt costs at sections with bad rock

Set the cost in the row for the bolt material (define the bolt material if needed). Each section is shown as columns in this table. For the column that shows the section where bad rock exists, specify a higher cost than the rest of the bolt columns.

8 Output interfaces

In this part, you will learn what type of results that exist after a successful simulation, and how to analyze the results. Simulation results are only available after a simulation has been run successfully. The results are available in the output tabs, which are all marked with a blue arrow on them. The tabs are always available and will show the results from the last successful simulation run. At start, when no simulation has been run, these tabs contain nothing. The tabs will continuous update its content during a simulation, to show the results collected so far. The number of visible output tabs (with a blue arrow) can vary depending on the license type you are running on.

Note! the results in all output tabs are only telling what has been going on during a simulation. They will not give answers for how to solve a certain problem. It is up the user to analyze the results, and try a different setup until the results are better of fulfills the requirements

8.1 Sequence

This tab is only available in the development package.

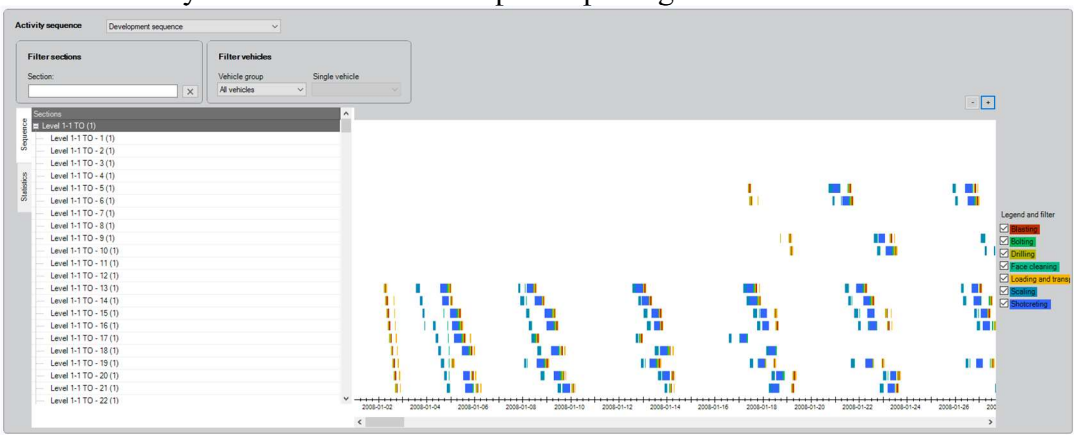


Figure 8-1 – Sequence

It contains statistics about all activities that has been performed in sections, as well as general section statistics. This view has 2 sub views - sequence and statistics. The are selected by the tabs to the left.

- Sequence: This shows each activity for each section in a color coded fashion. This can be filtered through the checkboxes to the right. This gets a bit overview in which order and when in time sections have been developed. It can also be used to examine any anomalies, with for example big gaps between two activties.
    - The shown sections can also be filtered by entering a filter string in the ***Filter Section*** box above the sequence.
- Statistics: This shows variour statistics for each section. It contain these values:
    - Utilization. This is calculated as the total time any activity has been performed at the section compared with the total time from when the first activity started and until the last activity was done. For sections which haven't been completed during the simulation run, the last reported activity is used as the last date and time. It

means that not only activties performed by a vehicle is counted in the face utilization presented here
- Complete – the length of the section which has been completed during the simulation
- Undone – The distance which has not been done during the simulation.
- Start time – The first date when the first activity was commenced at the section.
- End date – The date when the esction become done. When blank, then the section hasn't completed during the simulation. In that case, the undone column will also contain a number.
- Gross cycle time – The averag time for each round in the activity cycle (the time to perform the cycle from the first activity to the last in the activity cycle). This counts the total time, weekends, nights etc.
- Cycle time – The average cycle time, but it only counts the actual time an activity is performed.
- Cost/meter – This shows the total cost per meter for material at the section.

The column Cycle time is a good place to verify that the average activity cycle time correspond to the real life's expected activity cycle time. If not, some input data is most probably wrong. Is the work time for activties entered correctly for the vehicles for example: For work times which depend on length meter, the total work time must be recalculated to fit a per meter-basis. Example: The total bolt for a bolt rig is between 1 hour and 3 hours, with its average at 2 hours, when it bolts a 3 meter work area in a drift. If these times are entered directly into the work times for a vehicle (see Change time to perform a task for a vehicle at page 143), the resulting work time will become wrong. If a drillrig has drilled which advanced the face 3 meters, the total work time would average to between 3 and 6 hours, since the times enetered in the data for the vehicle is per length meter. The times enetered should be divided by 3, since the total work time is when the rig bolts a 3 meter work area.

8.1.1 Overview

Check which activities that have been performed,and when, at each segment in the mine.
Switch to the statistics sub tab to the left. This shows each activity type with a different color. The scale can be zoomed in or out.
Filter the view. Filters can be applied to vehicles and sections.

8.1.2 Functionality

8.1.2.1.1 Which activities have been performed for one section

There are two ways to check which activities that have been performed for a section.
Find the section in the list by scrolling
Use a filter to show only the section of interest.

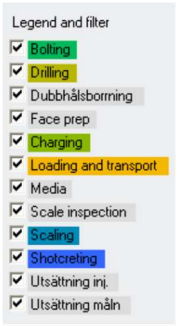
First, select "Sequence" tab to the left if it is not already selected. This will take you to the sequence view, which shows all activities for all sections in a color-coded fashion.
To use filter, find the section of interest in the filter sections list at the top in Figure 8-1 – Sequence. This will cause only the selected section to show in the center part. The filter only works for sections. All the filtered section's segments are also visible.
Now you can easily find the segment of interest. If the section only contains one segment, the activities are shown for the section instead of the segment.
Zoom in on the area of interest by using the '+' and '-' buttons above the chart.
You can use the scrollbar at the bottom to scroll to the point in time where you which to look.

8.1.2.1.2 Activities performed by one vehicle

Select the vehicle group to which the vehicle belongs in "Filter vehicles" part in Figure 8-1 – Sequence, above the chart. This will show all activities that have been performed by any vehicle within this vehicle group.
Next, select the specific vehicle to show activities for from the "Single vehicle" dropdown list.
Use the zoom buttons ( ) above the graph to zoom in and out, and then scroll to the position of interest to see the activities in more detail.

8.1.2.1.3 Filter the sequence view to show only a few activities

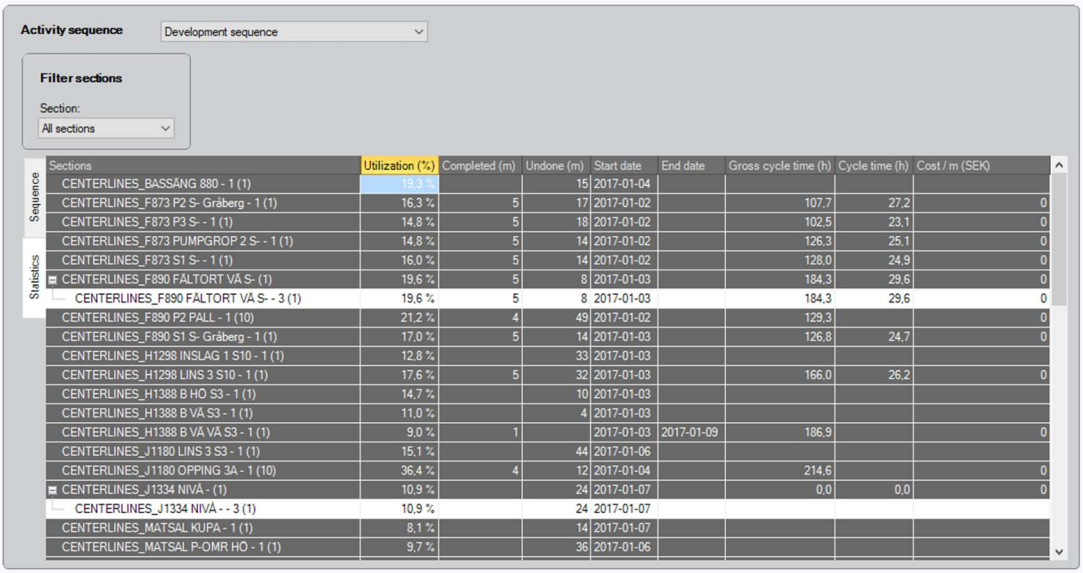
If you do want to check some activity types only, you can filter which activities that are shown in the sequence view by checking which activities shall or shall not be visible to the right of the sequence graph.



This shows each activity type that has been performed in the simulation.

8.1.2.1.4 Verify that the simulated cycle time is correct

An important step when verifying if the model behaves correctly, is to verify that the cycle time for a whole cycle is close to the cycle time in the real mine. The simulated cycle time is based on several factors, such as which activities are in the cycle, how long each activity takes to perform, the frequency of each activity etc. Of this reason, it is important to verify cycle times for segments where several rounds have been done - not just once, since it can result in cycle times which differs substantially from the reality.



Sections	Utilization (%)	Completed (m)	Undone (m)	Start date	End date	Gross cycle time (h)	Cycle time (h)	Cost / m (SEK)
CENTERLINES_BASSÄNG 880 - 1 (1)	19,3 %		15	2017-01-04				
CENTERLINES_F873 P2 S- Gråberg - 1 (1)	16,3 %	5	17	2017-01-02		107,7	27,2	0
CENTERLINES_F873 P3 S- - 1 (1)	14,8 %	5	18	2017-01-02		102,5	23,1	0
CENTERLINES_F873 PUMPGROP 2 S- - 1 (1)	14,8 %	5	14	2017-01-02		126,3	25,1	0
CENTERLINES_F873 S1 S- - 1 (1)	16,0 %	5	14	2017-01-02		128,0	24,9	0
CENTERLINES_F890 FÄLTORT VÄ S- (1)	19,6 %	5	8	2017-01-03		184,3	29,6	0
CENTERLINES_F890 FÄLTORT VÄ S- - 3 (1)	19,6 %	5	8	2017-01-03		184,3	29,6	0
CENTERLINES_F890 P2 PALL - 1 (10)	21,2 %	4	49	2017-01-02		129,3		0
CENTERLINES_F890 S1 S- Gråberg - 1 (1)	17,0 %	5	14	2017-01-03		126,8	24,7	0
CENTERLINES_H1298 INSLAG 1 S10 - 1 (1)	12,8 %		33	2017-01-03				
CENTERLINES_H1298 LINS 3 S10 - 1 (1)	17,6 %	5	32	2017-01-03		166,0	26,2	0
CENTERLINES_H1388 B HÖ S3 - 1 (1)	14,7 %		10	2017-01-03				
CENTERLINES_H1388 B VÄ S3 - 1 (1)	11,0 %		4	2017-01-03				
CENTERLINES_H1388 B VÄ VÄ S3 - 1 (1)	9,0 %	1		2017-01-03	2017-01-09	186,9		0
CENTERLINES_J1180 LINS 3 S3 - 1 (1)	15,1 %		44	2017-01-06				
CENTERLINES_J1180 OPPING 3A - 1 (10)	36,4 %	4	12	2017-01-04		214,6		0
CENTERLINES_J1334 NIVÅ - (1)	10,9 %		24	2017-01-07		0,0	0,0	0
CENTERLINES_J1334 NIVÅ - - 3 (1)	10,9 %		24	2017-01-07				
CENTERLINES_MATSAL KUPA - 1 (1)	8,1 %		14	2017-01-07				
CENTERLINES_MATSAL P-OMR HÖ - 1 (1)	9,7 %		36	2017-01-06				

Figure 8-2 - Sequence statistics

Switch to "Statistics" sub tab in the Sequence tab to see statistics. This tab is to the left in Figure 8-2 - Sequence statistics, where you also can see the statistics. Find the segment that will be compared, and look in the column ***Cycle time***. Cycle time, does only count the actual time an activity is performed. It only counts full cycles, so if the first activity cycle starts in the middle of it at the start of the simulation, that cycle round is not counted. Compare the value to the value from the real mine's measures. If these two differ much, your activity cycle needs to be looked through, to find where the fault could be. It is probably in the entered activity times for the vehicle which performs the activity. It can also be due to that measurement in the real mine has been for one set of vehicles, while in your simulation, another set of vehicles, with different work speed has been used. In that case, rerun the simulation but force the correct vehicles to work at the section and compare the results again. After the compare has been verified and correct, you can then switch back to the original configuration regarding which vehicles can work at the section.

8.2 Location sequence tab

This shows the sequence of activities which has occurred at placed objects (i.e. locations). It has the same look and feel as the sequence for the sections described in the previous part.

Since this shows locations only, it will in most cases only contain the loading and transport activity since any other activity type isn't performed at a placed object (with the exception being the main and secondary production locations).

8.3 Development tab

This tab is only available in the development package.

It contains several types of statistics:

- Developed length and available headings, together with tonnage kilometers.
- Developed length and amount per section
- Average haul distances for loaders, per section
- Developed length and amount per face profile

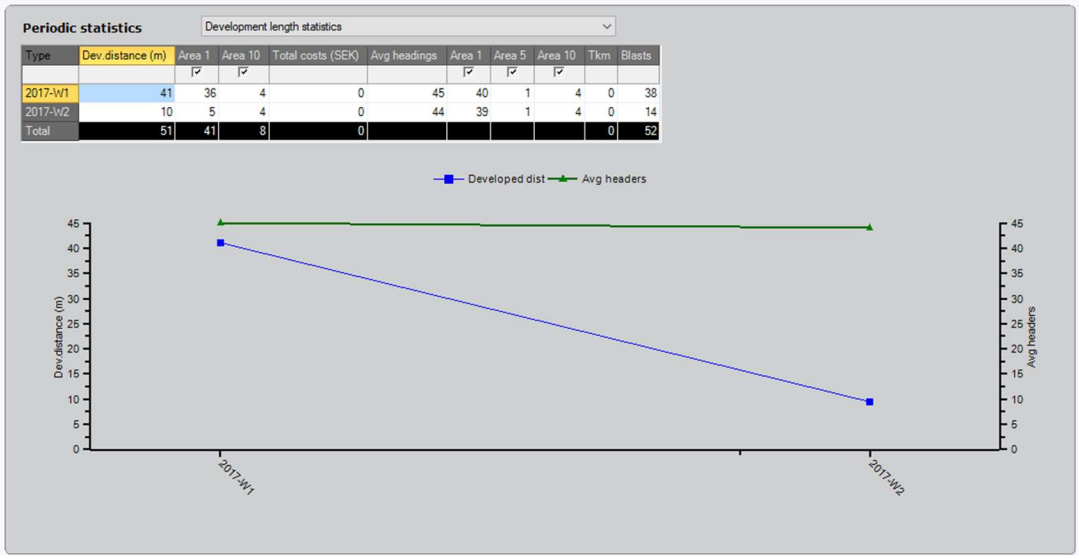


Figure 8-3 - Development statistics

This is a good place to verify that the number of development meters is close to the expected.

8.3.1 Overview

This contains different types of statistics for developed distance, and the haulage done from the development headings. All statistics is viewed per report period. The type of statistics to view is selected in the dropdown list at the top, which contains the statistics listed above.

8.3.2 Views

This tab has several views, which are selectable through the top dropdown list.

8.3.2.1 Development length and available headings view

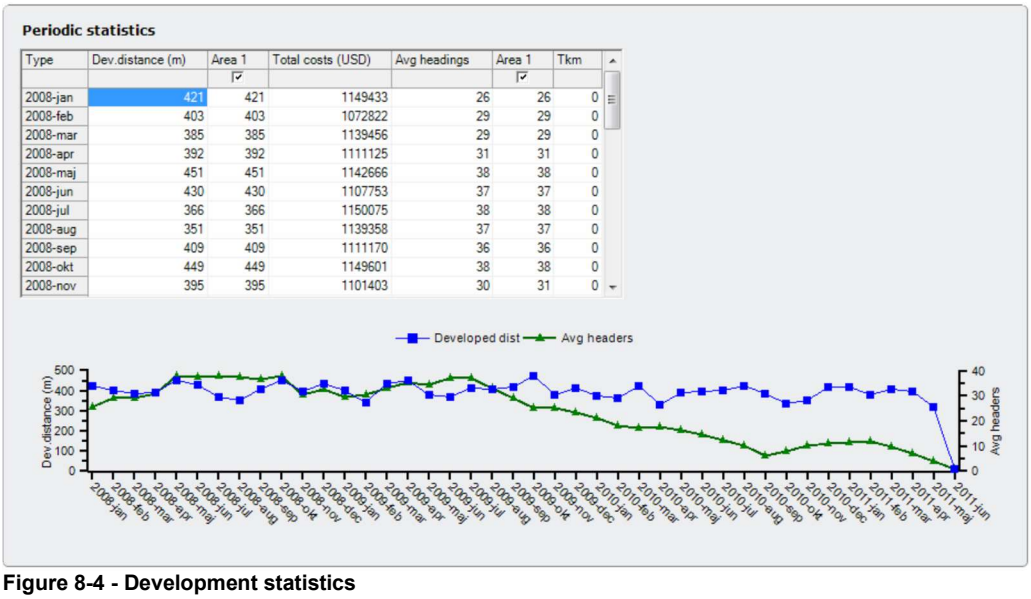


Figure 8-4 - Development statistics

This view contains a table showing development distance, costs, average headings and tonnage kilometers per report period. Is also contains a graph which shows developed distance and average headings for the selected mine areas from the table (done with the check boxes for each mine area at the second row in the table)

8.3.2.1.1 Functionality

8.3.2.1.1.1 Developed meters

The number of developed meters (or feet if imperial units are selected in General settings) can be seen both in the table and in the graph. In the column ***Dev. distance***, the total number of meters done during each reports period can be seen.
After this column, one or more columns show the developed distance per mine area and per period. In the second row, a checkbox exists for each mine area. Uncheck or check these columns to include the developed distance from these mine areas in the graph. As default, all mine areas are checked.
The graph shows developed distance for all checked mine areas in the table. See Mine areas on page 295 for how to define mine areas

8.3.2.1.1.2 Average number of available headings

The average number of available headings is visible both in the table and in the graph.
In the column ***Avg. headings***, the sum of all average headings for all mine areas is seen. After this column, one or more columns show the number of average headings for each existing mine area.
In the second row, a checkbox exists for each mine area. Uncheck or check these columns to include the average headings from these mine areas in the graph. As default, all mine areas are checked.
The graph shows average headings for all checked mine areas in the table.
The average number of headings is calculated as:
At each 24 hours, the number of available headings is counted and saved. Even if the number of headings has varied during these 24 hours, it is only counted at the end of each day. When displaying the average number of available headings, the total number of available headings are counted during a report period, and then divided by the number of days in that period.
Number of available headings is useful when examine why the vehicles get less utilized.

8.3.2.1.1.3 Total development cost during a report period

Find the row in the table that shows the data for the report period of interest. Check in the ***Total cost*** column.
This column shows the total cost associated with development during the report period.

8.3.2.1.1.4 Development progress

The development progress can depend on a number of things. In this view, a quick control can be made that the developed distance doesn't drop or is raised abnormally. This can easily be done in the graph by first selecting the areas of interest from the table.

There might exist unwanted areas due to simulation shortcuts, where for example shaft development is simulated as normal development and shown in this view as developed distance. This kind of development might not be of interest when checking the distance developed in the haul ways.
When the mine areas for development distance is selected, the same should be done for average heading, to only select the mine areas of interest. In the graph, only the selected areas are now visible and it is now possible to check if any report period has an abnormal drop or rise in developed distance. It can now be compared with the number of average headings. If both graphs (distance and headings) drop at the same time, the reason might be that it isn't enough headings to maintain a certain development pace.

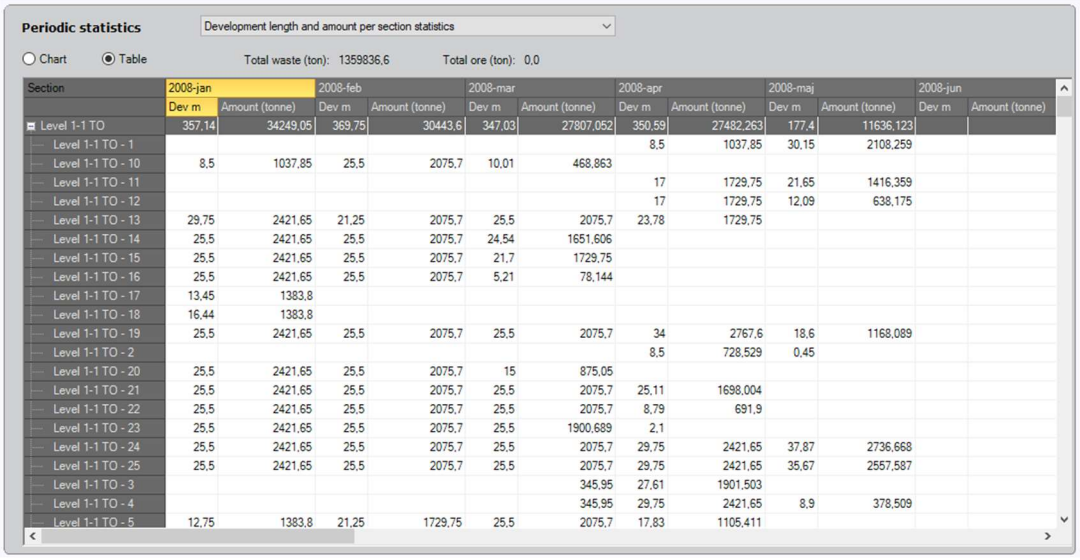
Tip! This can be further verified by looking at the utilization for the fleet during the same period. If this also drops, without that any vehicle is heavily used (i.e. all involved vehicles have not full utilization during that period), the low number of headings is probably the cause in the development distance drop

When it has been confirmed that the drop was due to available headings, the development plan could be changed if the goal is to maintain a high development pace.

8.3.2.1.1.5 Number of blasts per period

In the table, there is a column which contains the number of blasts that has been done during each report period. Since the number of blasts is in most cases a known number in the mine, this can be compared with how the real mine blasted, to verify if the model is calibrated or behaving as expected.

8.3.2.2 Development length and amount per section view



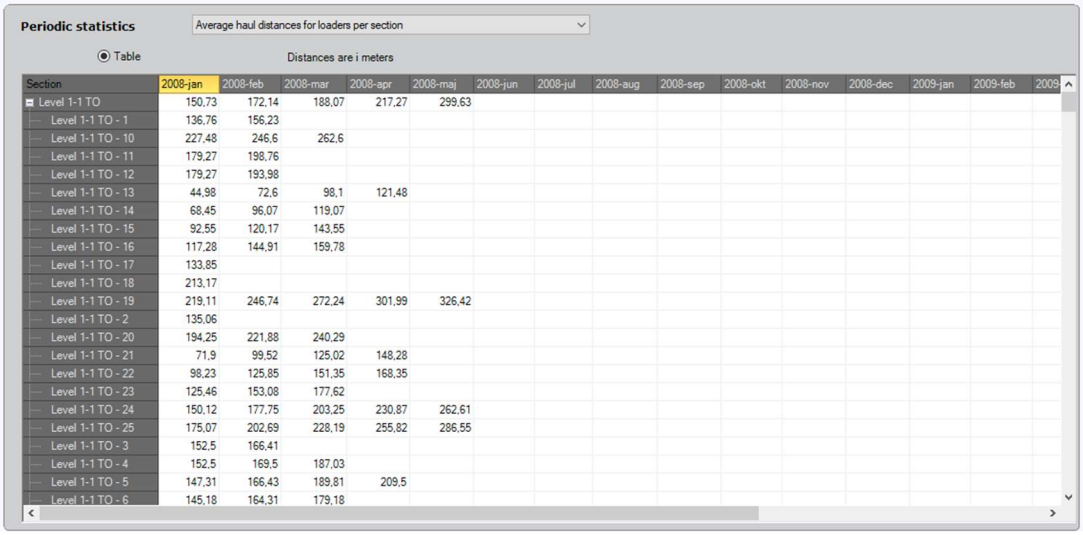
Section	2008-jan		2008-feb		2008-mar		2008-apr		2008-maj		2008-jun	
	Dev m	Amount (tonne)	Dev m	Amount (tonne)	Dev m	Amount (tonne)	Dev m	Amount (tonne)	Dev m	Amount (tonne)	Dev m	Amount (tonne)
Level 1-1 TO	357,14	34249,05	369,75	30443,6	347,03	27807,052	350,59	27482,263	177,4	11636,123		
Level 1-1 TO - 1							8,5	1037,85	30,15	2108,259		
Level 1-1 TO - 10	8,5	1037,85	25,5	2075,7	10,01	468,863						
Level 1-1 TO - 11							17	1729,75	21,65	1416,359		
Level 1-1 TO - 12							17	1729,75	12,09	638,175		
Level 1-1 TO - 13	29,75	2421,65	21,25	2075,7	25,5	2075,7	23,78	1729,75				
Level 1-1 TO - 14	25,5	2421,65	25,5	2075,7	24,54	1651,606						
Level 1-1 TO - 15	25,5	2421,65	25,5	2075,7	21,7	1729,75						
Level 1-1 TO - 16	25,5	2421,65	25,5	2075,7	5,21	78,144						
Level 1-1 TO - 17	13,45	1383,8										
Level 1-1 TO - 18	16,44	1383,8										
Level 1-1 TO - 19	25,5	2421,65	25,5	2075,7	25,5	2075,7	34	2767,6	18,6	1168,089		
Level 1-1 TO - 2							8,5	728,529	0,45			
Level 1-1 TO - 20	25,5	2421,65	25,5	2075,7	15	875,05						
Level 1-1 TO - 21	25,5	2421,65	25,5	2075,7	25,5	2075,7	25,11	1698,004				
Level 1-1 TO - 22	25,5	2421,65	25,5	2075,7	25,5	2075,7	8,79	691,9				
Level 1-1 TO - 23	25,5	2421,65	25,5	2075,7	25,5	1900,689	2,1					
Level 1-1 TO - 24	25,5	2421,65	25,5	2075,7	25,5	2075,7	29,75	2421,65	37,87	2736,668		
Level 1-1 TO - 25	25,5	2421,65	25,5	2075,7	25,5	2075,7	29,75	2421,65	35,67	2557,587		
Level 1-1 TO - 3						345,95	27,61	1901,503				
Level 1-1 TO - 4						345,95	29,75	2421,65	8,9	378,509		
Level 1-1 TO - 5	12,75	1383,8	21,25	1729,75	25,5	2075,7	17,83	1105,411				

Figure 8-5 - Development length and amount

This view contains a table showing the developed length and hauled amount per section for each report period. The development can be examined in more detail here compare with the overview statistics seen in Development length and available headings view on page 153.

The periods are along the first row, while all sections and segments are along the first column. Each segment has two values printed, one for developed distance and one for the hauled amount of rock for each period. If the activity cycle doesn't contain any loading and transport, the value for the hauled rock will be blank.

8.3.2.3 Average haulage distance per section view

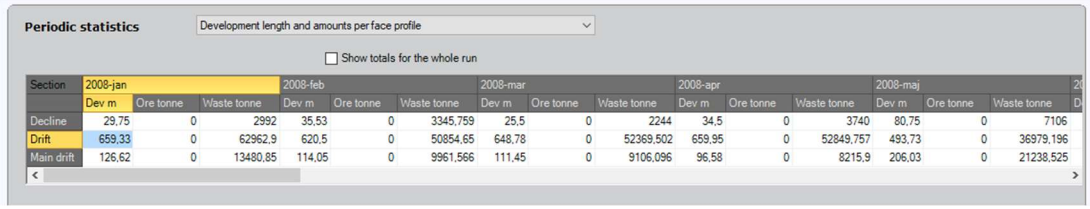


Section	2008-jan	2008-feb	2008-mar	2008-apr	2008-maj	2008-jun	2008-jul	2008-aug	2008-sep	2008-okt	2008-nov	2008-dec	2009-jan	2009-feb	2009
Level 1-1 TO	150,73	172,14	188,07	217,27	299,63										
Level 1-1 TO - 1	136,76	156,23													
Level 1-1 TO - 10	227,48	246,6	262,6												
Level 1-1 TO - 11	179,27	198,76													
Level 1-1 TO - 12	179,27	193,98													
Level 1-1 TO - 13	44,98	72,6	98,1	121,48											
Level 1-1 TO - 14	68,45	96,07	119,07												
Level 1-1 TO - 15	92,55	120,17	143,55												
Level 1-1 TO - 16	117,28	144,91	159,78												
Level 1-1 TO - 17	133,85														
Level 1-1 TO - 18	213,17														
Level 1-1 TO - 19	219,11	246,74	272,24	301,99	326,42										
Level 1-1 TO - 2	135,06														
Level 1-1 TO - 20	194,25	221,88	240,29												
Level 1-1 TO - 21	71,9	99,52	125,02	148,28											
Level 1-1 TO - 22	98,23	125,85	151,35	168,35											
Level 1-1 TO - 23	125,46	153,08	177,62												
Level 1-1 TO - 24	150,12	177,75	203,25	230,87	262,61										
Level 1-1 TO - 25	175,07	202,69	228,19	255,82	286,55										
Level 1-1 TO - 3	152,5	166,41													
Level 1-1 TO - 4	152,5	169,5	187,03												
Level 1-1 TO - 5	147,31	166,43	189,81	209,5											
Level 1-1 TO - 6	145,18	164,31	179,18												

Figure 8-6 – Average haulage distance

This view contains a table showing the average haulage distance for loaders, per section/segment and for each report period.
The periods are along the top row, and all the sections/segments are along the first column.
This can be used to examine if any part of the mine causes the loader to have a long tramming distance.

8.3.2.4 Development length and amount per face profile view



Section	2008-jan			2008-feb			2008-mar			2008-apr			2008-maj			2
	Dev m	Ore tonne	Waste tonne	Dev m	Ore tonne	Waste tonne	Dev m	Ore tonne	Waste tonne	Dev m	Ore tonne	Waste tonne	Dev m	Ore tonne	Waste tonne	D
Decline	29,75	0	2992	35,53	0	3345,759	25,5	0	2244	34,5	0	3740	80,75	0	7106	
Drift	659,33	0	62962,9	620,5	0	50854,65	648,78	0	52369,502	659,95	0	52849,757	493,73	0	36979,196	
Main drift	126,62	0	13480,85	114,05	0	9961,566	111,45	0	9106,096	96,58	0	8215,9	206,03	0	21238,525	

Figure 8-7 – Developed distance and amount per face profile

This view contains a table showing the developed distance and amounts per face profile for each report period.
The periods are along the top row, and all the unique face profiles are along the first column.
This can be used to verify that the correct amounts have been hauled from each face profile, since the area of a face profile is known.

8.4 Production statistics tab

This tab is only available in the production package.

It contains several different types of statistics about production:

- Produced amounts
- Blasted amounts
- Produced vs hauled amounts from production locations

8.4.1 Overview

This contains different types of statistics for produced amounts. All statistics is viewed per report period.
The type of statistics to view is selected in the dropdown list at the top, which contains the statistics listed above.
Some production locations are available in the development package, but this tab will not show unless the production license does exist.

8.4.2 Views

This tab has several views, which are selectable through the top dropdown list.

8.4.2.1 Produced amounts view

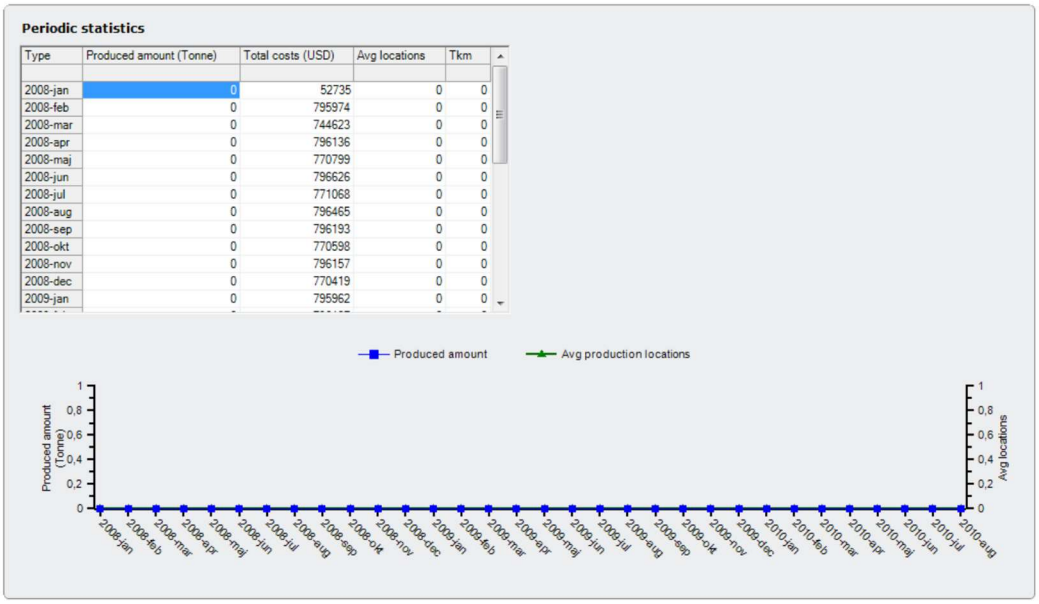


Figure 8-8–Production statistics

This view shows amounts, available production locations, costs and tonnage kilometers for each simulation period.
This view does only show statistics for production locations. Production object and Production plan object are part of the development package and will not show here.

This is a good place to verify that the number of production tonnes is close to the expected.

8.4.2.1.1 Overview

This view contains the following information:

- Produced amount from production locations per simulation period for the whole mine, or per mine area is shown here.

- Cost statistics per simulation period (this is the same as for development statistics)
- Statistics for average number of available production locations
- Statistics for tonnage kilometers associated with trucks transporting rock from the production locations.

8.4.2.1.2 Functionality

8.4.2.1.2.1 Check produced amount

The produced amount can be seen both in the table and in the graph. In the column "Produced amount ", the total number of meters each reports period can be seen.

8.4.2.1.2.2 Check average number of available production locations

The average number of available production locations is visible both in the table and in the graph.
In the column "Avg.locations", the sum of all average locations, independent of their mine area is seen.
The average number of locations is calculated as:
At each 24 hours, the number of available locations is counted and saved. Even if the number of headings has varied during these 24 hours, it is only counted at the end of each day. When displaying the average number of available headings, the total number of available headings are counted during a report period, and then divided by the number of days in that period.

8.5 Locations tab

This tab contains several different types of statistics about locations:

- Received and produced amounts
- Vehicle passages

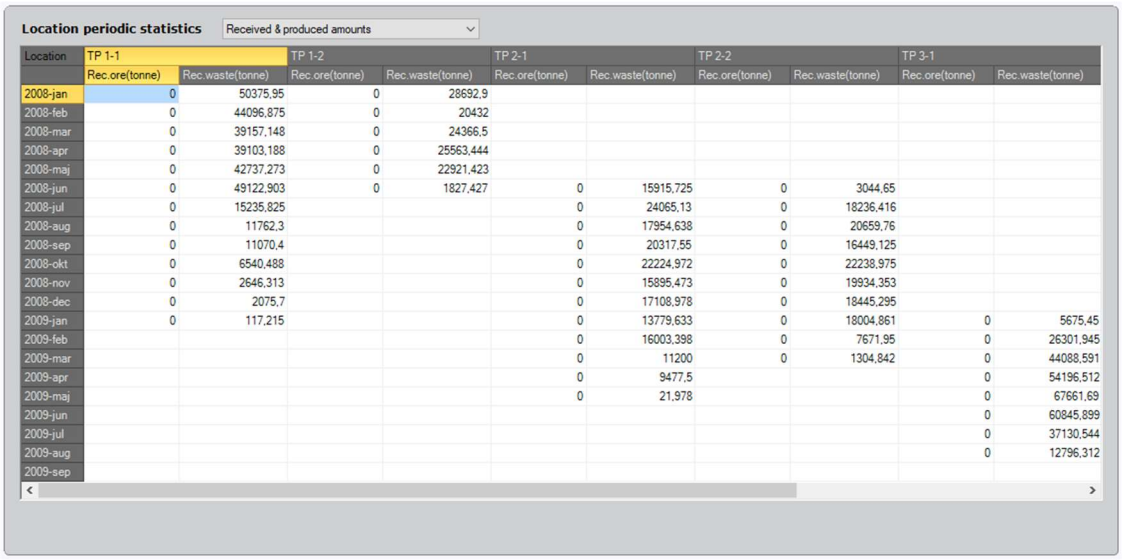
8.5.1 Overview

This contains different types of statistics for locations. All statistics is viewed per report period.
The type of statistics to view is selected in the dropdown list at the top, which contains the statistic types listed above.

8.5.2 Views

This tab has several views, which are selectable through the top dropdown list.

8.5.2.1 Received and produced amounts



Location periodic statistics — Received & produced amounts

Location	TP 1-1		TP 1-2		TP 2-1		TP 2-2		TP 3-1	
	Rec.ore(tonne)	Rec.waste(tonne)	Rec.ore(tonne)	Rec.waste(tonne)	Rec.ore(tonne)	Rec.waste(tonne)	Rec.ore(tonne)	Rec.waste(tonne)	Rec.ore(tonne)	Rec.waste(tonne)
2008-jan	0	50375,95	0	28692,9						
2008-feb	0	44096,875	0	20432						
2008-mar	0	39157,148	0	24366,5						
2008-apr	0	39103,188	0	25563,444						
2008-maj	0	42737,273	0	22921,423						
2008-jun	0	49122,903	0	1827,427	0	15915,725	0	3044,65		
2008-jul	0	15235,825			0	24065,13	0	18236,416		
2008-aug	0	11762,3			0	17954,638	0	20659,76		
2008-sep	0	11070,4			0	20317,55	0	16449,125		
2008-okt	0	6540,488			0	22224,972	0	22238,975		
2008-nov	0	2646,313			0	15895,473	0	19934,353		
2008-dec	0	2075,7			0	17108,978	0	18445,295		
2009-jan	0	117,215			0	13779,633	0	18004,861	0	5675,45
2009-feb					0	16003,398	0	7671,95	0	26301,945
2009-mar					0	11200	0	1304,842	0	44088,591
2009-apr					0	9477,5			0	54196,512
2009-maj					0	21,978			0	67661,69
2009-jun									0	60845,899
2009-jul									0	37130,544
2009-aug									0	12796,312
2009-sep										

Figure 8-9 - Produced and received amounts

This shows the amount produced and amounts received per location and per report period. It does only show those locations which has had any produced or received amounts during the simulation.
This resembles about the produced amount statistics for production locations, but this is visible with the development license, while the former requires the production license. This contains only amounts, while the former contains some additional statistics.
In this view, all locations in the mine layout, which have received any rock, is along the top row in the table. The simulation periods are printed in the first column.

8.5.2.1.1 Functionality

8.5.2.1.1.1 Verify that a location has received as expected

This might be for example that a crusher is expected to be operational at the beginning of April. You can check if this crusher has started to receive ore or waste during this month.
Find the location in the first row. Follow the columns for this location until April month. The number in the cell for April shows if it has received anything. If the cell is blank, nothing has been received during this month.

Note! If the location isn't found in the first row, it has not produced or received anything during the whole simulation period.

If a location is expected to receive ore only, it can be checked if this is the case. If there is a number in the waste column for that location, the logic in the model might be configured wrong.

8.5.2.1.1.2 Determine why a location hasn't received as expected

There exist a number of reasons why a location hasn't received as expected. Here is a list of possible reasons and how to verify which it might be.

Possible problems:

- The development hasn't reached the location as expected.
    - This can be seen in the location table that the location has received the right rock type, but later than expected. Use the Sequence tab, page 150, to check when a location has become available in the layout.
- The location has received the wrong type of rock
    - This can be due to that the location is set to only receive a specific rock type. See page 231 to set possible rock types to receive for a crusher. The same problem can exist for other types of locations and is fixed in the same way.
- The location has a receive schedule which doesn't permit it to receive rock until a certain time.
    - Check the receive schedule. Not all locations have a receive schedule. See page 231 to check this for a crusher.
- The location has received a small amount, but nothing more.
    - If the location is storing the rock until it shall be transported further, it might be due to that the location has become full, and the location where it shall transport its rock to isn't available, or doesn't allow the type of rock that is in the location. This can be examined in the transport analyze form. See Loading and transport analyzes on page 183 for how to use the transport analyze.

8.5.2.2 Vehicle passages view

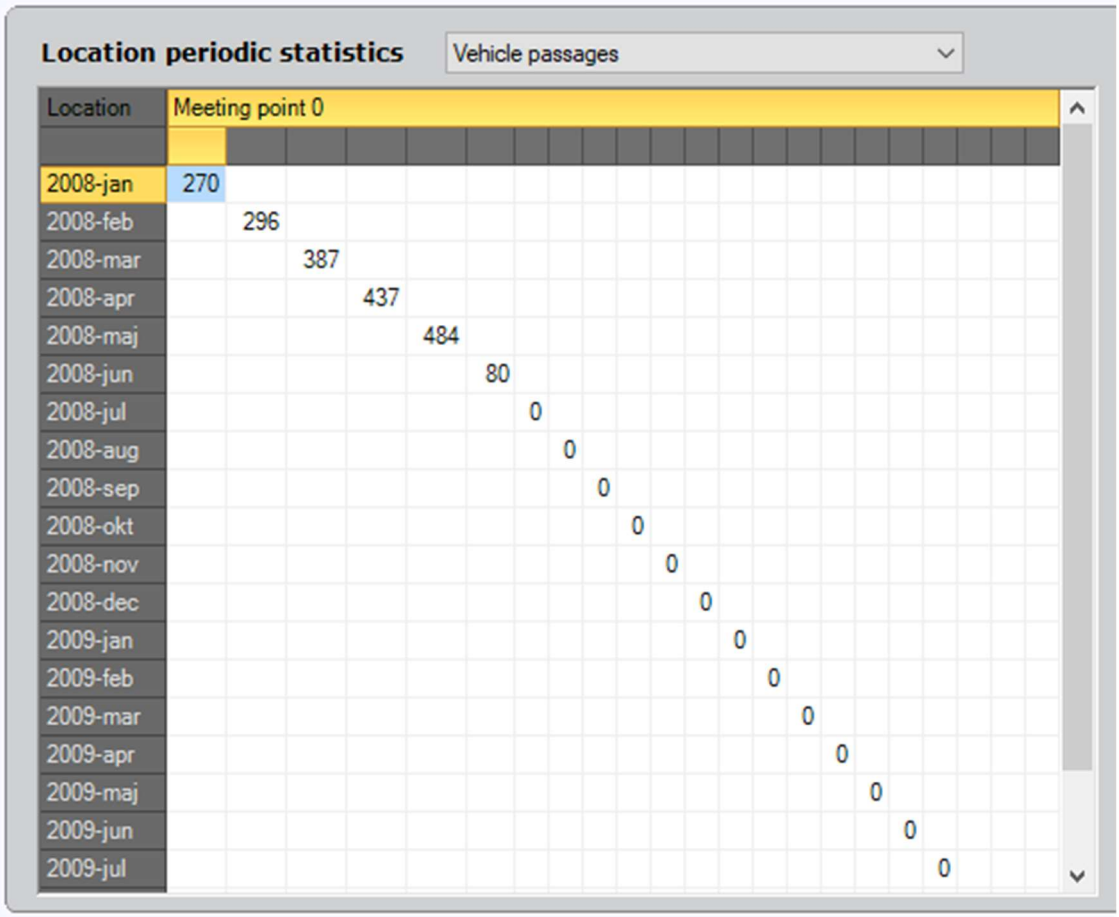


Figure 8-10–Vehicle passages

This view shows the number of times, per report period, that a vehicle has passed each placed meeting point in the layout.

This can be used to analyze the traffic within the mine (i.e. number of trips).

8.6 Fleet

This tab is only available in the development package.
It contains statistics for how the vehicles have been used during the simulation. The statistics include what the vehicles have done, driven distance, meeting time, queuing etc. These statistics can be viewed for the whole simulation period, or per report period.

8.6.1 Overview

In this tab you can:

- Check what the vehicles have done during the simulation. It can for example be work, idle, meal breaks and broken.
- Check queuing, meeting and travel amount.
- Check which vehicle or vehicles that are the bottlenecks.
- Check when in time a vehicle has become a bottleneck.
- Check if any vehicle has abnormally much travelling.
- Check how much each vehicle has worked in each mine area
- Check broken information for the vehicles

8.6.2 Views

The fleet only contains one view, which can show the statistics for the vehicles in different forms and types. The data can be viewed both in a graph and in a table.

Figure 8-11 - Fleet statistics

The graph in the picture above has two Y-axis:

1. The scale to the left shows the scale for all bar charts, and has the following meanings:

a. Yellow – Work time
b. Light blue – Idle time, which is scheduled work time, but no work is found. Vehicles with no or little idle time hasn't any 'free' time, and thus they can't do more work (i.e. all their scheduled, non-broken time is work time)
c. Black – broken time
d. Light green – Preventive maintenance time
e. Grey – Vehicle specific time. This is when a vehicle performs a task which is specific for the vehicle, such as refilling cement for the cement truck, or refilling bolts for the bolt rig.
f. Green – Operator waiting time. This is the time when a vehicle waits for an operator to become free. This is only valid if the operator license exists.
g. Light orange – Boulder fix time.
h. Light Purple – Wait for repair time. This counts when a vehicle is running autonomous, and breaks down. If a repair team isn't available, or off shift when the vehicle breaks down in this mode, it goes into wait for repair time.
i. Dark purple – Activity switch time. The time a vehicle spends in a mode of switching tasks. This is the time the vehicle is occupied after a task and until it can start searching for other tasks, or becoming idle. See Simulation logic 2 page on page 206 for more information about task switching time.
j. Pink – Waiting at face. Vehicles can be assigned tasks which haven't yet become the current task at the face. It is used to make the vehicle ready at, or close to the face, so that the activity at the face can be worked at as soon as possible. This time counts when the vehicle comes to the face to work with an activity which hasn't become the current activity yet. See Precheck configurations on page 77 for how to configure pre-check configurations, which are used to assign future activities to vehicles)

2. The scale to the right holds the line graphs and holds the following series:
   a. Red – Traffic time, which is traffic disturbance time
   b. Grey - Wait time. This is when a vehicle is in queue, waiting for its turn. For trucks, it counts when it is waiting to become first in the queue and loaded by a loader. When a truck will dump its load, and the dump spot isn't free, this time will also count. During the time a loader loads onto the truck, it has no wait time, then it has work time. For loaders, it is when a loader waits for a truck to arrive.
   c. Purple - Travel time. The time a vehicle spends travelling.
   d. Green - Other wait time. Only used for cement trucks, or multifunctional vehicles which has the cement truck function. It counts the time it refills at a cement station when the vehicle doesn't have unlimited capacity.
   e. Brown – Destination full time. Time when a vehicle comes to a location to dump, but the location is full. Only conveyor dump locations support this functionality. Other locations can overfill slightly (i.e. a truck is allowed to dump its load even if the location gets overfilled. It cannot go fetch another load destined to the same location though)

f. Orange – Autonomous outside shift time. This time counts when an autonomous vehicle works outside the manned shift (i.e. without any operator controlling it or sitting inside its cabin).

8.6.3 Functionality

8.6.3.1.1 Check one vehicle only

The graph (and table) can show an overview of each vehicle, or a more detailed view, by showing vehicle statistics for each report period during simulation. The overview shows the sum of work, idle time, breakdowns etc., while the more detailed view shows this data for each period during simulation.
There are two ways to show data for one vehicle only:

1. In the ***Vehicle filter*** panel, check the ***Single vehicle*** radio button. Then select the vehicle to show data for from the dropdown list.
2. In the graph – double click the vehicle for which to show a detailed view. The graph will then switch to show the data for the vehicle which was clicked
   a. When the graph is already in the detailed view, a double-click will switch back to the overview.

8.6.3.1.2 Overview for one type of vehicle

This is used when you want to examine one type of vehicles, for example all trucks, and not show data for any other vehicle.
This is done in the same way as for one vehicle only, except that it can only be done from the ***Vehicle filter*** panel.

- Check the ***Show only*** radio button in the ***Vehicle filter*** panel
- Select which type of vehicle to show an overview for in the list next to the radio button.

To switch back to show all vehicles again, check the "All vehicles" in the ***Vehicle filter*** panel.

8.6.3.1.3 Fleet statistics as numbers

To switch between showing all the data in a graph, or in a table (as numbers), there are two radio buttons above the graph/table.
Check the ***Table*** radio button to switch to the table view. This will show the current graph as numbers instead. To switch back to graph view, simply click the ***Graph*** radio button.

8.6.3.1.4 Which vehicle is the bottleneck

The bottleneck is the vehicle or vehicles that have the smallest amount of idle time (the light blue graph). The idle time is time when the vehicle is scheduled to run, but hasn't found any work.
First, verify that all vehicles are visible in the graph by checking the ***All vehicles*** radio button in the ***Vehicle filter*** part in Figure 8-11 above.
Next, sort all the vehicles according to their utilization by checking the ***Utilization*** radio button in the ***Sorting*** part. This will arrange all vehicles in the graph so the vehicle with the least utilization will come first, and the vehicle with the most utilization will come last - to the right in the graph.

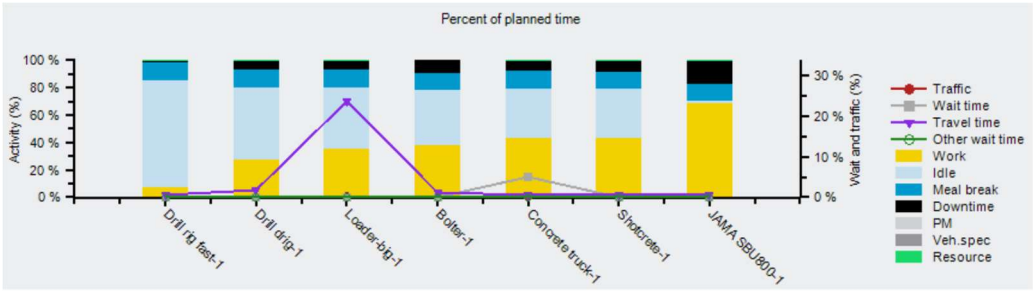


Figure 8-12 - Fleet utilization sorting

The vehicle with the most utilization is the vehicle that is most probably the bottleneck. In the picture above, the "JAMA SBU800-1" is the vehicle with the most utilization.

Note! It is not necessary the vehicle with the most utilization which is the bottleneck. There can for example be that the development faces are too few, so that it doesn't exist any bottleneck in the fleet. It can also be that another vehicle has become the bottleneck in the end of the simulation, but its total utilization is low. To verify this, open up each vehicle's detailed statistics show in Figure 8-13 - Detailed vehicle statistics below, to check if they are the bottleneck for only a certain time period for example.

To verify that a certain vehicle is the bottleneck, select that specific vehicle to show detailed statistics for it. It is done by double-click it in the graph when showing all vehicles.
This will show the detailed statistics, which shows the statistics for each report period:

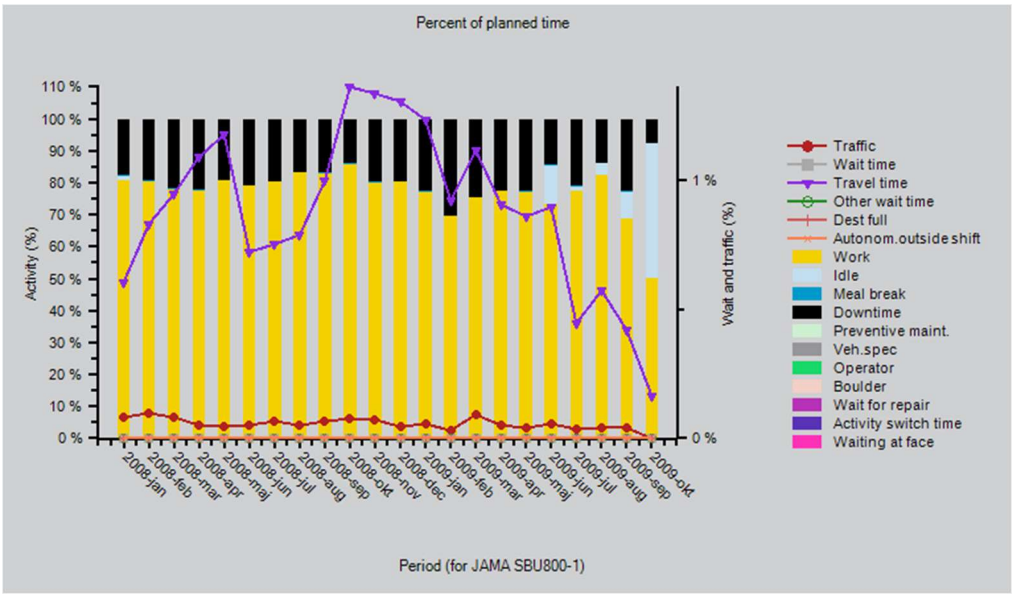


Figure 8-13 - Detailed vehicle statistics

In the detailed view, we can see what the vehicle has been doing during each report period. In the above example, we can see that the vehicle has been very busy the whole time (with hardly no idle time). It is clear that this vehicle is the main bottleneck in this simulation. It is only in the end of the simulation that its idle time increases. This is due to that the number of available headings drops (see Average number of available headings on page 154 for how to examine number of headings)

The detailed view should be compared with the development statistics view (see Development length and available headings view on page 153 for the development statistics). In that view, the number of available headings has dropped considerable in the end, which is the probable cause to the dip in work time for this vehicle. This tendency should be visible for all vehicles. To return to the view where all vehicles were visible, just double click inside the graph. This can be used in conjugation with the development statistics to determine a cause to a drop in developed distance.

8.6.3.1.5 Bottleneck is due to few headings

When it comes to a bottleneck that is due to vehicle capacity, it can easily be examined in the Fleet output tab. However, it is not equally clear when the bottle neck is due to too few available headings.
To determine if the bottleneck is from too few headings, you can check the Idle state for all vehicles.
The IDLE state is when the vehicles has been scheduled to work, but hasn't found any work. When the IDLE time does exist for every vehicle, with more than a few percent of the total time, the bottleneck may lay in number of available headings. It simply means that all the vehicles have had idle time at the same time due to work shortage. The reason that work shortage exist, is that there aren’t enough headings.
Due to the fact that some vehicles can only work in certain mine areas, this must also be taken into consideration when analyzing the results for heading shortage. For example: Assume that 10 vehicles exist. 5 of these can only work in mine area 1, and the other 5 in mine area 2. If the vehicles for mine area 1 has high utilization (their work state is high, and their idle state is low), does indicate that mine area 1 has enough headings. However, if the vehicles for mine area 2 have a high idle percentage, it indicates that mine area 2 has the bottleneck in the number of available headings.
To further analyze that the number of available headings in mine area 2 is the probable cause, the separate vehicles must be analyzed further.
Show statistics for one of the vehicles for mine area 2 only. This shows the vehicle states for each report period during the simulation run, see Figure 8-13 - Detailed vehicle statistics above.
If the idle time is constantly high, it tells that the vehicle hasn’t found enough work during the simulation run. This process should be repeated for all the vehicles that worked in mine area 2. It may exist situations where one of the vehicles has had very much to do during half of the simulation run, and during the other part of the simulation run, it hasn't had much to do at all. When showing all vehicles, the idle time percentage for the vehicle will show the average during the whole simulation run, and not reflecting the fact that the first half of the simulation, it had very much to do.
The above example, where a vehicle had much to do during half the simulation run, and not much to do during the second part of the simulation run, indicates that heading shortage is only for a certain period, and not the bottleneck during the full simulation run.

8.6.3.1.6 Abnormal driving

All vehicles will drive within the mine. What is then abnormal driving? This is up to the user or engineers to decide. Trucks and loaders will of cause drive more than drill rigs and shotcrete rigs.
You can check the amount of driving a vehicle has had in the graph. It is the purple line, and its scale is to the right in the graph.
Abnormal driving does not necessary occur during the whole simulation time, instead it can be during a short period of time, which might last one or more simulation periods.
First, check if any vehicle has a total traffic time that is high. Showing all vehicles in the ***Vehicle filter*** part in Figure 8-11 above does this. Look at the purple line to see if a vehicle's total travel time is high. You can always look at the vehicle's detailed statistics by double clicking on the vehicle in the graph. A graph similar to the one in Figure 8-13 - Detailed vehicle statistics shows.
If there exist one or more vehicles with abnormal driving, what does it depend on? A number of reasons exist, but no quick way exists to determine the correct cause. Reasons might be:

- A dump location is far from the work location.
    - This is true for trucks and loaders, which travel to a dump location.
    - It can be further analyzed the average distance to the dump location, but only for loaders. See Average haulage distance per section view on page 156 for more information regarding this.
- If the vehicle has a high amount of traffic during the full simulation run, look into changing the way loading and transport will be done.
- If high traffic amount has occurred during a limited time period only, it is probably due to that during that time, the development faces are a long distance from the location where its rock will be dumped.
- A loader has a long distance to dump onto a truck.
    - Analyze this further in Average haulage distance per section view on page 156 .
    - A loader, which should load onto a truck, will as default dump onto a truck in the nearest intersection. If the face is far from an intersection, this is probably the case. It is then possible to set the loading onto a truck shall happen at the face. Use checkbox in section properties to set this (see Average haulage distance per section view on page 156).
    - A location from where a loader shall be loading onto a truck (for example from a loading bay) may have been placed directly onto a main drift. This could make a long way to the nearest intersection. In this case you can set that loading shall be done directly at the location, in the Loading bay properties.
- One vehicle has 2 work areas which are very far apart
    - When a vehicle will perform work at 2 work areas and these areas are very far apart, it might cause the vehicle to travel. Consider adding another vehicle, or delaying work in one work area so the vehicle will only work in one work area at the same time. A preferred section start date can be set in the section properties.

8.6.3.1.7 Total engine hours for trucks

Verifying the total engine hours is a good thing to do, to check that the vehicles (in this case, the trucks), has worked according to expectations. If this is not the case, some configuration might be wrong.
Check ***Show only*** radio button in the ***Vehicle filter*** part in Figure 8-11 - Fleet statistics above. Then select ***Trucks*** in the list. This will show all trucks in the graph. The ***Statistics*** part shows the travelled distance, work hours and utilization for the shown vehicles.
If the information in ***Statistics*** is higher or lower than expected, vehicle properties should be changed, or the work logic.

Note! Even if this differs from the expected, it might be lower due to that one or more vehicles have had too much idle time. During idle time, no travelling occurs. If the expected numbers are when the vehicles are working with full utilization, the shown statistics cannot be directly compared with any expected numbers.

8.6.3.1.8 Vehicle utilization

The utilization shown in ***Statistics*** in Figure 8-11 - Fleet statistics is for all vehicles shown in the graph. The utilization is calculated as:

$$Utilization = \frac{worktime}{worktime + idletime}$$

8.7 Vehicle costs tab

This tab contains statistics for any vehicle costs during the whole simulation. It shows costs for each vehicle, as well as the different types of costs for the vehicles.

8.7.1 Overview

In this tab you can:

- Check the total cost per vehicle.
- Check the different types of costs for one vehicle at a time, such as cost for fuel and tires.

8.7.2 Views

The vehicle cost only contains one view, which can be viewed in table form or graph form.

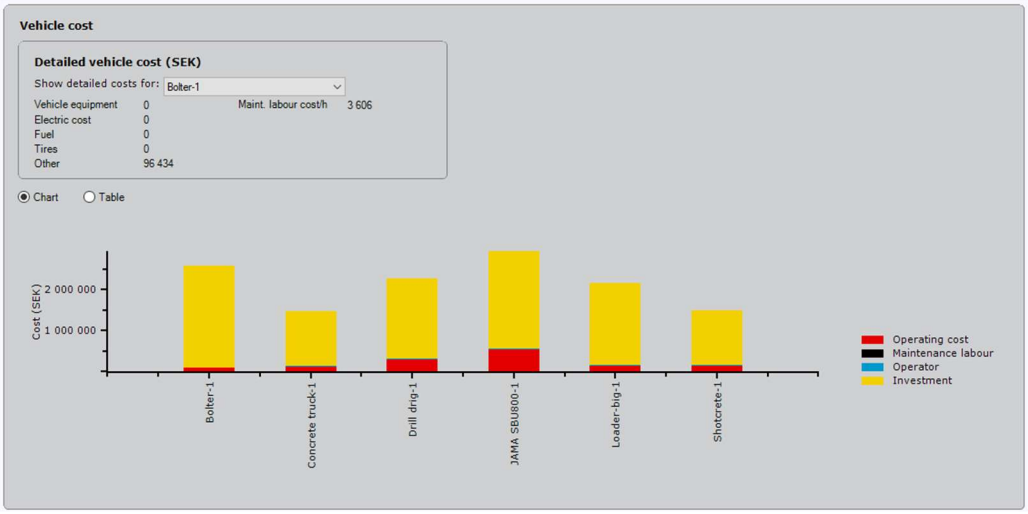


Figure 8-14 - Vehicle output costs

8.7.3 Functionality

8.7.3.1 Check specific costs for one vehicle

Select the vehicle in the dropdown list at the top. The selected vehicle's costs show up for the different cost types, such as fuel and tires. The graph will not change – it will always show the costs for all vehicles.

8.7.3.2 Show the costs as numbers

Switch between the graph and a table by checking the "Chart" and "Table" radio buttons above the graph/table. This will switch views so that the graph will be shown as a table.

8.7.3.3 Check any abnormal cost

For vehicles which should run equal much, and have equal costs, a cost that differ much for one of these vehicles could be the cause of a misconfiguration. To further check the cause of any abnormal cost, the following should be checked:

- Compare the vehicle hours that the vehicles have been running. If these differ much, and the vehicle are expected to work equal much, the problem may be in which areas the vehicles are allowed to work.
- Check the utilization of the vehicles. If one of the vehicle has a high utilization, while the other has a low utilization, a configuration issue could exist. Check allowed work areas, shift schedules etc for the vehicles.

8.8 Loading and transport statistics (LT_Statistics)

This tab contains several different types of statistics about loading and transport:

- Vehicle amount statistics
- Detailed loading and transport statistics
- Cost statistics
- Hauled amount per section

8.8.1 Overview

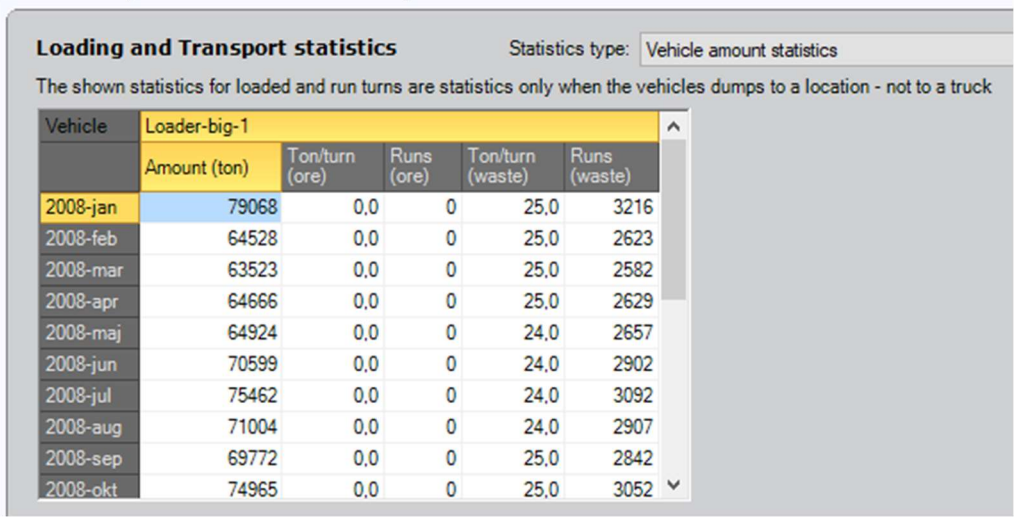
This contains different types of statistics for loading and transport. All statistics is viewed per report period.
The type of statistics to view is selected in the dropdown list at the top.

8.8.2 Views

This tab has several views, which are selectable through the top dropdown list.

8.8.2.1 Vehicle amount statistics

Here you get an overview of the amount of rock that has been transported by each vehicle. It doesn't tell from where, or to which destination the rock has been transported. In this tab, it exists a good view to search for reasons why loaders and trucks might have much travel time, for example if the amounts they have transported is abnormal high.



Vehicle	Loader-big-1				
	Amount (ton)	Ton/turn (ore)	Runs (ore)	Ton/turn (waste)	Runs (waste)
2008-jan	79068	0,0	0	25,0	3216
2008-feb	64528	0,0	0	25,0	2623
2008-mar	63523	0,0	0	25,0	2582
2008-apr	64666	0,0	0	25,0	2629
2008-maj	64924	0,0	0	24,0	2657
2008-jun	70599	0,0	0	24,0	2902
2008-jul	75462	0,0	0	24,0	3092
2008-aug	71004	0,0	0	24,0	2907
2008-sep	69772	0,0	0	25,0	2842
2008-okt	74965	0,0	0	25,0	3052

Figure 8-15 - Loading and transport statistics

8.8.2.1.1 Overview

This shows for each vehicle, and for each report period, how much rock have been transported.
In this tab you can:

- Check the total amount of different rock types hauled by each vehicle.

8.8.2.1.2 Functionality

8.8.2.1.2.1 Verify average tonnage carried per turn for a truck

This is a good verify process to verify that the capacity for a truck is according to the real life (or a truck which might be a part of the mine in the future). Find the truck in the first row in the table. Each vehicle has a number of columns. Check the column "T/turn (ore)", which shows the tonnes of ore the truck has carried each turn is has driven to a dump location.

8.8.2.2 Detailed loading and transport statistics

This view shows statistics for loading and transport in a detailed fashion.

Figure 8-16 - Detailed loading and transport

In the detailed amount statistics form, there are 3 parts:

- A graph, which shows the selected statistics from the two lists to the right.
- A list of locations, which has the ***Detailed amount statistics*** enabled
- A list of vehicles, which has the ***Detailed amount statistics*** enabled

The statistics for the detailed amount statistics needs to be enabled in the Detailed amount statistics settings in the Model options group in the Start tab in the ribbon. These settings hold how the detailed amount statistics shall be collected.
For the locations, there are several different statistic types that can be shown. These options are underneath the list of locations and are:

- Fill grade – this shows how much of a location's total capacity is filled at each time. For locations with unlimited capacity, this will always be 0.
- Amount at location – shows the current amount at the location at each time
- Received amount – Shows how much has been received at the location at each time
- Hauled amount, which is the total amount that has left the location. Not all locations support this statistic type

8.8.2.2.1 Show statistics

Each selected location has its scale on the left Y axis in the graph, and each selected vehicle has its scale on the right Y-axis in the graph.
To show detailed amount statistics, select the locations or vehicles for which you wish to show the statistics.
Under the list of locations, select which type of statistics to show.
Under the list of vehicles, select the type of statistics to show for the vehicles.

Note! Even if a statistics type is selected to show, it may still show as 0 value. This can be due to that the location/vehicle hasn't received anything, or that the location is configured to not hold any rock. This is the case for a crusher, which normally only records the received rock. If detailed amount statistics for fill grade is selected, it will always have 0 since it will never have any rock.

8.8.2.2.2 Functionality

8.8.2.2.2.1 Verify that a truck is working in the correct mine area

This analyze can not be conclusevly done here, but you can at least get an indication that a truck or loader is working in the expected mine area.
This is true when different mine areas contains different rock types. Find the truck to check in the table, and look at the statistics for hauled ore and waste. If the truck is expected to work in areas where only waste is, and it has hauled ore, some misconfiguration has probably happened.

8.8.2.2.2.2 Check a cause for much travel time for vehicles

If a loader or truck has much travel time, more than expected to be normal, it often depends on that it has a long distance to its dump location.
For ramps, where it exists loading bays at certain intervals, and loading from a face is done to the nearest loading bay, the long travel distance might be due to that loading bays fill up, which then could cause the loader to select the next loading along the ramp, and thus increasing its travel time.
To check if any loading bays has filled up, check the checkbox next to the loading bay in the "Locations" list. This will plot the fill grade in the graph during a simulation period. In the graph it is now visible the fill grade across time in that loading bay.

Note! The locations in the "Location" list in Figure 8-15 does only contain those locations which has been enabled for loading and transport statistics. See page 227 for information how to enable it in their "properties".

When showing a graph for fill grade at one or more locations, you can also check the checkboxes in the "Vehicles" list. This will plot how much the selected vehicles have hauled from the selected locations.
If no location is selected, and a vehicle is selected, it will show how much that vehicle has hauled in total, independent from where it is hauled.

8.8.2.3 Cost statistics

Here you can get information for costs associated with the work at locations for loading and transport, as well as haulage pace. The total cost during the simulation can be found elsewhere. This part lists the total costs for vehicles associated with loading and transport, spread among the transported tons.

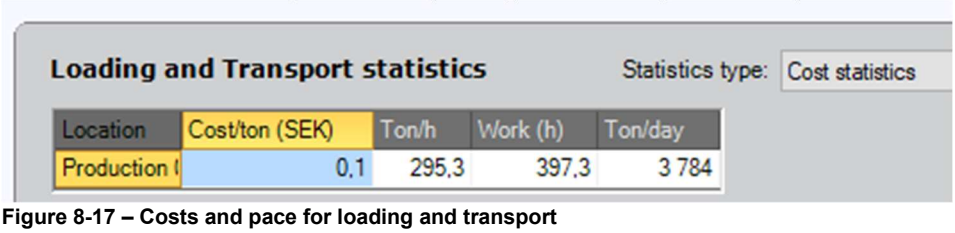


Figure 8-17 – Costs and pace for loading and transport

8.8.2.3.1 Overview

This shows for each location where any loading and transport has taken place:

- The cost per transported ton
- The transported ton/work hour
- The total work hours at the location

- The ton/day of simulation time

Note! For this view to show any statistics, the option to collect work time for locations needs to be set. This is set in Statistics page on page 203.

Only locations which has any hauled amounts, as well as any costs associated are listed here.
Costs are calculated as:

- The work time for each vehicle at the location is recorded (if this setting is activated under Statistics page on page 203).
- The total tons hauled from the location is recorded.
- The start time and finish time when each location started and finished its operations are recorded. This is used to calculate the total days of work done at the location.
- Cost per ton is then calculated as the total work time for all vehicles at the location, divided by the total amount of rock hauled from the location
- The ton/hour is calculated as total hauled rock from the location divided by the total work time for all vehicles ta the location
- The ton/day is calculated as the total time the location has had work to be done, divided by the total amount hauled from the location.

8.8.2.3.2 Functionality

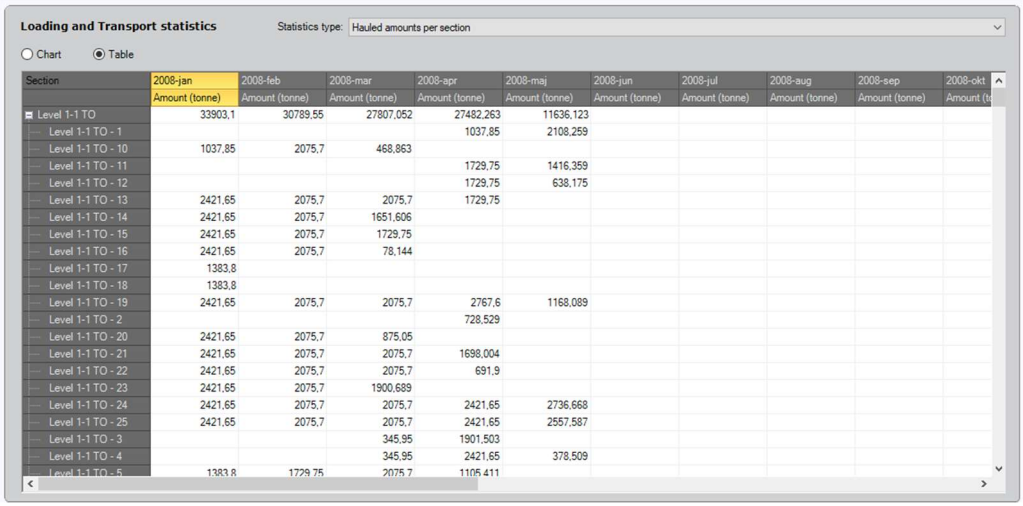
8.8.2.3.2.1 Verify average pace of loading from a location

In the table, find the row containing the location to get information for. In the column for ton/hour, you can check how many tons have been hauled from the location for each work hour by the vehicles. This should be close to what is expected. If this differs too much, possible reasons can be:

- The destination for the hauled rock has been misconfigured, resulting in too close/too far distance to the dump location.
- The vehicles which are performing work at the location are misconfigured (wrong speed, or wrong total capacity)
    - The speed settings can be checked in global settings Vehicles on page 58
    - The capacity can be checked in the properties for the vehicle. Please keep in mind that the capacity as well as fill factors affects the total capacity for the vehicle.

8.8.2.4 Hauled amount per section

This shows the hauled amounts from each section in the layout where haulage has occurred. This is the same statistics as shown under Development length and amount per section view on page 155, but with the exception that this shows only the hauled amounts, and not the developed meters.



Section	2008-jan	2008-feb	2008-mar	2008-apr	2008-maj	2008-jun	2008-jul	2008-aug	2008-sep	2008-okt
	Amount (tonne)	Amount (tonne)	Amount (tonne)	Amount (tonne)	Amount (tonne)	Amount (tonne)	Amount (tonne)	Amount (tonne)	Amount (tonne)	Amount (t
Level 1-1 TO	33903,1	30789,55	27807,052	27482,263	11636,123					
Level 1-1 TO - 1				1037,85	2108,259					
Level 1-1 TO - 10	1037,85	2075,7	468,863							
Level 1-1 TO - 11				1729,75	1416,359					
Level 1-1 TO - 12				1729,75	638,175					
Level 1-1 TO - 13	2421,65	2075,7	2075,7	1729,75						
Level 1-1 TO - 14	2421,65	2075,7	1651,606							
Level 1-1 TO - 15	2421,65	2075,7	1729,75							
Level 1-1 TO - 16	2421,65	2075,7	78,144							
Level 1-1 TO - 17	1383,8									
Level 1-1 TO - 18	1383,8									
Level 1-1 TO - 19	2421,65	2075,7	2075,7	2767,6	1168,089					
Level 1-1 TO - 2				728,529						
Level 1-1 TO - 20	2421,65	2075,7	875,05							
Level 1-1 TO - 21	2421,65	2075,7	2075,7	1698,004						
Level 1-1 TO - 22	2421,65	2075,7	2075,7	691,9						
Level 1-1 TO - 23	2421,65	2075,7	1900,689							
Level 1-1 TO - 24	2421,65	2075,7	2075,7	2421,65	2736,668					
Level 1-1 TO - 25	2421,65	2075,7	2075,7	2421,65	2557,587					
Level 1-1 TO - 3			345,95	1901,503						
Level 1-1 TO - 4			345,95	2421,65	378,509					
Level 1-1 TO - 5	1383,8	1729,75	2075,7	1105,411						

Figure 8-18 – Hauled amount per section

8.8.2.4.1 Overview

This shows for each section and segment, the hauled amounts from them.

8.8.2.5 Transported amount between locations statistics

Here you can analyze the amount of rock that has been transported between locations in the mine, per report period. This does however not show any statistics for transported amount from faces, only between locations placed by the user. In this way you have a tool which can be used to verify that your plan, or your model is working as intended.

This statistic need to be activated and is done by having the model collect transport analyze information in the model options (see COLLECT DATA FOR TRANSPORT ANALYSES CHECKBOX on page 204)

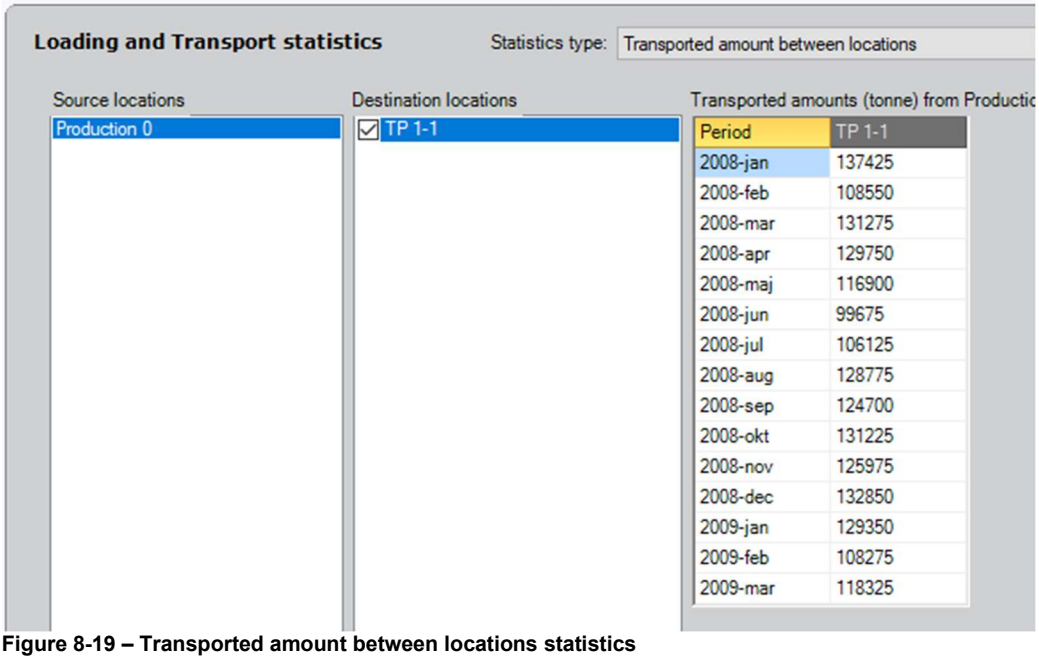


Figure 8-19 – Transported amount between locations statistics

8.8.2.5.1 Overview

This shows two lists, with locations that has statistics for transported amount. To view statistics, select a source location from the source list, and a destination location in the list of destinations. The transported amounts between those selected locations is then shown in the table.

8.8.2.5.2 Functionality

8.8.2.5.2.1 Verify that your transport setup is working as intended

In your plan, you could have a plan that a certain amount shall be transported from point A to point B under a limited time period. This can be verified here by selecting Point A and Point B in the source and destination lists. The transported amounts, per period is tshown for you to verify that your model, and your setup is working as planned

8.9 Activity statistics

This tab contains statistics for activities, and how much each activity has been waiting until it has been worked with. Here is a good place to check which activity is the bottleneck, and possible to have the bottleneck at the most suitable activity in the future.

8.9.1 Overview

In this tab you can check statistics for activities:

- Activity wait time per activity, per area or a combination thereof. The activity wait time can be used, in congestion with the fleet output tab on page 161 to get a more complete picture which activity and which types of vehicle that is the bottleneck in the mine. This form allows more in-depth analyze of in which mine area a certain bottleneck exist.
- Total activity time for each activity, per mine area, or a combination thereof. This can be used to examine the number of required hours to get the work done in certain mine areas, or to simply verify that the times are within expectations.
- Total number of activities done, per activity, per mine area, or a combination thereof. This can be used to verify that the activities have been done according to expectations.

8.9.2 Definitions

8.9.2.1.1 Activity wait time

The activity wait time is the total time that an activity has had to wait until it got started or worked with. Activity wait time is grouped according to the activity type that has waited, meaning that drilling has its own activity wait time, loading and transport has its own waiting time etc.

Example: In a mine there are 3 headings active. All of these headings have face drilling as their current activity. Only one vehicle exist which performs face drilling. This vehicle never breaks down or takes any meal break. Face drilling takes exactly 60 minutes per face.

When the simulation starts, the drill rig vehicle starts at face 1. When face 1 is done, the other 2 faces have waited for 60 minutes to get started. This totals up with 120 minutes of wait time for the drilling activity. After another 60 minutes, when face 2 is done, face 3 has waited another 60 minutes, which totals the wait time for drilling to 180 minutes.
These 180 minutes is just for the first drill activity - and this might increase during the simulation.
Suppose further on, that the vehicle got a meal break of 45 minutes in the middle of the work with face 2. This means that face 2 and face 3 did have to wait another 45 minutes until the work continued, ending with additionally 90 minutes of wait time = total of 270 minutes just for the first round of drilling.

8.9.3 Views

This does only contain one view, which can be viewed in table form or graph form.

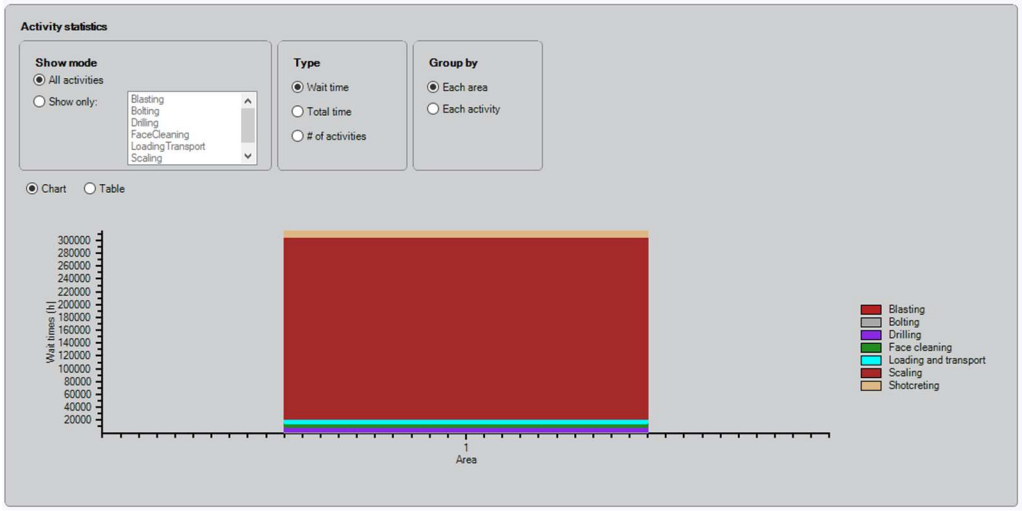


Figure 8-20 - Activity statistics

8.9.4 Functionality

8.9.4.1.1 Activity wait time for each report period

This will show the wait time for one activity only, for each report period. In this mode, it can be examined when in time a certain activity had the most wait time. It also shows the wait time per mine area, so from this view mode, issues with activities in certain mine areas during certain time periods can be seen.
To view this mode, do as:

- Check the ***Show only*** radio button from ***Show mode*** panel
- From the list beside the ***Show only*** radio button, select the activity to view. Only one activity can be selected.
- Select the ***Each activity*** in ***Group by*** panel. This will show the selected activity's wait time per report period and mine area

Note! Only examine an activity's wait time and the cause of it further if the activity's wait time is high enough and don't spend time on activities that have a small impact on the end result, or where the vehicles performing an activity isn't the bottleneck.

8.9.4.1.2 Check which activity has the highest total waiting time

This will show the activities and their total waiting time. The shown data doesn't differ on waiting times from different mine areas.

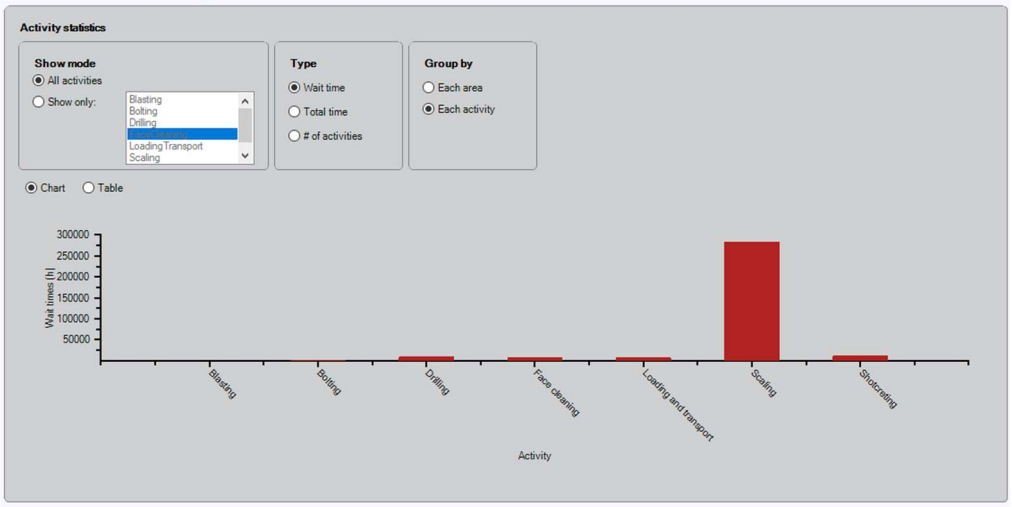


Figure 8-21 - Wait time per activity

Note! This method is more suitable for mines that do only have one mine area. For mines with several mine areas, it is better to view the wait time per mine area instead.

- Select the ***All activities*** radio button from the ***View mode*** panel.
- Select the ***Each activity*** radio button from the ***Group by*** panel.
- The graph is now sorted, so the activity with the most waiting time (regardless of which area that waiting time belongs to), is viewed to the right in the graph.

8.9.4.1.3 Check the total amount of hours spent for different activities

This will show the total work time for each activity, per mine area if desired.

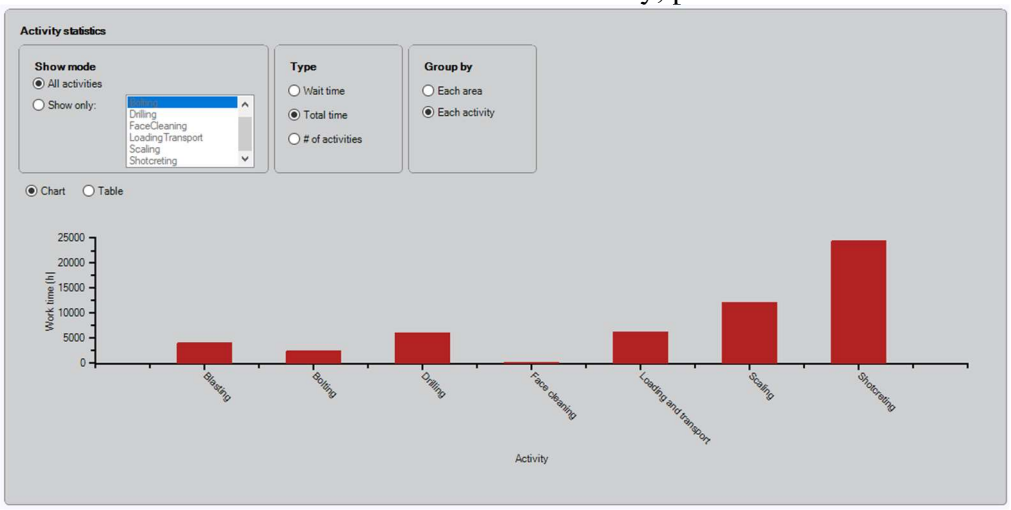


Figure 8-22 – Work time per activity

- Select the ***All activities*** radio button from the ***View mode*** panel.
- Select the ***Total Time*** radio button in the ***Type*** panel
- Select the ***Each activity*** radio button from the ***Group by*** panel.
    - By selecting Each area in the Group by panel, all activities are stacked on top of each other, so the total work time per mine area can be viewed.

8.9.4.1.4 Check number of activities done per report period

When displaying data per report period, only one activity type can be examined. This will show the number of times a certain activity has been done per report period. It also shows this per mine area.

Figure 8-23 – Number of activities done per report period

- Select the ***Show only*** radio button from the ***View mode*** panel, and select which activity type to show data for in the list next to it.
- Select the ***# of activities*** radio button in the ***Type*** panel
- Select the ***Each activity*** radio button from the ***Group by*** panel.

8.9.5 Analyze examples

8.9.5.1.1 Which activity is the bottleneck

The activity that is the bottleneck is most probably the activity that has waited the most time until it has been started. This is a good indication that vehicles working with the bottleneck activity have too little capacity. However, since the bottleneck can move during the simulation, from one activity type to another, or that different mine areas have different bottlenecks in terms of activities, it will in some cases require more analyze work to get when, in which mine area and which activity has been the bottleneck.

Note! All activities will get some wait time when performed by a vehicle. If the bottleneck lies within the number of available headings, so that lack of headings is the problem, it is of no or little use to check this screen. Analyze the Fleet output tab and try to find out if there are too few headings.

Start by selecting ***All activities*** in ***Show mode*** in Figure 8-20 above. Then select ***Wait time*** in the ***Type*** panel, and finally, select ***Each area*** from the ***Group by*** panel. This will show all the activities in the graph and table. In the graph, the wait time is shown per mine area. In this way, you can check for a bottleneck activity in several areas. It cannot be granted that the same activity is a bottleneck in all mine areas.
Look at one mine area at a time. When an activity that is the bottleneck has been found, a check should be done if that activity is for sure a bottleneck. Check this by comparing the bottleneck activity here with the bottleneck found in the output fleet tab (see Fleet on page 161 for more information).
The vehicles which performs the activity which is found to be the bottleneck, should also be the bottleneck, or at least highly utilized.
When verified against a vehicle bottleneck, actions can be taken to try to avoid this bottleneck if desired.
It is also possible to group the activities by each activity. In this case, you will not see in which area the bottleneck activity exists. This does not matter if all the vehicles can work everywhere.

8.10 Summary tab

This tab contains statistics and summary of the costs, development length done and vehicles summary.
It exists some numbers that can be used as key number when presenting the results. These numbers are a good way to compare different simulations.

8.10.1 Overview

In this tab you can:

- Check total costs, together with costs divided on tonnage and engine hours.
- Check production numbers

- Check which activity has waited the most time until a vehicle has worked with it (this is a summary from the Activity statistics on page 174)
- Check detailed statistics per vehicle in terms of utilization, work time, travelled distance etc.

8.10.2 Views

This does only contain one view, which can be viewed in table form or graph form.

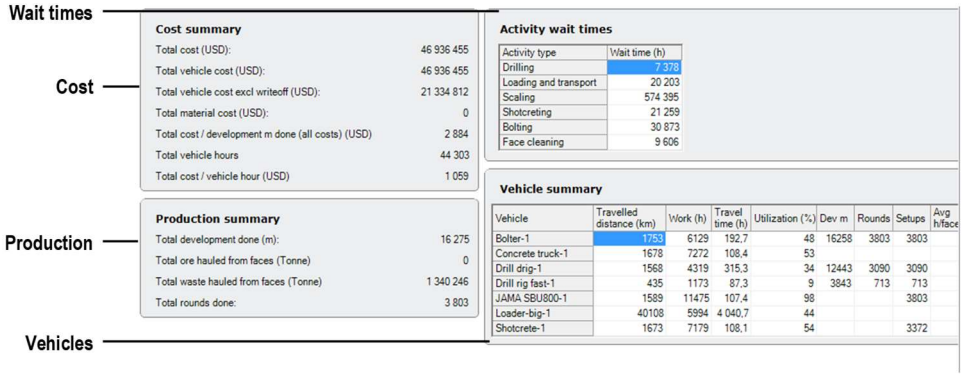


Figure 8-24 - Summary

8.10.3 Definitions

8.10.3.1.1 Activity wait time

The activity wait time is the total time that an activity has had to wait until it got started or worked with. Activity wait time is grouped according to the activity type that has waited, meaning that drilling has its own activity wait time, loading and transport etc.

8.10.3.1.2 Costs

The costs showed in this tab show the costs in different ways (per meter, per vehicle hour etc.). The following types of cost exist:

- Total cost – This is all costs summarized.
- Total vehicle costs – This does include all costs for the vehicles and operators. It excludes the cost associated with materials
- Total vehicle cost excl write-off – This is only the running costs for the vehicles and the operator costs.
- Total material costs–This is the costs associated with sections (materials used in sections)

8.10.3.1.3 Production numbers

The production summary part that exists contains different production summary data such as developed distance, produced tonnes etc. This shows:

- Developed distance – This is the total completed developed distance. It will count when a full activity cycle has been completed, and not when face activity or blast occurs (if that isn't the last activity in the cycle)
- Total ore from faces - This shows the total amount of ore that has been hauled from the development faces, independent of where it was transported.

- Total waste from faces – This shows the total amount of waste hauled from any face.
- Total rounds done – This shows the total number of completed rounds done. One round is when all activities in an activity cycle has been completed.

8.10.4 Functionality

8.10.4.1.1 Key numbers for costs

Key numbers, such as cost per ton hauled, cost per engine hour etc. can be found in the "Cost" part in Figure 8-24 above.

8.10.4.1.2 Total number of produced ton and developed distance

See the Production numbers part above for information regarding the production numbers available in this tab.

8.10.4.1.3 Vehicles work times results

Each vehicle's work time is entered in the vehicle properties. These work times can be entered as a distribution, for example as a triangular distribution, where min, mode and max values are used. To verify that the entered numbers are correct, look in the "Vehicle summary" table in Figure 8-24 above.
In the "Avg. h/face" column, the average time each vehicle has worked at a face is printed. This time does not include setup time, only work time at the face. This time should correspond to the average work time the vehicle has in the real mine.
Only use this time when the vehicle can only perform one activity.

Warning! This time includes work times for all activities the vehicle has performed. If a vehicle can perform both face drilling and bolt drilling, the times for both these are shown as one average work time.
Example: A drill rig can perform face drilling, which takes on average 60 minutes per face, and bolt drilling, which takes on average 30 minutes per face. When this vehicle has performed 10 face drill activities and 10 bolt drill activities, the average time/face will be close to 45 minutes. However, if only 2 bolt drill activities have been done, the average time is 57,5 minutes.

You should also check and compare numbers between vehicles. If you have too high values for a vehicle, you should ask yourself if the values are correct. This is for example if all trucks except one have around 5000 work hours during the simulation period, and the last one having 10000 hours. In this case, it might be depending on the simulation configuration itself, that it has more work, but it may also be due to a configuration error.

8.11 Mineral statistics tab

This tab shows the amount and mineral value hauled in the mine. For the statistics to be collected, minerals must be assigned to the sections/locations where applicable. The price for the minerals should also be specified. These are specified in the global settings for minerals (Minerals on page 74).

8.11.1 Overview

In this tab you can:

- Check hauled amount of each defined mineral
- Check value of hauled minerals

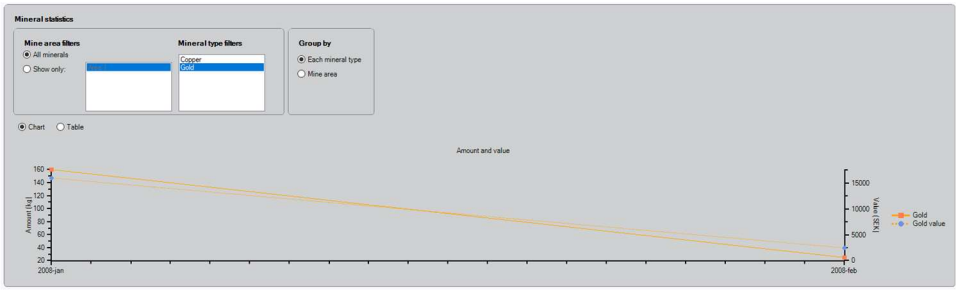


Figure 8-25 - Mineral statistics

The data can either be viewed per mineral type, or per mine area.
The graph in this form has 2 Y-axis:

- Y-axis to the left: The amount of the shown mineral
- Y-axis to the left: The value of the shown mineral

8.11.2 Functionality

8.11.2.1.1 Show hauled amount of one mineral type

Select All minerals from the mineral statistics settings, and then select the Mineral type to show from the list of minerals (the list to the right. The graph will display, for each report period, the amount of hauled minerals and their value.

8.12 Time statistics tab

The loading and transport analyze isn't a tab. Instead it is a button in the ***Start*** tab, under the ***Extra*** group. The Transport analyze view is in its first version and therefore it lacks some functionality for more advanced analyze.

8.12.1 Overview

In this form, you can analyze several aspects of loading and transport:

- Reasons why transport has stopped to a certain location
- When in time events have occurred at a location

It is helpful to analyze and better understand why some issues have arisen in the model, or that the model didn't behave as expected.
For this to contain data, transport analyze information collecting must be enabled in Model options (See Statistics page on page 203)

8.12.2 Views

This does only contain one view, which is divided into two parts:

- Vehicle cycle time statistics
- Cycle time statistics

8.12.2.1 Vehicle cycle time statistics

This shows cycle time for the vehicles, which is for loaders and trucks only. It shows how long a vehicle takes from the point it is loaded, and the travel time to the dump spot, dumping and then back again. It doesn't include load time into the shown cycle time.

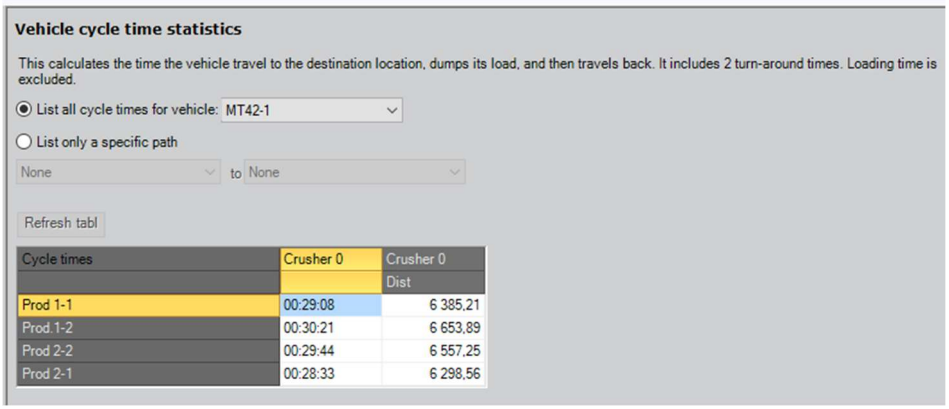


Figure 8-26 - Vehicle cycle time statistics

This can be used to verify that the cycle time for a vehicle is as expected. If it differs too much from expected values, its settings for travel speed and dump time needs to be looked through. Since this doesn't include any load time, the load time itself shall be added on top of the cycle time to get a full cycle time. The reason why load time isn't included is that for trucks, it is highly dependent of which loader is loading it.

8.12.3 Functionality

8.12.3.1.1 Show cycle times for a vehicle

In the dropdown list for List all cycle times for vehicle, select the vehicle to view. All possible cycle times are shown in the table. The table is arranged as:

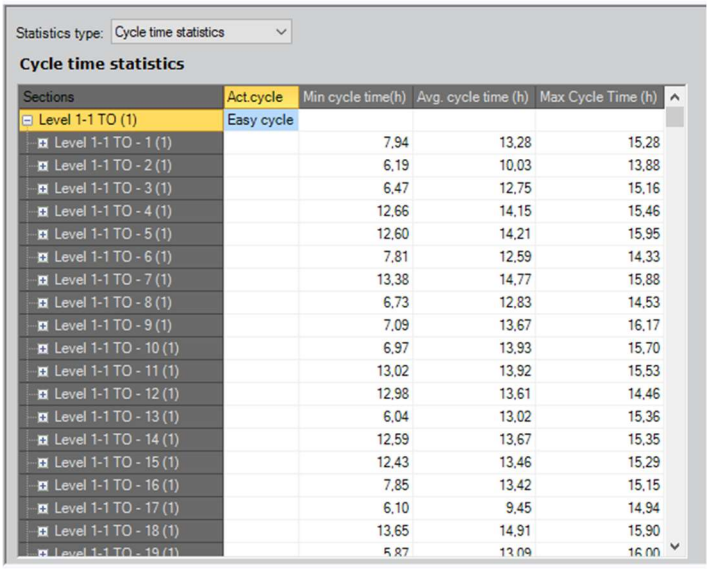
- Along first column: all possible work locations are printed.
- Along the top row are all possible destinations printed
- In the grid is the cycle time printed for the work location printed on that row, and to the destination printed at the column.

8.12.3.1.2 Show cycle times for a specific path

To see the cycle time for all vehicles, for a specific path in the layout, select the List only a specific path radio button in the Figure 8-26 - Vehicle cycle time statistics above. The select the start and end locations for the path to show. All loaders and trucks are shown in the table with their cycle times printed.

8.12.3.2 Cycle time statistics

This shows cycle time for the work locations. In this form, the duration of activities can be checked against the real-life values. This is a good place to verify that the duration of activities is within reasonable values.



Sections	Act.cycle	Min cycle time(h)	Avg. cycle time (h)	Max Cycle Time (h)
Level 1-1 TO (1)	Easy cycle			
Level 1-1 TO - 1 (1)		7,94	13,28	15,28
Level 1-1 TO - 2 (1)		6,19	10,03	13,88
Level 1-1 TO - 3 (1)		6,47	12,75	15,16
Level 1-1 TO - 4 (1)		12,66	14,15	15,46
Level 1-1 TO - 5 (1)		12,60	14,21	15,95
Level 1-1 TO - 6 (1)		7,81	12,59	14,33
Level 1-1 TO - 7 (1)		13,38	14,77	15,88
Level 1-1 TO - 8 (1)		6,73	12,83	14,53
Level 1-1 TO - 9 (1)		7,09	13,67	16,17
Level 1-1 TO - 10 (1)		6,97	13,93	15,70
Level 1-1 TO - 11 (1)		13,02	13,92	15,53
Level 1-1 TO - 12 (1)		12,98	13,61	14,46
Level 1-1 TO - 13 (1)		6,04	13,02	15,36
Level 1-1 TO - 14 (1)		12,59	13,67	15,35
Level 1-1 TO - 15 (1)		12,43	13,46	15,29
Level 1-1 TO - 16 (1)		7,85	13,42	15,15
Level 1-1 TO - 17 (1)		6,10	9,45	14,94
Level 1-1 TO - 18 (1)		13,65	14,91	15,90
Level 1-1 TO - 19 (1)		5,87	13,09	16,00

Figure 8-27 – Cycle time statistics

8.12.4 Functionality

8.12.4.1.1 Check the average duration of an activity

In the table for activity cycles, find the section for which you wish to check the activity. Expand the section, and all the activities which have been performed at the section will appear. Each activity is printed on its own row. For the activity to check, look at its row and read its values for minimum, average and maximum duration for that particular activity. For sections which are short, it means that its activity cycle has only been performed a few times, and thus, the minimum, average and maximum values could show values a bit out of range if random values have resulted in low or high values just for the few times the activity has been performed.

8.13 Loading and transport analyzes

The loading and transport analyze isn't a tab. Instead it is a button in the ***Start*** tab, under the ***Extra*** group. The Transport analyze view is in its first version and therefore it lacks some functionality for more advanced analyze.

8.13.1 Overview

In this form, you can analyze several aspects of loading and transport:

- Reasons why transport has stopped to a certain location
- When in time events have occurred at a location

It is helpful to analyze and better understand why some issues have arisen in the model, or that the model didn't behave as expected.
For this to contain data, transport analyze information collecting must be enabled in Model options (See Statistics page on page 203)

8.13.2 Views

This does only contain one view, which shows one graph for locations and time.

To show data in this form, you need to click the ***Collect and show results*** button at the lower left corner. The graph will then be filled with all work locations.

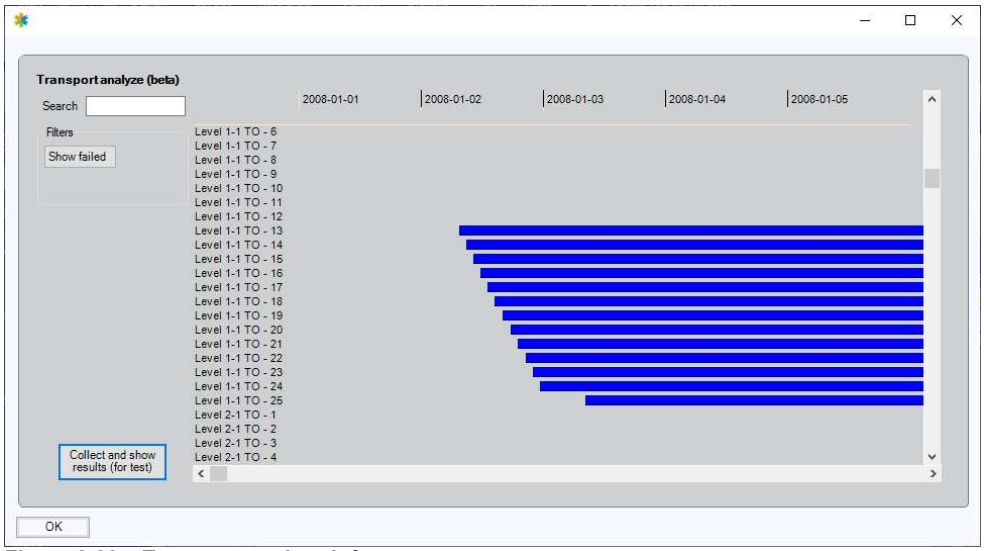


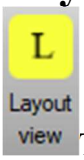
Figure 8-28 – Transport analyze info

8.13.3 Functionality

8.13.3.1.1 Show why a certain work location has stopped hauling

In the graph, find the work location to examine. You can also filter it by entering a filter condition in the Search textbox. After the location is shown, scroll to the time when the transport stopped. If this time is not known, scroll as long as there is a bar for the location. It means that it has had a valid transport destination.

8.14 Layout view



The layout view is not a tab. It can be opened by clicking the Layout view button in the Extra group in the Start tab in the ribbon.

8.14.1 Overview

In this form, the result layout is shown. It is only shown after a successful simulation run, since it will show the result view, together with statistics. In the layout view, the following tasks can be done:

- See where different parts of the layout exist in the layout, based on selected objects, sections or segments in output tabs.
- Get an overview of traffic disturbances

This form will help in analyzing where thing takes place. When a section, object or segment is selected from any output tab (from a table), it is selected in this form as well. This greatly improves the speed at which you can see where different parts of the layout are location.
The layout view form can be placed anywhere on your screen, so that it is always visible, for example on a secondary monitor.

8.14.2 Views

This view has two modes: Layout mode and traffic disturbance mode.

8.14.2.1 Layout mode

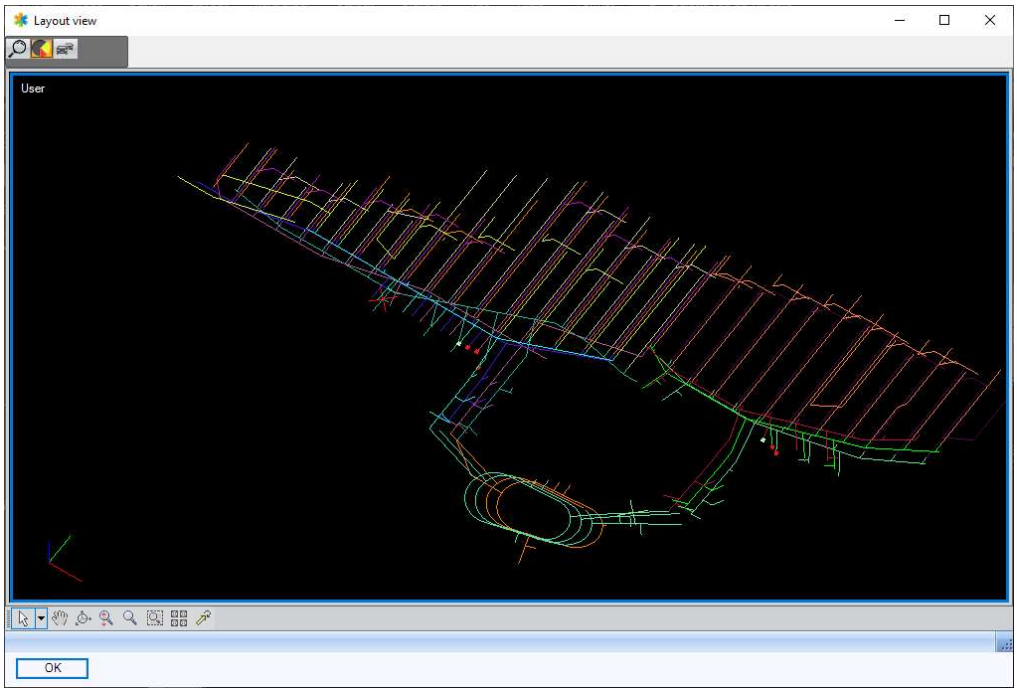


Figure 8-29 – Layout view mode

The only task which can be done in this mode is to see where a selected object or section is located in the layout. You can also zoom into the selected object or section.

Every result tab in SimMine which contains sections, are linked to the layout view, and whenever a section or segment is selected in any output view, it is also selected in the layout view.

8.14.3 Functionality

8.14.3.1.1 Select a section to see where things have happened in the layout

This is useful when you look at statistics for sections for example, and wish to see where a section is located in the layout. Open up the layout view. It can be moved so that you can see SimMine at the same time as the layout view. Next, select the output tab which contains the statistics you wish to examine, for example the average haul distances statistics:

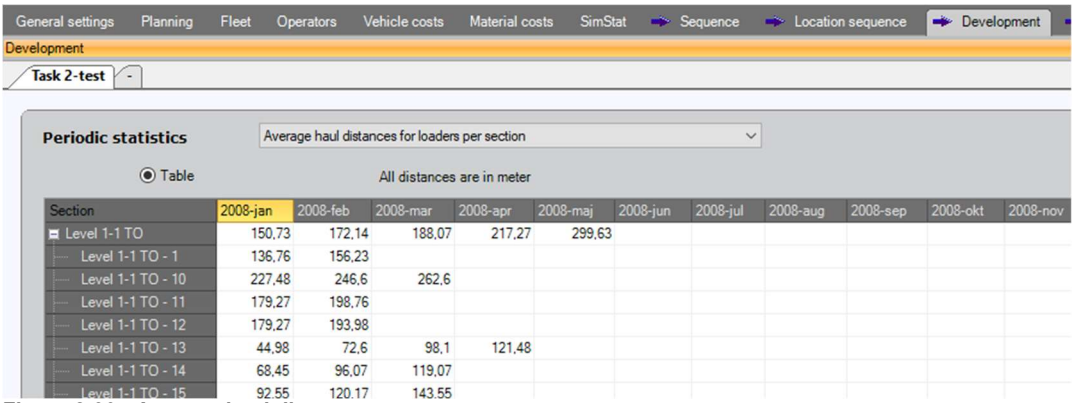


Figure 8-30 - Average haul distances

Click on a section or segment in the table (The first column) for which you want to know where it is located. It is selected in the layout view. In the layout view, you can click on the Zoom to selected button ( ). This will zoom the layout to the selected section or object.

8.14.3.2 Traffic disturbance mode

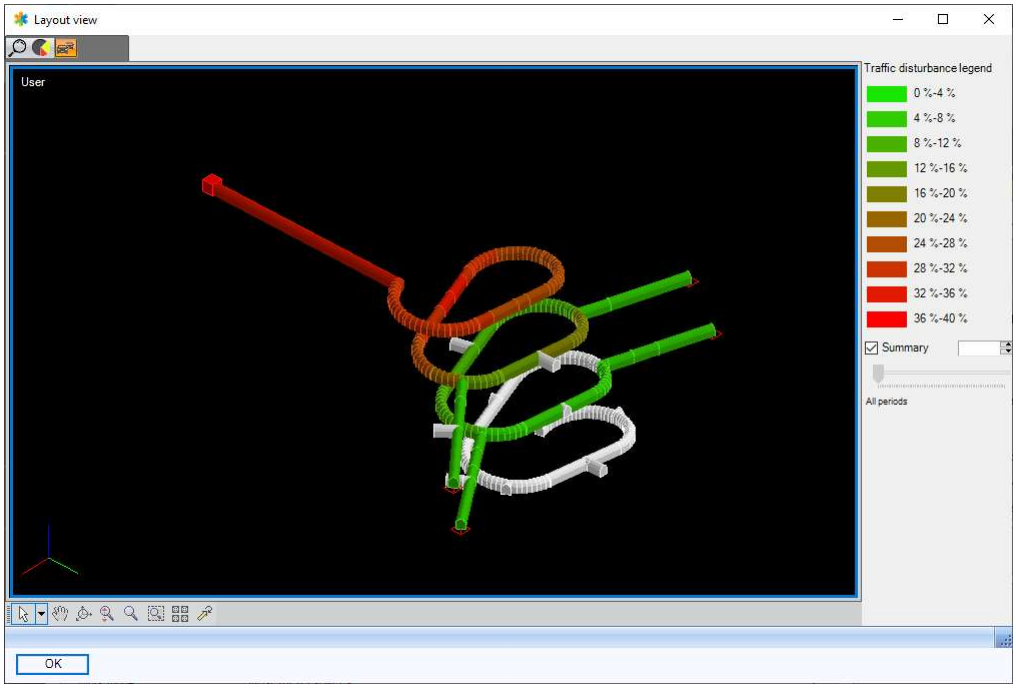


Figure 8-31 – Traffic disturbance mode

Switch to the traffic disturbance mode by clicking the corresponding button at the top ( ). In this screen, the amount of traffic disturbances is shown as colored parts in the layout, together with a legend for the colors to the right. The traffic disturbance statistics will only be collected in a simulation if this is set. To set this option, see COLLECT TIME DATA DURING TRAVEL on page 204.

9 Help and Troubleshooting

This chapter shows some common tasks and how these can be handled within SimMine. This also lists some common problems and discuss solutions

9.1 Calibrate loading and transport

The majority of the activities are fairly easy to enter correct times for and get their duration right, since they only consist of one phase. For example: face drilling, which consists of that the face drill rig drills the face. The times entered for the face drill rig tells the simulation how long time the drill rig will take to perform that task.

For loading and transport, the times entered in the properties for the loader is not the total time for the loading activity. Instead, it is the time to fill the scoop, and to dump.

The total time to perform loading from a face needs to be as accurate as possible for the simulation to be trustworthy. The calibration of the times for loading and transport must therefore be done in a slightly different way. To do a loading and transport calibration, do as follows:

1. Select a known situation from the real mine to calibrate against. This should include:
   a. A loader only operation (no truck involved)
   b. A known distance to transport the rock
   c. The average tonnage per bucket.
   d. The total time it took to clear the face or work location
2. Enter the load and dump times for the loader in SimMine.
3. Setup a small layout with a crusher. The layout should look according to the figure below. This layout can coexist with any existing layout. If any existing layout exist, disable all the other locations and sections (through the ***Disabled*** property in the section properties)
4.
5. The small green section shall be set as a development section, so it will be developed. Set it according to:
   a. Create an example activity cycle for this case which contains Drilling, blasting and loading and transport
   b. Create an example rock property which has a density of 10000 kg/tonnes (very heavy rock, but it will be explained later)
   c. Open up the section properties for the green section, and set that it will be a development section. Also set that its total length is 2 meters. Assign the activity cycle to the section (under the Development tab).
   d. Open up the Drilling properties and set that it will not require a vehicle. Set that its default advance length is 0.1 m (10cm). This short length, together with the short total length of the section will ensure that the face will not move too much, so the total distance to travel will remain the same (or close to). The total distance of 2 meter will force the activity cycle to be repeated 20 times (with a 0.1 m advance for the drilling).
   e. Calculate a required size of a face profile so that a 0.1 m advance of the face and a 10000kg/ton will result in a total tonnage as the real scenario has. For example: If a blast will result in 400000 tonnes in the work location selected under point 1, then the face area shall be:

[Face area]*[Rock density]*[Advance length] = [Total amount] => [Face area]=[400000]/([10000]*[0.1m] => 400m^2. A very big face profile, which is used just to get the correct tonnages.

f. Set that the loading and transport method shall be loader only.

6. Set that no breakdown or preventive maintenance will be used (at the bottom of the input Fleet form, page Fleet on page 138)
7. Run the simulation.

9.2 When simulation finishes, switch to the Time statistics tab (see Mineral statistics tab

This tab shows the amount and mineral value hauled in the mine. For the statistics to be collected, minerals must be assigned to the sections/locations where applicable. The price for the minerals should also be specified. These are specified in the global settings for minerals (Minerals on page 74).

9.2.1 Overview

In this tab you can:

- Check hauled amount of each defined mineral
- Check value of hauled minerals

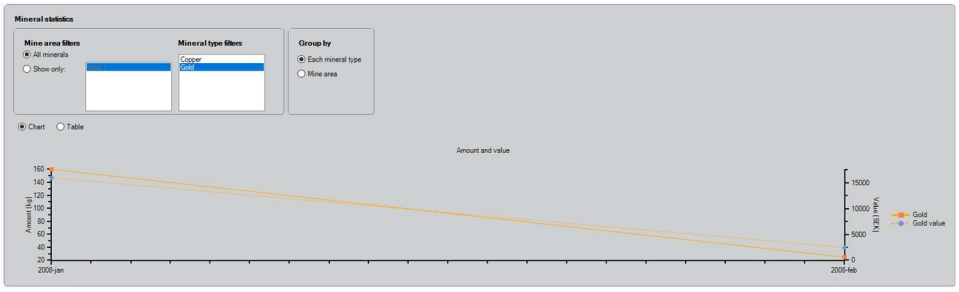


Figure 8-25 - Mineral statistics

The data can either be viewed per mineral type, or per mine area.
The graph in this form has 2 Y-axis:

- Y-axis to the left: The amount of the shown mineral
- Y-axis to the left: The value of the shown mineral

9.2.2 Functionality

9.2.2.1.1 Show hauled amount of one mineral type

Select All minerals from the mineral statistics settings, and then select the Mineral type to show from the list of minerals (the list to the right. The graph will display, for each report period, the amount of hauled minerals and their value.

8. Time statistics tab on page 180). Find the average time for loading and transport for the example section in the ***Cycle time statistics*** table. This should be close to the real time for hauling the same amount of ton. If the average time from the simulation is not close to the real value, several values may be adjusted to achieve a closer time:

a. The turnaround time in General settings. This is used twice per round (i.e. after the bucket has been filled, and after it has been dumped)
b. The load and dump times for the loader.
c. The tramming speed of the loader. Remember that the example layout is flat, and if the data from the real scenario is taken from a situation where it needs to travel in steep conditions, it may affect the final result)

9. If the above adjustments do not help, some rethinking is required: Does it really take this long time to haul this amount from the work location etc.

9.3 Cannot access database

The database is a Microsoft SQL Server, which runs as a service on a computer. It can run locally as well on a network server, through which access is granted for SimMine. Normally, the database service cannot be changed or controlled by a user without higher privileges, so the steps to verify that the service is running as it should be the last step to check. To verify that the SQL Server is running and that you have access to it, the following should be done by an IT administrator with privileges to access services and SQL configuration:

- Verify that the SQL Server is installed
- Verify that the SQL Service is running
- Verify that the credentials used to connect to SQL Server are valid and allows access to the database to use.

The SQL connection dialog box allows you to enter information about the database to use. It is opened from the Settings/Data tab in the main form, under the Database group. The button name is SQL Database:

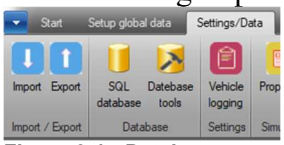


Figure 9-1 - Database connection button

The connection dialog itself can be seen below:

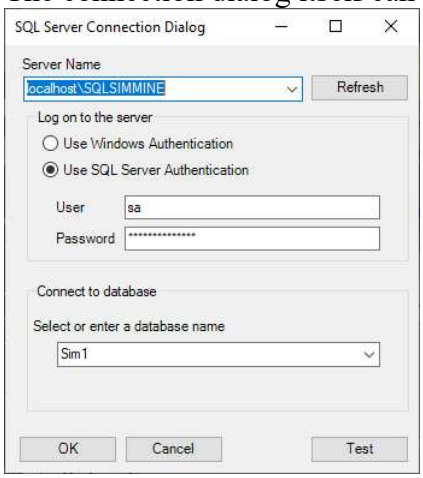


Figure 9-2 - SQL connection dialog

To verify that the correct information is given, ensure the following:

- Server Name: If the SQL Service is running on the local computer (i.e. your computer), the default database name is localhost\SQLSIMMINE. If the database service is running on a remote computer, or in your own

configured SQL instance, you should consult your local IT staff for SQL Server information
    - You can browse for SQL server instances on your local network by pulling down the Server name dropdown list. However, only SQL Servers are found on computers where the SQL Server Browser service is running.
- SQL Server credentials and log on information. This information must correspond to the configured method to log in, and credentials for a user which have access permissions to the database. The default information for how to log on to a SQL server when it is configured during installation of SimMine are:
    - Log on method: Use SQL Server Authentication
    - User name: sa (this is the SQL administrator user, which shouldn't be used when running against a database which is not only used by SimMine)
    - Password: the default password is simmine_180930

9.4 Simulation issues

Simulation issues are problems with a simulation and that it doesn't perform as expected.

9.4.1 Development distance dips the last month in the simulation

This can be seen in "Development" tab. An example can be seen in Figure 9-3.

Type	Dev.distance (m)	Area 1	Total costs (SEK)	Avg headings	Area 1	Tkm
2009-dec	400	400	0	29	29	38569
2010-jan	446	446	0	64	64	41012
2010-feb	393	393	0	78	78	36973
2010-mar	449	449	0	82	82	42485
2010-apr	431	431	0	84	84	39992
2010-maj	442	442	0	81	81	40666
2010-jun	9	9	0	86	86	1169
Total	2570	2 569	0	504	506	240866

Figure 9-3 - Development dip

SimMine reports statistics per report period. Each report period has a fixed period as:

- Report period = 1 day. Period is any day
- Report period = one week. Period starts on Monday, and ends on Sunday
- Report Period = one month. Period starts the 1st of a month, and ends the last day in the same month.
- Report period = three months. Period starts the 1st in January, April, July or October. It ends the last day three months later than the start day.

- Report period = one year. Period starts 1st of January and ends 31st of December.

The last report period in the simulation can be shorter in time than other report periods due to that the simulation can end before the last day in the report period.
In General settings tab (see page 79) you can set the start and end dates during which time the simulation shall be run.
If the end date is set to a day earlier than the last day in a report period (for example 2nd of June when using report period length of one month), the last period will only be 2 days, while the other periods will be a full month. The development during these 2 days in June is much lower than the development during a whole month and therefore, the last period for a simulation can show lower numbers than the other periods.
Even if the end date is set to the 2nd of June, it is not visible in the development tab – here the whole last simulation period is visible.

For example: A normal month, development is around 400 meters. The last month, only 2 days are simulated. During these 2 days only 15 meters of development is done. This will show as a dip in the development for this last month.

The dip in developed meters can also be caused by the number of available headings. If a simulation runs for a long time, the number of available headings can decrease and become 0 at the end of the simulation, which will then decrease number of developed meters. The number of developed meters will decrease towards the end of a simulation if the ***Simulate until finished*** in General settings tab is used. The developed meters will in most cases gradually decrease and not suddenly dip in this situation.

9.4.2 Vehicle cannot find a path between two locations

It is described earlier how to verify that the layout doesn't contain gaps. However, it can still occur that vehicle doesn't find a path between two work locations. This can for example happen when there exists a work location in the middle of the mine, even though no development has reached that point. This can happen in an intersection, if the development directions for all segments leading out from that intersection is set to start at the intersection according to the Figure 9-4 - Development direction issue below.

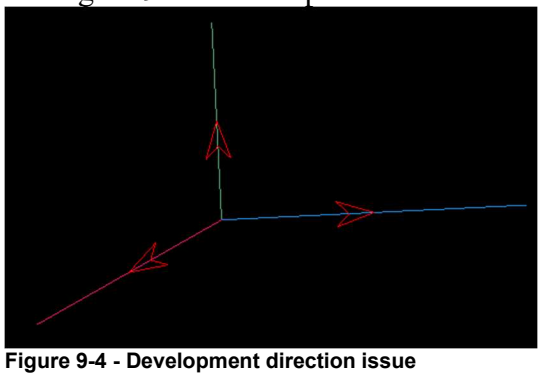


Figure 9-4 - Development direction issue

In this case, the development can never reach the intersection point. In this case, SimMine allows the intersection to be a start point (i.e. available for work). In the same time, if there are other work locations in the mine, it means that anyone that shall work at this location needs to jump when it will start work here. These issues can be examined through the log window at the end of a simulation.
In the lower part of SimMine, it is visible which simulations are running/has finished:

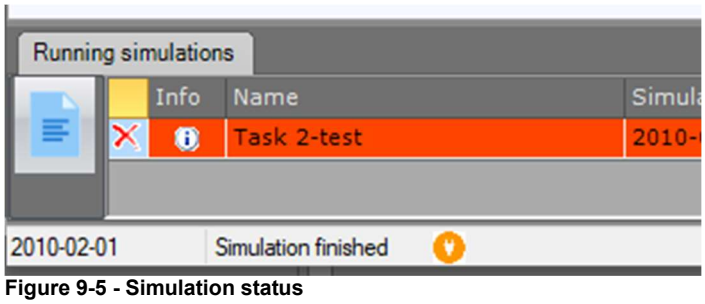


Figure 9-5 - Simulation status

Each run simulation will be printed in one row. A simulation which is run twice, will be printed twice in this table. The color on a row shows its state, which can be:

- Light yellow – the simulation is running without any warnings
- Green – the simulation has completed without warnings
- Light orange – the simulation is running, but with warnings
- Dark orange – The simulation has completed, with warnings.

When there are warnings, they can be viewed by selecting the row which has warnings from the simulation list, and click the note icon to the left. A log window shows, which shows all warnings during the simulation:

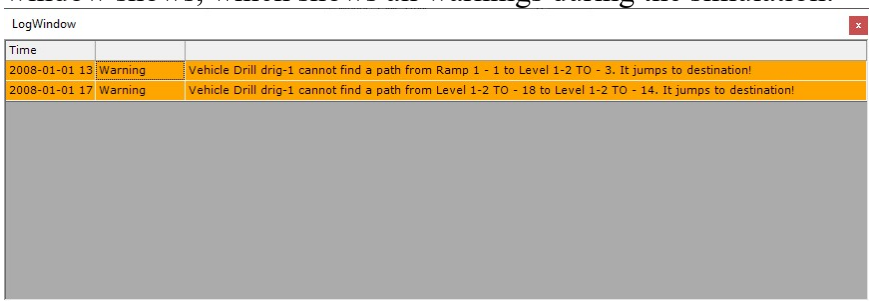


Figure 9-6 - Warning window

From this, it can be examined which sections that needs attention. It stated in the example of jumping vehicles the source and destination of a travel. When a vehicle jumps, it means that somewhere in between the source and destination locations, there is a fault, for example wrongly set development directions.

10 Appendix A – definitions

This section contains definitions and other resources not printed in any other section.

The different definitions that are used in SimMine are described here, and what they are based upon.

10.1 Vehicle utilization

Utilization is calculated as time worked compared to total time available for work + broken time. The formula is: Utilization = work time / (work time + idle time + broken time)

10.2 Face utilization

Face utilization is presented under the Utilization column in the Sequence tab. This is the amount of time any activity has been performed at the face, including non-vehicle times such as curing/ventilation.

10.3 Total planned time

This is the total time an object is planned to work. Any off-shift time is removed. Example: If a shift is setup so that it contains 20 working hours each day, with 2 hours of lunch break, and 2 hours of off-shift, the total planned time each day is 22 hours.

11 Appendix B– Interfaces

11.1 Main interface, Menu and ribbon

The following chapter will give a description of the items in the ribbon bar as well as the options in the file menu.

Figure 11-1 - Start ribbon

The main interface contains a ribbon bar at the top, which has three tabs, as well as file menu (the blue button in the top-left corner).
The buttons in the ribbon tabs are grouped based on their function and purpose.

11.1.1 Start tab

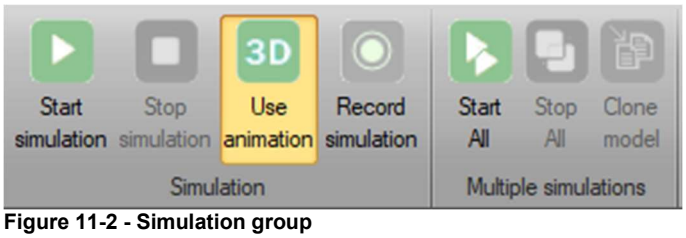


Figure 11-2 - Simulation group

The buttons in these groups are:

- Start simulation – This starts a simulation for the current model. When a simulation is started, this button will switch to ***Pause simulation***.
- Stop simulation – stops an ongoing simulation. This is enabled when a simulation is running
- Use animation – When this is enabled, the animation will show when a simulation is started. It will open up the animation window through which the simulation will be controlled. See Animation view on page 282 for more information regarding the animation)
- Record simulation – Will record the simulation events and save them to a file when the simulation stops. This could be used to replay a simulation without running the simulation again. The replay function will be added in a future version.
- Start all – This will start all opened simulations.
- Stop All – this stops all running simulations. It will be enabled when simulations are running.
- Clone model. This clones the current state of a simulation to a new model. It can only be done when a simulation is paused (the pause button will be the start button during a simulation run)

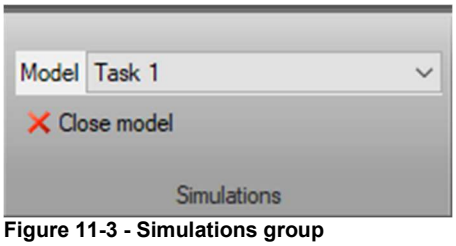


Figure 11-3 - Simulations group

The simulations group lists all opened simulations. In this a simulation model can be closed by selecting the model, and click the ***Close model*** button.

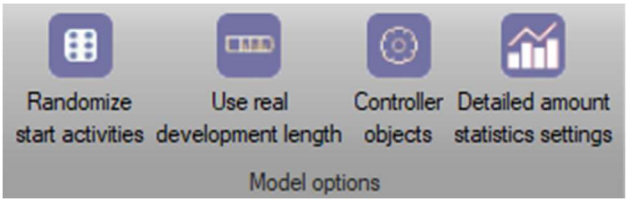


Figure 11-4 - Model options group

The buttons in these groups are:

- Randomize start activities – This will randomize which activity will be the first activity at start of simulation. When this is not clicked, the default start activity will be the first activity in the assigned activity cycle. The start activity will only be set for those section which are accessible at the start of simulation.
- Use real development length – This controls the development length. The layout's center lines are always longer than the length to develop. When this activated, the development length is adjusted as described under Development length version center line length on page 295.
- Controller objects – opens up the controller objects dialog box. Controller objects are objects which can control multiple locations in the layout as a group, to control how they behave.
- Detailed amount statistics settings- Opens up the dialog box to define how detailed amount statistics shall be collected. See Detailed loading and transport statistics on page 169 for information about detailed amount statistics)

Figure 11-5 - Extra settings

The buttons in these groups are:

- Transport analysis. It opens up transport analysis form, which is used to analyze issues with loading and transport. See Loading and transport analyzes on page 183 for more information about this.
- Layout view – opens the layout view window, which is used to see the layout and where different sections in the result tabs are located. Check Layout view on page 184 for more information about the layout view

- Production plans – opens a window which shows the production plans for all production locations.

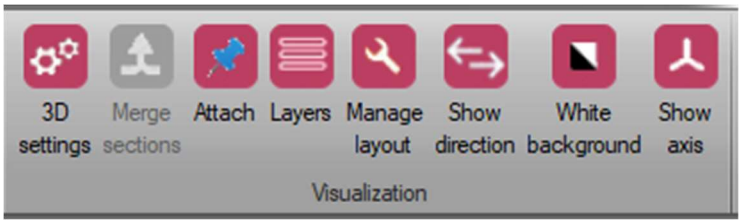


Figure 11-6 - Visualization group

This contains buttons for the 3D layout view, and contains the following buttons:

- 3D settings – opens up the settings for the 3D view (see 3D layout view settings on page 208 for more information)
- Merge sections – Merges two or more sections into one section. This is enabled when more than one section in the layout is selected. The properties for the first selected section are retained.
- Attach – open up the attach dialog, which allows the user to attach loose parts in the layout. See Attach tool on page 211 for more information.
- Layers – Shows the layer dialog, where layers can be defined and controlled. See Layers tool on page 212 for more information.
- Manage layout – allows the user to remove duplicate points in the layout. This is described under Manage layout tool on page 213
- Show direction – shows/hides the development direction for each segment in the layout.
- Which background – alters the background color between white/black in the 3D layout view.
- Show axis – Shows/hides the axis control in the bottom-left corner of the 3D layout view.

11.1.2 Setup global data tab

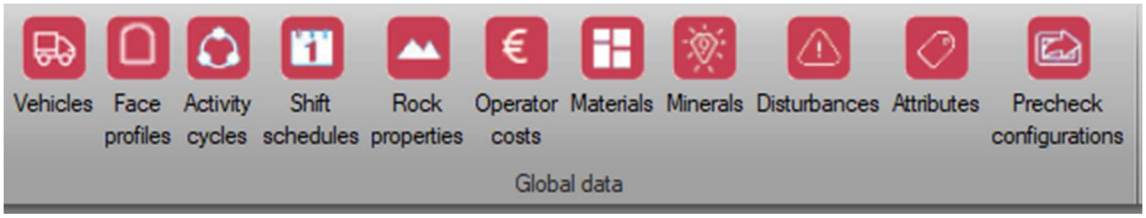


Figure 11-7 - global data group

The global data tab has buttons to define and control global data for each global data category. The global data can be used and assigned to different simulation entities. Each global data is described under Global Settings on page 56.

11.1.3 Settings/Data tab

It contains these groups:

Figure 11-8 - Import / export group

These buttons will show an import/export wizard that allows the user to import or export data to/from the current database. The import and exports are described under Import and Export starting at page 273.

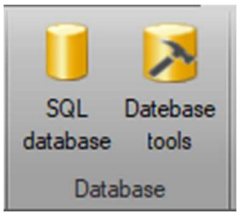


Figure 11-9 - database tasks

The database tasks allow the user to set which database to use, and to perform some simple tasks. This is described under Database management tasks on page 31.

Figure 11-10 - Settings and properties

The buttons in this group are:

- Vehicle logging – specifies how the position for vehicles during a simulation shall be logged to a file. This log information can then be used in ventilation simulations and analyze tools.
- Properties – this brings up properties for the current simulation model, which can be changed in this dialog box.
- Simulation comments – opens up a dialog where comments about the simulation can be added and changed. The comments are good when the model needs some more description.

Figure 11-11 - Other groups

The buttons here are:

- License info – show which licenses exist in the hardware key.
- Request support – this will send the current opened simulation to SimMine support, together with a description about the issue.

11.1.4 File menu

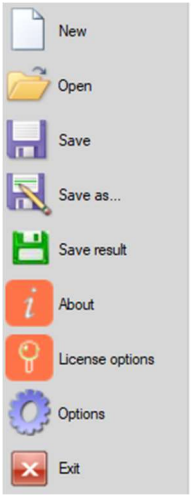


Figure 11-12 - file menu

The file menu and its options are described in more detail under Simulation model operations on page 23.

11.2 Input forms

11.2.1 Fleet form

This contains any vehicle which is added to the simulation. More vehicles can be added. The vehicles which are added is taken from the global list of defined vehicles (see Vehicles on page 58 for information how to define global vehicles).

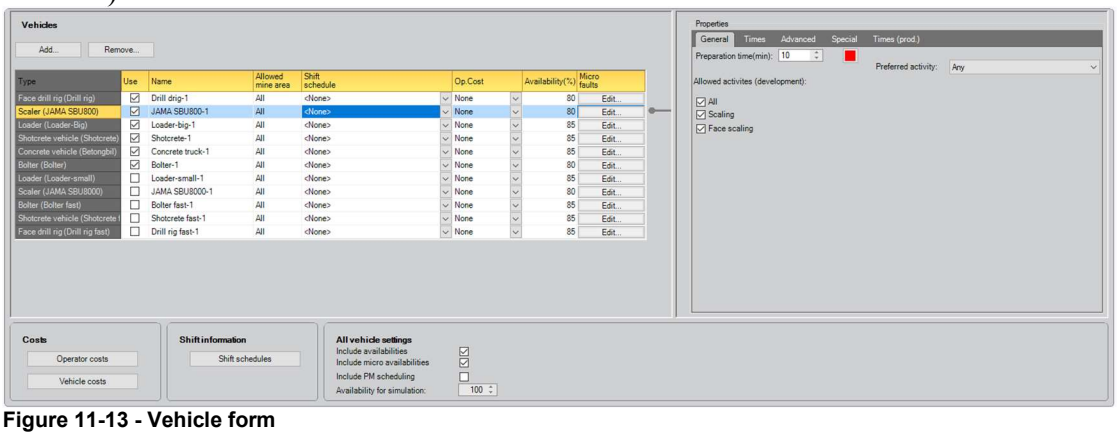


Figure 11-13 - Vehicle form

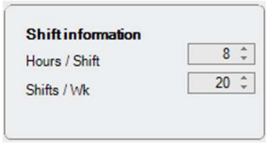
The fleet form contains a grid with common properties for the vehicles as well as vehicle properties, a tab-based control which contains multiple tabs for different vehicle properties.
The grid with common properties looks as:

Type	Use	Name	Allowed mine area	Shift schedule	Op.Cost	Availability(%)	Micro faults
Face drill rig (Drill rig)	☑	Drill drig-1	All	<None>	None	80	Edit...
Scaler (JAMA SBU800)	☑	JAMA SBU800-1	All	<None>	None	80	Edit...
Loader (Loader-Big)	☑	Loader-big-1	All	<None>	None	85	Edit...
Shotcrete vehicle (Shotcrete)	☑	Shotcrete-1	All	<None>	None	85	Edit...
Concrete vehicle (Betongbil)	☑	Concrete truck-1	All	<None>	None	85	Edit...
Bolter (Bolter)	☑	Bolter-1	All	<None>	None	80	Edit...
Loader (Loader-small)	☐	Loader-small-1	All	<None>	None	85	Edit...
Scaler (JAMA SBU8000)	☐	JAMA SBU8000-1	All	<None>	None	80	Edit...
Bolter (Bolter fast)	☐	Bolter fast-1	All	<None>	None	85	Edit...
Shotcrete vehicle (Shotcrete f	☐	Shotcrete fast-1	All	<None>	None	85	Edit...
Face drill rig (Drill rig fast)	☐	Drill rig fast-1	All	<None>	None	85	Edit...

Figure 11-14 - Vehicle properties

The grid has the following columns:

1. Type – the type of vehicle. This cannot be changed
2. Use – This sets that a vehicle will be used in the simulation or not. Multiple vehicle can be defined in the vehicle grid, but not of them needs to be used in a simulation run.
3. Name – The name of the vehicle, which will be seen in numerous places in the output tabs.
4. Allowed mine areas – The mine layout can be split into multiple mine areas (see Mine areas on page 295). In this column you can assign a vehicle to exclusively work in a certain mine area. Write 'All' to allow the vehicle to work in all mine parts. Separate mine parts with ',' if a vehicle can work in several mine areas.
5. Shift utilization or shift schedule. Depending on how shift information is entered, this can either hold a shift utilization, or an assigned shift schedule. The shift mode is specified in General settings (see Set the kind of shift schedule to use on page 79).
   - When in easy shift mode, you can enter a percentage of shift that the operator can use for work. Transport time of operator, education, meetings and unplanned breaks are example of losses that affects utilization. Lunch and other planned breaks should be excluded from the total available time in the box. The number of shifts and length of each shift is entered in shift information at the bottom of the fleet form

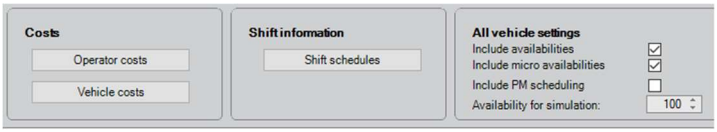
     

   - When advanced shift mode is used, you assign a shift schedule defined in the global settings.
6. Operator cost - In this column you can enter a predetermined operator cost per hour to your vehicles. When easy shift schedule is used (see Set the kind of shift schedule to use on page 79), you enter a cost/hour. When advanced shift mode is used, you can assign an operator cost schema defined in the global settings.
7. Availability – This allows you to specify the mechanical availability of a vehicle. The availability can cause a vehicle to break down. The vehicle can only break down during work. The availability mode can be either easy or advanced, as specified in Set that advanced availability shall be used on page 80.
   - When easy availability is used: Set the vehicle availability in this column.

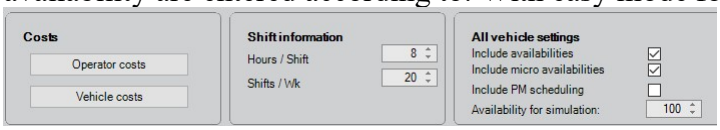
- When advanced availability is used, you edit the availabilities by clicking the Edit button in this column.

8. Micro faults. Micro faults are a mechanical availability similar to the availability, but with some differences:
   - It only counts when the vehicle is working at the face (i.e. loaders working with loading and transport can never have a micro fault).
   - When a vehicle breaks down due to a micro fault, the repair is always conducted at the face.
   - Micro faults can be set to be repaired by a repairman working according to his/her own shift, which might cause big wait times due to repair shift.

At the bottom of the fleet form, there is some common properties which apply to all the vehicles:



These properties have different content depending on which mode shifts and availability are entered according to. With easy mode for shift, it looks as:



The properties here are:

COSTS

These opens up the cost forms, where costs can be specified.

SHIFT INFORMATION

When advanced shift schedule mode is used (Set the kind of shift schedule to use on page 79), this button will open up the global shift schedule dialog.
For easy shift scheduling, you can enter hours/shift and number of shifts per week.

INCLUDE AVAILABILITIES CHECKBOX

When checked, vehicles break down according to the availabilities specified in the availability column. When uncheck, no break down will occur. Micro faults can still occur.

INCLUDE MICRO AVAILABILITIES

When checked, vehicles break down according to the micro fault settings specified in the micro fault column. When uncheck, no micro fault will occur. Normal break downs (from the availability column) can still occur.

INCLUDE PM SCHEDULING

When checked, preventive maintenance will be done according to preventive maintenance settings for each vehicle (see PREVENTIVE MAINTENANCE BUTTON on page 263).

AVAILABILITY FOR SIMULATION SETTING

This is the amount each vehicle is available for simulation. When set to 100%, the vehicles will be available for simulation 100% of their scheduled time. When set to a lower value, vehicles will from time to time be unavailable, much like how the mechanical availability works, with the exceptions:

9. A vehicle will never abort work before it becomes non-available
10. A non-available can occur at any time, not only during work time.

This setting is used if the vehicles are performing work which isn't simulated. In this case, the simulator needs to take that into consideration that they aren't available all their time. This setting can be overridden and set on a per-vehicle basis. See AVAILABILITY FOR SIMULATION SETTING on page 200.

11.2.2 Planning form

The planning form holds data for the layout. In this part, controls and functions within the planning form is described.

11.2.2.1 Section list

The section list is a list which contains all sections that exist in the layout are listed. This list shows each section, and its segments, one per row. The list shows a tree structure where each section is at one node level, and its segments underneath it. Figure 11-15 - Planning form with section list below shows the section list. The section list is only visible when the Planning tab along the left border of the form is selected

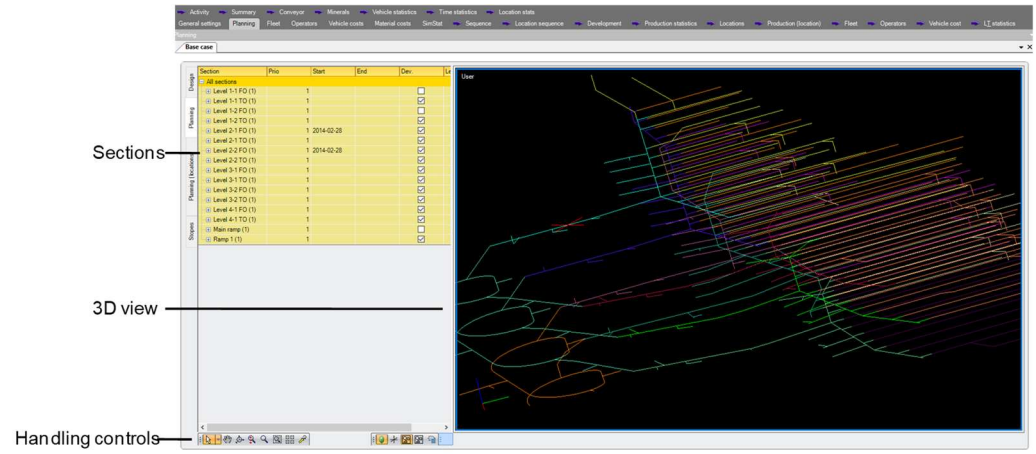


Figure 11-15 - Planning form with section list

The list itself can hold one or more columns as seen in the figure below:

Section	Dev.	Face profile	Act.cycle	Length (m)	Rock type
All sections					
Level 1-1 FO (1)	☐	Main drift		687	None
Level 1-1 FO - 1		None		8,1	None
Level 1-1 FO - 2		None		24,8	None
Level 1-1 FO - 3		None		8,6	None
Level 1-1 FO - 4		None		49,5	None

Figure 11-16 - Section list (expanded)

The section list has the following row types:

11. Title row, for each column. The column type, and their order can be changed
12. Top level row (dark yellow): The "All Sections" title

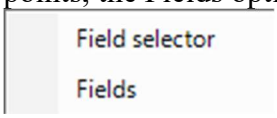
13. Section row (medium yellow): One row for each section
14. Segment row (light yellow): One row for each segment. A segment must always belong to a section.

The values shown in the section list can be changed by simply changing it in the list. Not all values for segments can be changed.
To change the same value for multiple sections, select all the sections to change the value for in the list. It can be done by selecting one, and then holding down either the CTRL key or Shift key, and then click on another section. Change a value in one of the selected rows, and the changed value will be changed on all selected sections.

11.2.2.1.1 Change columns

The columns in the section list can be changed and reordered. To add or remove columns, do as:

1. Right-click on the title row. A context menu with two options appear. Either option will enable you to change the columns. In the following points, the Fields option is explained as seen below:



It opens up a dialog box where the order and which columns to display exist:

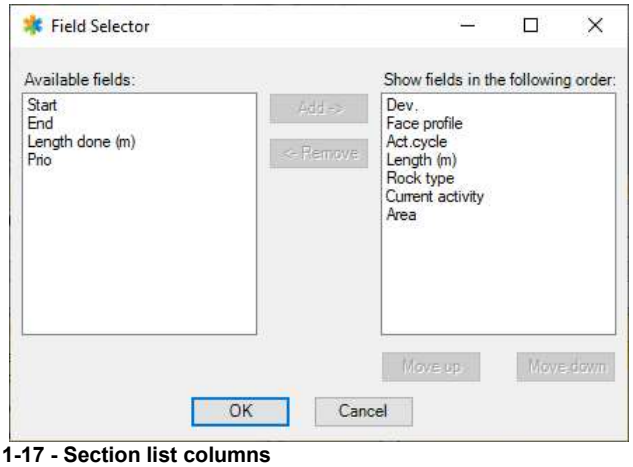


Figure 11-17 - Section list columns

2. Move the columns to display to the list to the right (the ***Show fields*** list)
3. To reorder the columns, move the columns in the right list by using the ***Move up*** and ***Move down*** buttons below the list. The columns will be displayed in the order that they are listed.
4. Click ***OK*** when satisfied. The columns will be changed to reflect the order which is specified

11.2.2.1.2 Columns

The columns which can be shown are:

Column name	Description
Start	The earliest start date when the section can commence to be developed.
End	The end date when it is desired that the section will be completed.

Dev	Section to be developed, or when unchecked, already done (and will not be developed during simulation)
Face profile	The assigned face profile
Act. Cycle	The assigned activity cycle
Length	The length of the section
Length done	The done length at simulation start. This can be modified for segments.
Rock type	The assigned rock type
Current activity	The current activity which will be the one at start of simulation. When not set, it will be the first activity in the assigned activity cycle.
Area	The mine area
Prio	Priority for the section/segment. It is used when Highest priority is selected as work mode.

11.3 Model options settings

The model options, which are common options reachable through the General settings input form, hold settings which has less-frequently settings for a simulation model. Its interface looks as below and has multiple sub-pages:

11.3.1 Statistics page

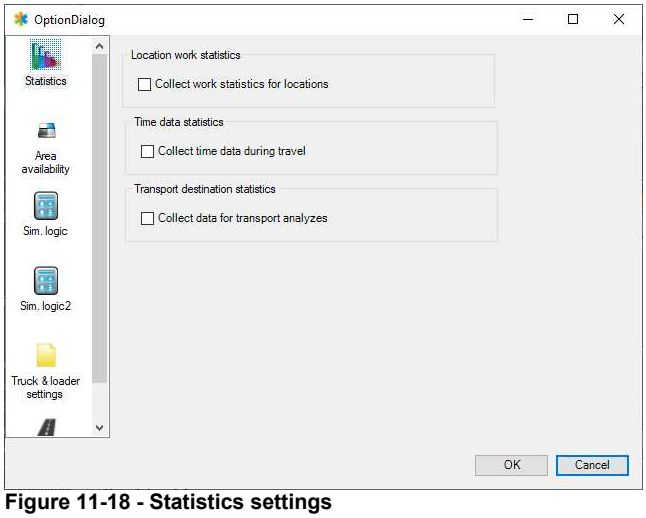


Figure 11-18 - Statistics settings

The settings here are:

COLLECT WORK STATISTICS FOR LOCATIONS CHECKBOX

This controls if work statistics shall be collected for locations. Default, it is collected only for sections (i.e. development). Some result forms contain work statistics for locations as well. When this is not checked, these result forms will not contain any results. It is written that this option needs to be enabled to get anything in those result forms.

COLLECT TIME DATA DURING TRAVEL

This will collect statistics during travel of the vehicles, which will be used when analyzing traffic disturbances throughout the mine. See Traffic disturbance mode on page 186 for how traffic disturbances are analyzed.

COLLECT DATA FOR TRANSPORT ANALYSES CHECKBOX

This enables collection of data for transport analyses, which can show when and why rock has stopped to be transported to or from locations. See Loading and transport analyzes on page 183 for further info regarding transport analyze.

11.3.2 Area availability page

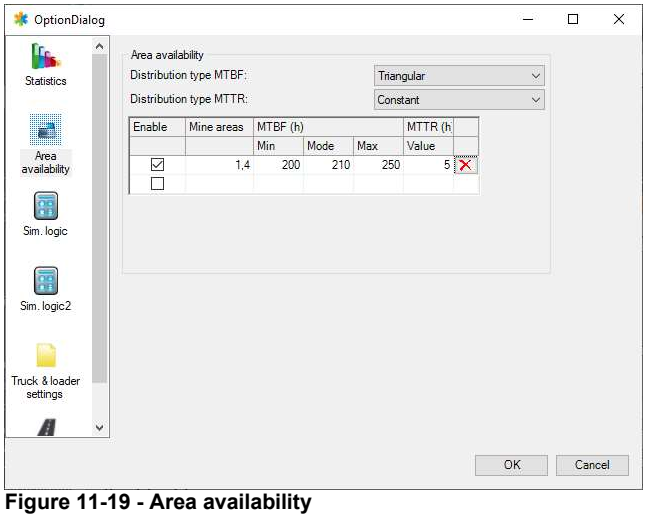


Figure 11-19 - Area availability

In this page, area availabilities can be set, which are settings for the availability of whole mine areas in the mine. It may for example be that the ventilation doesn't work, which prohibits work in that area. When area availabilities are used, it requires that the mine is properly divided into mine areas to allow an area to become unavailable. If the mine is poorly divided, it may result in a big part of the mine becomes unavailable.

The settings to control area availability are:

DISTRIBUTION TYPE MTBF DROPDOWN LIST

This sets which distribution that shall be used for area availability, mean time between failure

DISTRIBUTION TYPE MTTR DROPDOWN LIST

This sets which distribution that shall be used for area availability, mean time to repair

AVAILABILITY SETTINGS TABLE

This table holds the actual availability data. It has one availability setting for each row. It has the following columns:

15. Enable – To enable/disable the settings on that row
16. Mine areas – The mine areas which this row contains settings for. If multiple areas are specified, use a comma-separated list of mine areas.

17. MTBF columns. Depending on the setting for which MTBF distribution you have selected earlier, this can contain different number of columns. These are for entering the mean time between failure.
18. MTTR columns. Depending on the setting for which MTTR distribution you have selected earlier, this can contain different number of columns. These are for entering the mean time to repair.
19. Delete – deletes a row.

11.3.3 Simulation logic 1 page

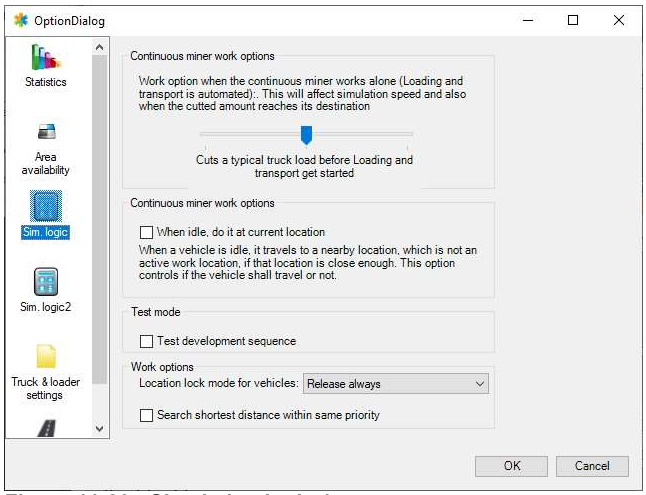


Figure 11-20 - Simulation logic 1

This page has settings for how the continuous miner logic will behave, as well as settings for test mode and work option, which affect all vehicles.

CONTINUOUS MINER WORK OPTIONS

This controls how continuous miners will cut the rock prior to loading it onto trucks.

CONTINUOUS MINER WORK OPTIONS

This sets where continuous miners will spend any idle time. Due to the size of them as well as their inability to move around fast in the mine, the default option is to spend any idle time at their current location. The default behavior for other vehicles are to spend any idle time at the nearest intersection.

TEST MODE CHECKBOX

This allows you to test the sequence of the development very quickly, to check if the sequence, direction of development and any dependencies seems to behave as intended. This will affect all simulations, but will only be visible when running the simulation with animation. It basically cuts down the complexity of each development cycle so it is only face drilling which is performed, and it takes a short amount of time. This will run the simulation very quick, with the possibility to visually inspect the result in animation mode.

WORK OPTIONS

This allows you to specify how work locations will be locked and released during work, as well as if the nearest vehicle will be selected. Normally, the vehicle which is first in queue is checked for work first. The nearest vehicle option consumes a bit more CPU power, which makes the model run slower.

11.3.4 Simulation logic 2 page

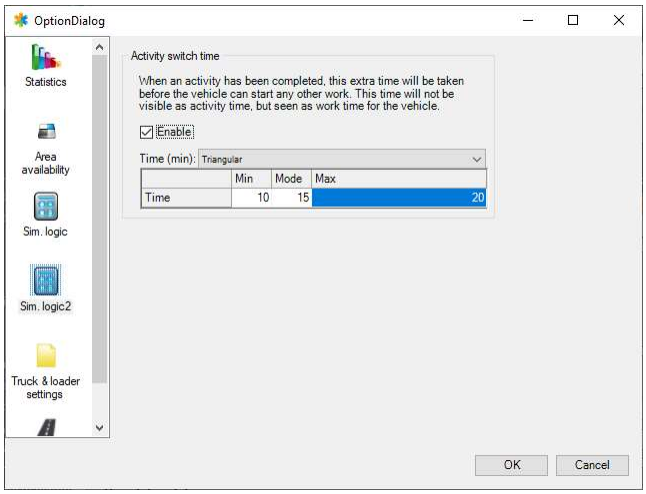


Figure 11-21 - Simulation logic 2

This has options to specify an activity switch time. Activity switch time is the time from when an activity is completed by a vehicle, and until that vehicle can be assigned work again. During the activity switch time, the face or work location will be free for other vehicles to work at, but the vehicle which just finished work at it, will be occupies during this activity switch time. The activity switch time can be used to simulate communication and work assignment process.

11.3.5 Truck and loader settings page

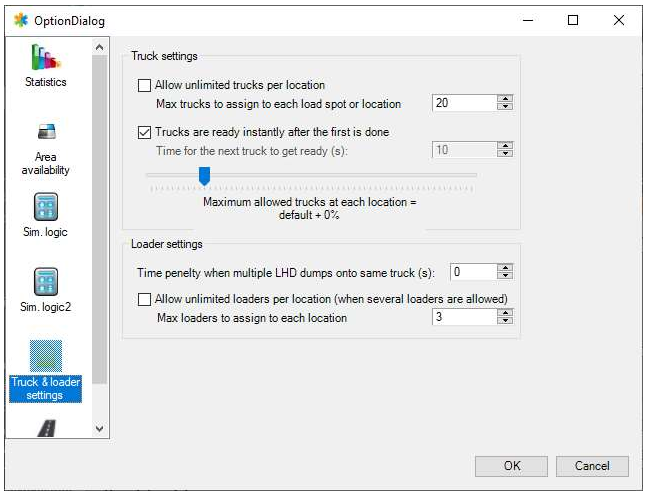


Figure 11-22 - Truck and loader settings

This has options to control how trucks and loaders behave. All trucks and loaders are affected by these settings.

MAXIMUM NUMBER OF TRUCKS PER LOCATION SETTINGS

These allows the user to specify the maximum number of allowed trucks per work location. This setting can be overridden for each section, in the properties for loading and transport.

TRUCK SWITCH BEHAVIOR

These settings control the behavior for truck switching, which is when one truck is filled, and the next in queue will become ready to accept rock. It can be set to become ready at once, or at a specified time after the first truck was filled.

MAXIMUM ALLOWED TRUCK MODIFICATION SETTING

This setting allows the maximum allowed trucks to have a certain amount of freedom if more trucks will be tested.

LOADER PENALTY WHEN MULTIPLE LOADERS DUMP

This will allow a time penalty when multiple loaders dump into the same location.

MAXIMUM LOADERS PER LOCATION

This sets the maximum number of allowed loaders at the same work location. This has only effect when multiple loaders are allowed to work at the same time at a location.

11.3.6 haul way settings page

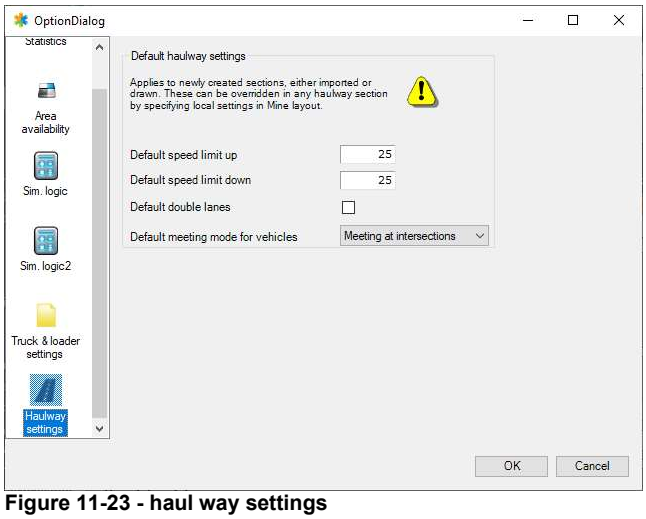


Figure 11-23 - haul way settings

This holds default settings for haul ways in terms of maximum allowed speed, and default meeting behavior. See Section General tab on page 219. for more information about meeting settings. The default settings only affect newly added sections. Already existing sections will not be affected by any changes here.

DEFAULT SPEED LIMITS

These controls the default setting for maximum allowed speed limits up and down.

DEFAULT DOUBLE LANES

This controls the default setting for if sections will have double lanes or not (when set, it won't cause any traffic disturbances due to meetings)

DEFAULT MEETING MODE

This controls the default setting for meetings

11.4 3D layout view settings

The settings box for the 3D view is opened from the Visualization group under Start tab in the ribbon. The settings done in these settings doesn't affect the layout itself, only the view in how it behaves and display different entities. The 3D settings dialog box has several tabs.

11.4.1 Section profiles

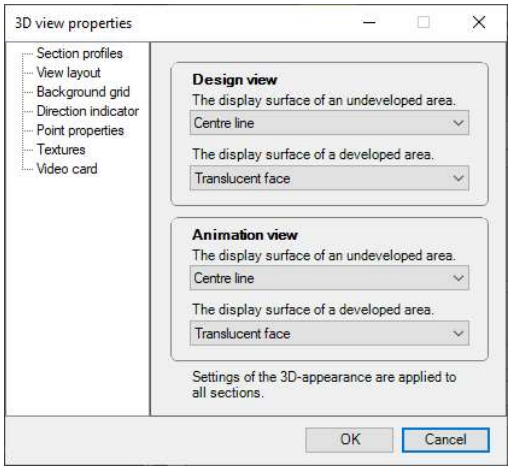


Figure 11-24 - 3D settings (profiles)

This allows the user to set how the sections will be displayed in the 3D view. There is one set for the design view, which is shown in the user interface, and one set for the animation view, which is shown when running a simulation with animation.
Tip. To hide undeveloped sections in the animation view, select ***Hidden*** in the list of options from the undeveloped area profile for animation.

11.4.2 View layout

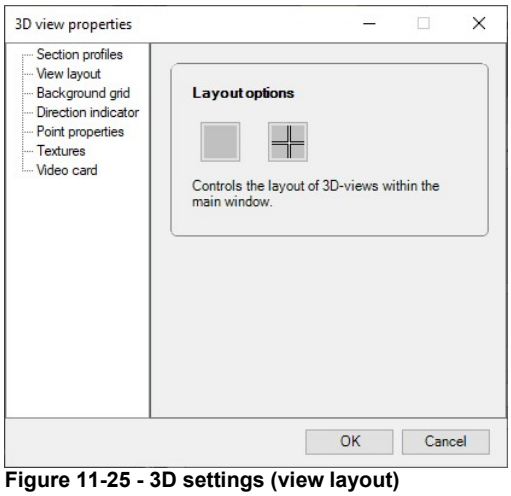


Figure 11-25 - 3D settings (view layout)

This sets how the 3D layout will be arranged. It supports two modes – a single view, or 4 different views which can display the layout from different directions.

11.4.3 Background grid

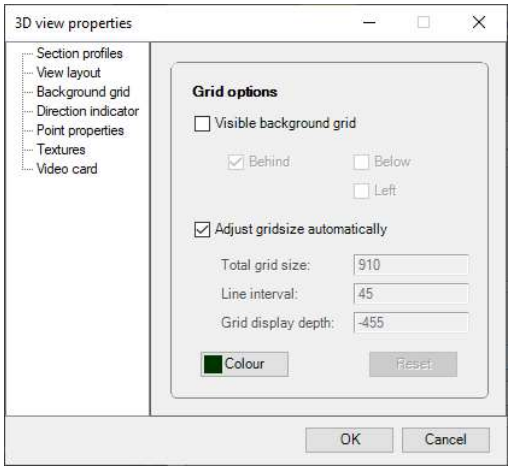


Figure 11-26 - 3D properties (background grid)

This has settings for how a background grid shall be displayed in the 3D view

11.4.4 Direction indicator

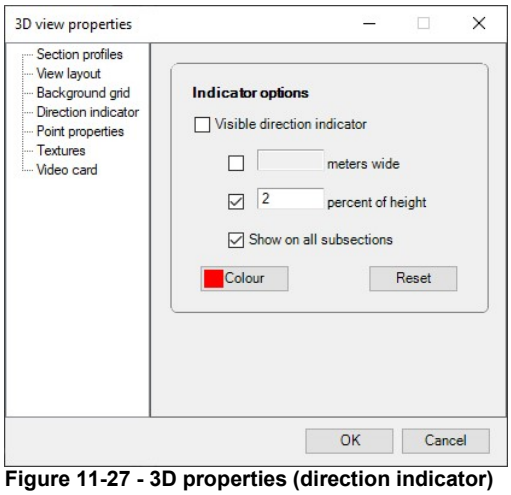


Figure 11-27 - 3D properties (direction indicator)

This has settings for how the development direction indicator will be displayed. The direction indicator is controlled by the ***Show direction*** button in the ***Visualization*** group under ***Start*** tab in the ribbon, and shows the development direction for segments.

11.4.5 Point properties

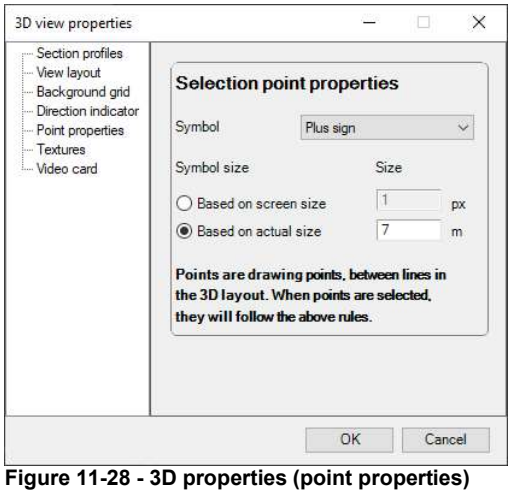


Figure 11-28 - 3D properties (point properties)

This has settings for how the selected point indicator will be shown. This shows when single points are selected in the 3D layout. As default, it is shown as a box with diagonal lines. Here it can be selected as a plus sign, which is smaller and doesn't hide the layout equal much.
It is also possible to set the size of the point indicator.

11.4.6 Textures

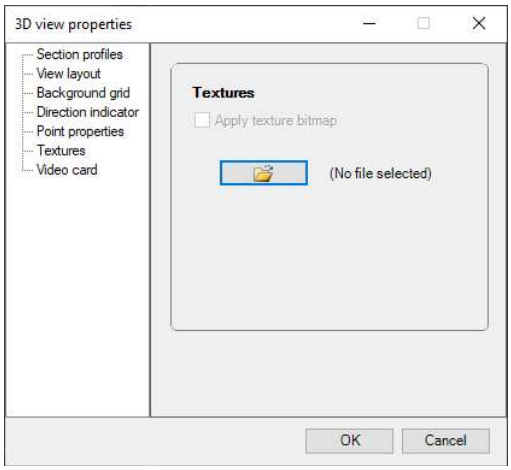


Figure 11-29 - 3D properties (textures)

This holds settings for assigning textures to the walls of each drift in the mine layout. It is shown in the animation view if either translucent face profile or solid face profile is selected in the ***Section profile*** properties in this dialog.
Note! This is only available if Graphics+ license exists in the license.

11.4.7 Video card

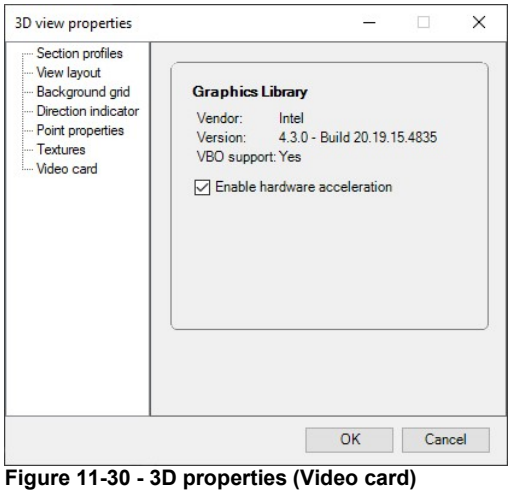


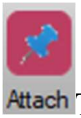
Figure 11-30 - 3D properties (Video card)

This shows the properties for the current graphics adapter in the computer. It also allows hardware acceleration to be turned on or off.

11.5 Layout tools

The layout tools are the tools found under the Visualization group in the Start tab in the ribbon. It contains tools to handle the 3D layout as well as objects and sections in it.

11.5.1 Attach tool



This tool opens up the Attach tool window, which lets you attach non-connected parts of the layout. The attach tool window looks as the figure below

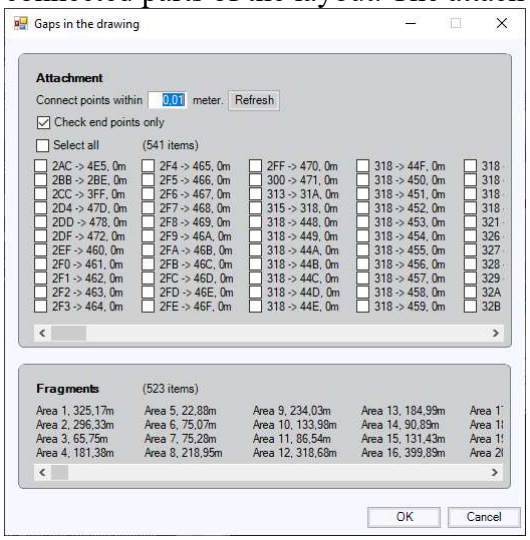


Figure 11-31 - Attach tool

The attach tool will find gaps in the layout. It has the following parts:

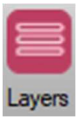
20. Gap length – This is the maximum length of a gap. Gaps longer than this will not be found
21. Find endpoints only setting – This checkbox will, when checked, only search for gaps which are at the end of lines. It will not search for gaps close to the middle of a line. Gaps may exist in the middle

of a line when two lines are crossing each other. The location where the intersect can be a gap since the lines are not connected to each other. When this checkbox is unchecked, the search for gaps takes considerably longer time to perform.

22. Found gaps part (upper part). This lists all gaps which are less or equal in distance than the specified maximum gap length (at the top in this window).
23. Found fragments – This shows all parts of the layout which are not connected to any other part. A complete layout should only have one fragment, since having anything more than one means that there are at least two non-connected parts in the layout, which might cause vehicle to jump when they cannot find a path between the fragments.

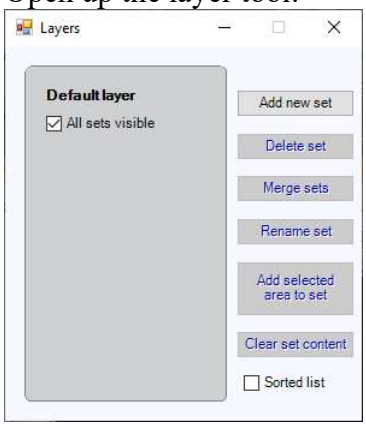
To attach gaps, simply click the checkbox next to a gap to attach it. The list of fragments will update whenever a checkbox is toggled. The attach itself is done when you click OK in this tool window. To see where a gap exists, click on the gap label. It is then marked in the layout. To connect all gaps, check the ***Select All*** checkbox. Click OK to perform the attach. Repeat the attach process until all parts are connected. There exist other ways to connect lines in the layout as well. These methods are described under the Connect broken paths on page 104.

11.5.2 Layers tool



The layers tool can assign lines, segment and sections to different layers. The layers can then be shown or hidden to simplify the process of modifying or selecting things in the layout.

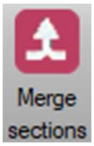
To assign lines to a layout, do as below:

1. Open up the layer tool:
2. 

3. This shows all defined layers (0 in the figure above)
4. Create a new layer where the lines will be assigned to by clicking ***Add new set*** button. The new layer is created with a default name. Click on its name to enable it for renaming and rename it to a descriptive name. Select the layer in the layer window.
5. In the layout, select the line, segment or sections which shall be assigned to the new layer.
6. Click ***Add selected area to set*** button. This adds the current selection to the selected layer.

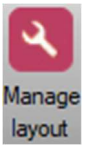
7. Hide show the parts which belong to the layer by unchecking/checking the checkbox next to the layer name.

11.5.3 Merge sections tool

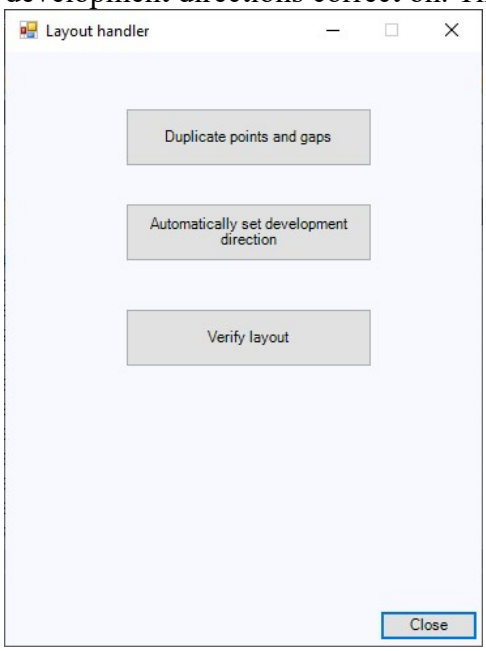


This allows the user to merge two or more sections into one. When two or more sections are selected, this button will be enabled. Clicking it will merge all selected section into one section. The merged section will take all properties from the first selected section.

11.5.4 Manage layout tool



This allows the user to manage the layout. The tools and functionality found within this tool does manage the layout to help the user to get a good and functional layout. A layout, independent on how well it is designed, can contain duplicate points, which are points that are on top of each other, or very close to each other. The layout, especially if the layout is large, can also be hard to set all development directions correct on. The Manage layout tool looks as:



The manage layout opens a tool selection, which contains these tools:

Duplicate points tool	This tool searches for points which are at a certain interval from each other, and removes one or more of these points so that only one point remains. The attach tool described earlier can connect points which are close to each other. In some cases, the attach tool cannot fix issues in layout where multiple points, or the start and end points on the same line is on top of each other. The duplicate points tool is preferred

	instead of the Attach tool when handling duplicate points.
Development direction tool	This tool will set the development directions in the layout so that every part of the layout can be developed. This tool will start from each section which is already developed at start of simulation, and from those points progress through the layout, in the direction of the set development directions. If there are parts which cannot be reached dur to wrong development direction, this wool will change the directions.
Verify layout	This verifies the layout and corrects and issues detected. The task it performs is to check that there are no invalid development directions in the layout, and corrects them if detected.

In the Manage layout tool, click the tool to perform.

11.5.4.1 Duplicate point tool

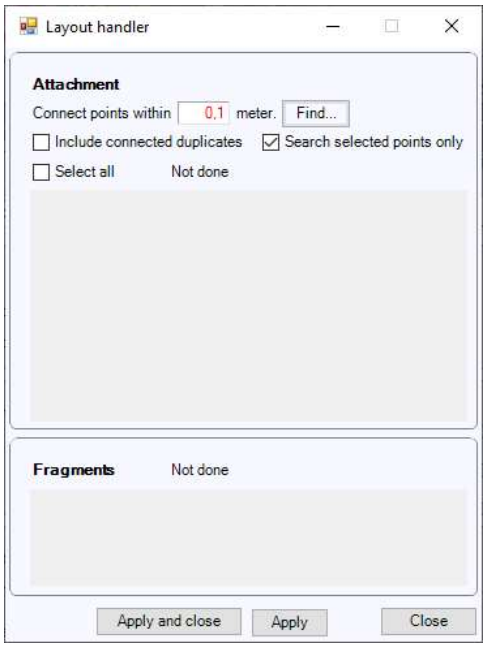
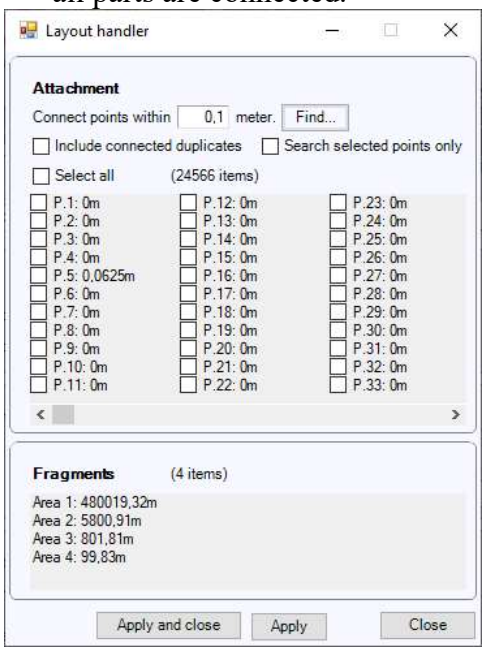


Figure 11-32 - Duplicate points

To find and remove duplicate points in the layout, do as:

1. Enter the distance at which points are treated as duplicate in the textbox at the top (where is says 0.1).
2. Click Find. This searches through the whole layout after duplicate points which are within the specified distance from each other.
    a. The check box Include connected duplicates will also search for duplicates, even if they are already connected with each other (through a short connection). If this is not checked, only unconnected points will be searched.
    b. Check box Search selected points only will only search through any points which are already selected by the user. When unchecked, the whole layout is searched.

3. When the search is complete, all found duplicate points are shown in the left pane. The right pane shows number of fragments. The number of fragments is the parts in the layout which isn't in contact with any other part. Only one fragment should exist in a layout, which will ensure that all parts are connected.



4. Check the checkbox next to a duplicate point to remove one of the duplicates from the layout. The actual removal isn't done until ***Apply*** is clicked.
5. The list of fragments at the bottom shows how many fragments there exists (separate parts, which are not connected with each other). When duplicate points are checked in the upper list, the list of fragments will be updated to reflect the changes.
6. When done, click ***Apply***, ***or*** ***Apply and Close*** to remove all marked duplicate points from the layout.
7. Steps 1 to 6 can be repeated as many times as judged necessary until the layout contains one fragment only.

11.5.4.2 Set development direction tool

This till will set the development direction in the layout automatically, so that all parts of the layout can be developed. For large layouts, it may be hard to have an overview of the development directions and to ensure that the set directions allow all parts of the layout to be developed. This tool will help the user to ensure that all parts can be developed.
The functionality of the tool is:

1. At each opening in the layout, which has at least on already developed section, the check will start
2. It will progress through the layout in the set development direction.
3. When the whole layout has been progressed, if there are still parts which cannot be reached dur to that the wrong development direction is set, it will change the direction on the necessary segments to ensure that development can reach those parts. It will then continue to progress through the layout

4. Point 2 and are repeated until the whole layout has been progressed through and all parts are reachable

Note! Only visible parts will be checked. Before running this tool, ensure that all required parts are set to visible so that the whole layout is searched

To perform a development direction task, open up the Development direction tool:

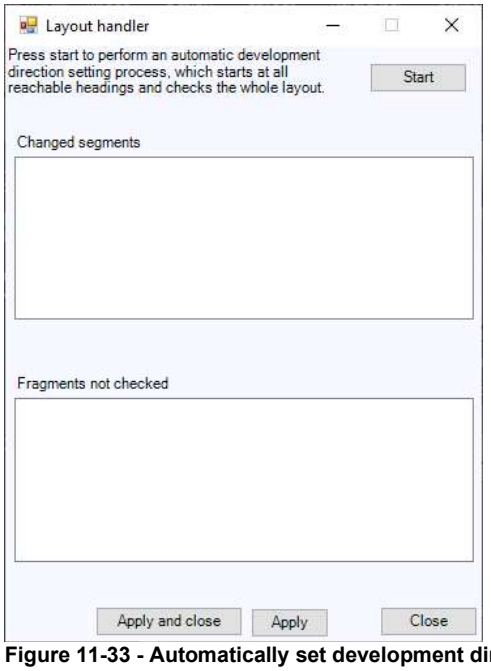


Figure 11-33 - Automatically set development direction tool

The tool will show. Perform the following steps to perform a development direction task:

Click ***Start*** to start the development direction task. When the task is complete, it will present the results in the two list boxes as:

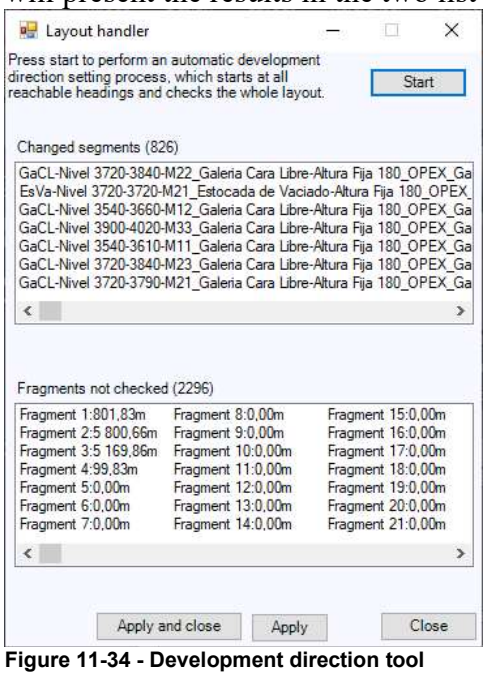


Figure 11-34 - Development direction tool

In the upper list are segments where the development direction will change when you click ***Apply***
In the bottom list are fragments which have not been checked. The reason why certain fragments have not been checked are:

- There are parts in the layout which are not connected to any other part, and those free-standing parts do not have any already developed sections. This means that there are no natural openings where the development can start in those parts. The development will still start in those parts due to that development will start at each part in the layout which cannot be reached with the current development direction, but they are not handled in this tool.
- There are hidden parts in the layout, which means that the hidden parts have created free-standing parts in the layout, which then behaves as described in previously point. Ensure that all parts are visible in the layout prior to running this tool.

You can right-click in the fragments list to zoom the layout to a certain fragment, or to hide everything except the fragment so you will be able to more in detail check where it is not connected to the rest of the layout.

11.6 Activity properties

Both sections and locations which can have at least one activity, can also show properties for it. When only loading and transport activity is allowed, its properties is shown directly in one of the tabs in its property window. For sections, which can hold an activity cycle containing multiple activities, the properties for each activity can be shown by double-clicking on the activity. It will then show in its own window. The properties which are available differ slightly between different types of activities. The common activity property window looks as below:

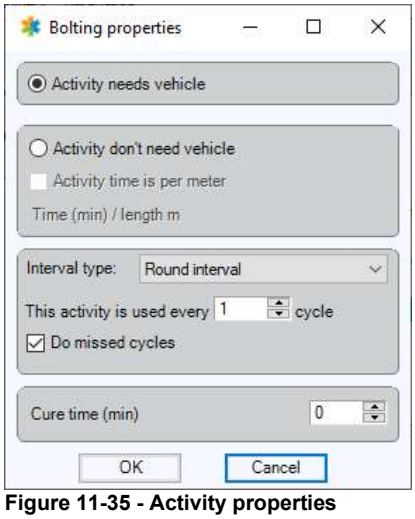


Figure 11-35 - Activity properties

ACTIVITY NEED VEHICLE

This sets that a vehicle must perform the activity. The time to perform the activity is configured at the vehicle. This allows a user to test out different vehicles with different work times to check the effects of a faster vehicle.

ACTIVITY DON'T NEED A VEHICLE

This sets that the activity will be performed autonomously. When this is checked, a table where the activity time can be entered is shown. An activity

which doesn't require a vehicle will be performed as soon as possible. There is no limitation in how many concurrent activities that are done at the same time.

ACTIVITY TIME IS PER METER CHECK BOX

This is enabled only when the activity doesn't require a vehicle. When it is checked, the total time to perform the activity depends on the number of previously drilled meters at the section, and the activity times entered in the activity times table (not shown in the figure above, but is shown when the activity doesn't require a vehicle)

INTERVAL TYPE SETTINGS

Each activity can be configured to be performed at certain intervals. These settings are not available for Face drilling, which must be performed every round. The possible interval types are:

5. Round interval. Here it is possible to set how frequent the activity shall be performed. With a value of 3 in the interval number, the activity is performed every 3 rounds (in the other 2 rounds, the activity will not be performed)
    - Do missed round: When this is checked, and the activity is not done every round (a number greater than 1 in the interval number), the missed rounds will be done when the activity is performed. For example: If the interval is to perform the activity every 3 rounds, 2 rounds are done without that the activity is performed. When the 3rd round comes and the activity is performed, the 2 rounds which are missed will also be done. The total work time will be the total time for 3 rounds, but without any setup time for the vehicle.
6. Round interval with probability. This allows a round interval to be specified, together with a probability to be performed. It means that whenever it is time to perform the activity due to its interval setting, it will only be done according to a probability chance. I.e. if the probability is set to 25%, it will only be done 25% of the times.
7. Meter interval – The activity will be performed every x meter only. Here the interval length is meter instead of rounds.
8. Meter interval with probability – The activity will only be performed every x meter, with a probability to be performed. For example: If the meter interval is set to 20m, and the probability is set to 25%, it will only be performed at 25% of the times for each 20m. This will average it out that the activity will only be performed every 80m.
9. Probability to be performed. This is the same as Round interval setting, but with the round interval always set to 1 (each round).

CURE TIME

This is only available for Shotcrete activity and Bolting activity. For Blast activity this is ventilation time. During this time, no other activity can be performed at the location.

11.7 Section Properties dialog

The property window for a section is displayed when the properties for selected section(s) is shown and contains several tabs. Some of these tabs may or may not be visible depending on the current configuration. The tabs in this property windows are:

11.7.1 Section General tab

The general tab contains general settings for a section, such as maximum speed limits, section type and light vehicle disturbances

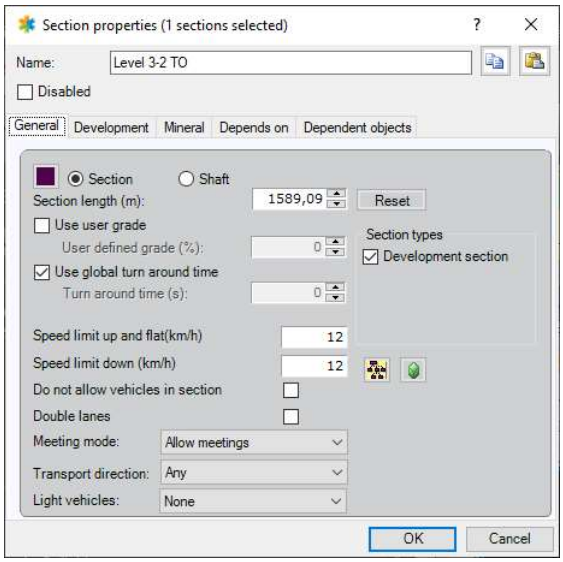


Figure B-11-36 - Section properties - General

NAME

This is the name of the section. This can be any user-supplied name

DISABLED CHECK BOX

When checked, this section, and all placed objects on it will be disabled and not part of the simulation

COLOR button

Allows the user to set a color on this section

SECTION TYPE

This allows you to select if the section will be a section or a shaft. The only difference is graphically, where the latter has a round profile, and the first has a drift face profile

SECTION LENGTH

This is the length of the section. The user can change this to any value. If changed, the new value will be the total section length even if the section in the 3D layout is shorter or longer. To reset the length back to the original length, click the Reset button to the right of the section length textbox

USER GRADE CONTROLS

This allows the user to set the incline of a section. The direction of the incline cannot be changed. If a segment goes uphill, the incline will be positive, and it goes downward (the other direction), it will be negative.

TURNAROUND TIME

In General settings, a global turnaround time for vehicles is specified. To override this and have a turnaround time only for this section, specify it here.

SPEED LIMIT UP AND FLAT

This is the maximum speed any vehicle can travel upwards or flat in this section

SPEED LIMIT DOWN

This is the maximum speed any vehicle can travel downwards in this section

DO NOT ALLOW VEHICLES IN SECTION CHECKBOX

When this is checked, no vehicle is allowed to travel through the section. Vehicles are still able to travel in the section during the development phase of the section. As soon as a segment is developed, that segment will no longer allow any traffic. This should be checked for shafts. When shaft development is simulated by vehicles, they can travel there as long as it is developed.

DOUBLE LANES CHECKBOX

When this is checked, vehicle can meet each other at full speed without slowing down

MEETING MODE

This controls how meetings can be done in this section. The supported modes are:

- Allow meetings. This will hold one of the vehicles during the specified meeting time in General settings tab. Meetings can occur everywhere. This option is good when meetings do not need to be simulated in detail
- Meetings at intersections. This will force one of the vehicles to wait at an intersection or placed object until the other vehicle has passed. This require the layout to contain spots where meetings are allowed
- Only one vehicle in section – This will only allow one vehicle at a time in the whole section. This cannot be assigned when there are activities that require multiple vehicles, such as shotcreting.

TRANSPORT DIRECTION

This setting sets the allowed transport direction for vehicles travelling in this section. The transport is set relative to the development direction. If the development direction is set to "both directions", the transport direction is automatically allowed in any direction in the section. Even though a section isn't a development section, it still has a development direction for which the transport direction can be set.

LIGHT VEHICLE DISTURBANCE

This assigns a light vehicle disturbance setting. This controls how much disturbances light vehicles (or all other vehicles not part of the simulation) will cause in this section. See Light vehicle disturbances on page 74 for how to define light vehicle disturbances.

DEVELOPMENT SECTION CHECKBOX

When this is checked, the section becomes a development section, which shall be developed. When this is checked, several additional tabs appear – Development, Mineral, Depends on and Dependent objects. Even if a section is a development section, parts of it can be set as already developed. See page Section list on page 201 for more information about this

11.7.2 Development tab, section

The development tab contains properties for the development phase and is only visible if the section has been set to be a development section in the General tab.

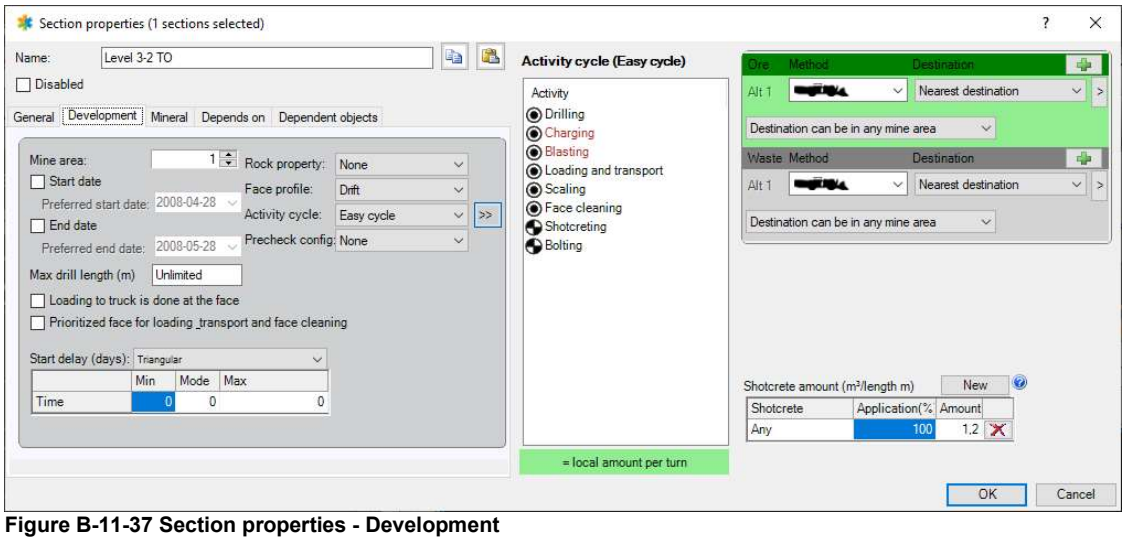


Figure B-11-37 Section properties - Development

This tab contains multiple panels:

- Property panel, which is the properties under the Development tab
- Center panel, which contains the activities in the assigned activity cycle
- Right panel, which shows properties for the loading and transport activity, as well as the shotcrete cement type to use.

MINE AREA TEXTBOX

This is which mine area the section belongs to. This can be any positive number and is used to divide the mine into mine areas. The vehicles can then be allowed to only work within some mine areas. Other things are also based on mine areas, such as blast times, mine area disturbances etc.

START DATE CHECKBOX / DATE

This allows you to specify that the section is not allowed to start prior to a set date. When the checkbox is unchecked, this option is not used.

END DATE CHECKBOX / DATE

This sets a preferred end date when the section should be completed. When the checkbox is unchecked, this option is not used. The end date is only used when work mode is set to most meters per week. See Set how vehicles search work on page 81 for how to set work mode.

MAX DRILL LENGTH TEXTBOX

This sets a maximum allowed drill length at the section. When this is ***Unlimited***, the drill rig working at the section decides the maximum drill length. When this is above 0, no drill rig is allowed to drill longer rounds than the set value.

LOADING IS DONE AT THE FACE CHECKBOX

This setting does only affect loading when loading is done by LHD to a truck. When this is checked, loading from an LHD to a truck is done at the face. Normally, when this is not checked, the truck is waiting in the nearest intersection.

PRIORITIZED FACE FOR LOADING AND TRANSPORT CHECKBOX

This sets that the face is prioritized, which means that a loader may abort any ongoing work when this has loading and transport as its current activity. Only loaders which are set to listed for prioritized faces will abort any ongoing work, if that work is done at a non-prioritize location. See PRIORITIZE WORK AT FACE on page 266 for how to specify that a loader can abort non-prioritized work.

ROCK PROPERTY DROPDOWN LIST

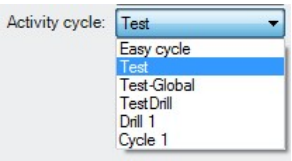
Select which rock property to assign to the section. This list contains all globally defined rock properties. The rock property holds information about the rock, and also the affection it has on different activities, for example, it can specify that drilling will take twice the amount of time as normal. See Rock properties on page 70 for information about rock properties.

FACE PROFILE DROPDOWN LIST

Select which face profile to assign to the section. This list contains all globally defined face profiles. The face profile decides the width and the area of the section, which affects the blasted amount. Each development section must have an assigned face profile. See Face profiles on page 59 for how to define new face profiles.

ACTIVITY CYCLE DROPDOWN LIST

Select which activity cycle to assign to the section. This list contains all globally defined activity cycles.
When an activity cycle is assigned to a section, it is copied to the section so that any change in its properties won't affect the globally defined activity cycle.
Of this reason, this list also contains the current activity cycle twice – one with "global" added to its name.



The global is the activity cycle defined in the global data, while the activity cycle without the "global" is the local, already assigned cycle. In the above picture, the Test cycle is the currently assigned cycle. This Test cycle holds the settings for the test cycle as well as any modifications done locally at the section. Of this reason, a "Test-Global" also exist, which contains all settings defined in the global data.
When an activity cycle is selected, and another activity cycle is already assigned, the properties done in the already assigned cycle is copied to the new cycle. Each activity's properties are copied to the same activity in the new cycle. If the new cycle lacks an activity from the already assigned cycle, no properties for that activity is retained.

Precheck config
Select which precheck configuration to use. Precheck configurations are used to release an activity for work assignment prior to the point when it becomes the current activity. In this way, high-priority faces can have their next activity

already assigned to a vehicle, which will start to drive towards the face when it gets an activity assigned to it, even if that activity isn't the current one. It will then stand ready and wait until it will become active. This list contains all globally defined precheck configurations. See Precheck configurations on page 77 for more information

START DELAY

This is the start delay, in days, from the time that the section becomes available and the time until it can be started to work at. When set to 0, the section can be started to be developed at the same time as it becomes available in the layout. The start time distribution can be changed to include randomness in the simulation.

11.7.2.1 Center panel, Activities

The center panel contains the activities in the currently assigned activity cycle. This panel can be show or hidden by clicking the button next to the ***Activity cycle*** dropdown list.
The properties for an activity can be displayed by double-clicking the activity. For the bolt activity, it looks as below:

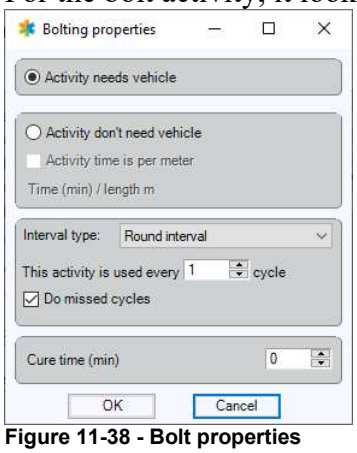


Figure 11-38 - Bolt properties

For a description of the activity properties, see Activity properties on page 217

11.7.2.2 Right panel, transport properties and cement data

This panel can be shown/hidden by clicking the button next to the activity cycle dropdown list. This contains some properties for loading and transport and cement data.

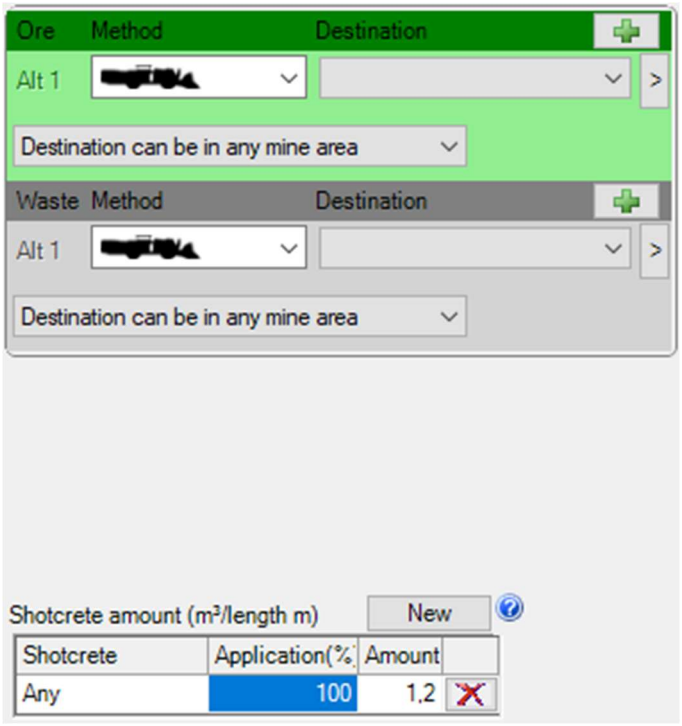


Figure 11-39 - Right panel

TRANSPORT PROPERTIES

This will only show if there is a loading and transport activity in the assigned activity cycle. This contains basic properties for loading and transport.
See Loading and transport on page 288 for a more in-depth description on how to configure loading and transport.
Some locations have functionality to directly transfer their rock to another location without the need for any vehicle. This functionality and settings for how the direct transfer location is found reminds much how the destination location for loading and transport is found.
The control for direct transfer looks as the picture below:

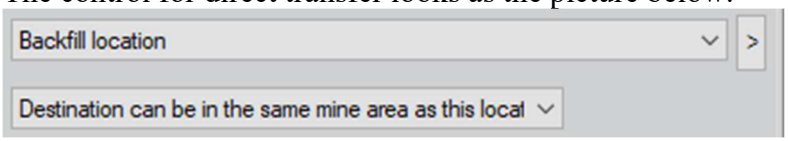


Figure 12-3 - Direct transfer properties
See Direct transfer of rock properties on page 287 for more information how to setup and configure direct transfer of rock, for locations where it is supported.

SHOTCRETE AMOUNT TABLE

This is only visible if the current assigned activity cycle contains a shotcrete activity. This table holds which type of shotcrete to use at the section. Several shotcrete types can be shown in this table, but only one shotcrete type each cycle round is used.

For example: If this table contains 2 rows:
Normal shotcrete, application 70%, and amount 1 m^3 per length meter.
Fiber shotcrete, application 30%, and amount 1,5 m^3 per length meter.

Assume further on that a shotcrete rig and a cement truck exist in the simulation, where the cement truck can hold 5 m^3 of shotcrete.

Each round is 5 meters (a drill rig which allows the blast to be 5 meter is used – drill rods longer than 5 meter)
The above example will result in that around 70% of the times when shotcreting shall be done, normal shotcrete is used, and 30% of the times, fiber shotcrete is used. When normal shotcrete is used, 5m^3 of shotcrete is needed, which can be fitted in one cement truck.
When fiber shotcrete is used, 7,5m^3 is needed, which requires the cement truck to refill during the shotcrete phase.

11.7.3 Mineral tab, section

The mineral tab contains which minerals there are at the section.

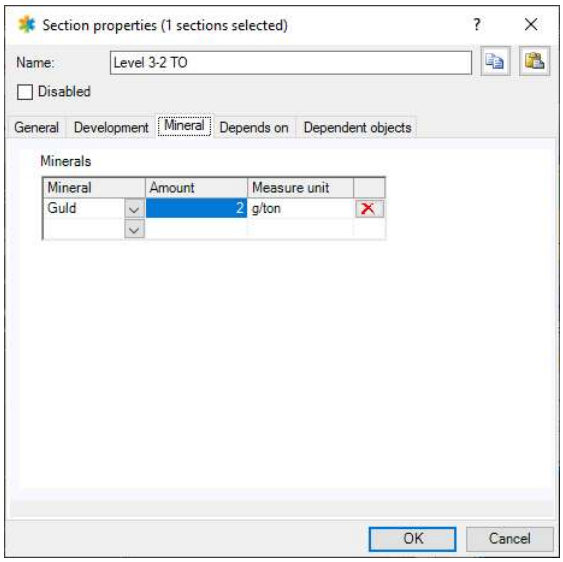


Figure B-11-40 Section properties - Minerals

MINERAL TABLE

This table holds all minerals that exist at the selected section. Minerals can only be defined at a section if a section's rock type is ore. It is set in the ***Development*** tab. This table has the following columns:

- Mineral – This is the mineral name. To select a mineral, just drop down the drop-down list and select a mineral. The shown minerals are defined in the global settings. See Minerals on page 74 for how to define new minerals.
- Amount – This is the mineral amount for the selected mineral.
- Measure unit – This is the measure unit for how the amount is measured. The measure unit is not changeable and is set when defining the mineral.
- Remove – Click the remove button to remove the mineral at that row.

11.7.4 Depends on tab, section

The depends on tab shows which objects and sections the selected section depends on. A dependency is when this section depends on another object or section in some way, for example that the dependent object must be completed before the current section can be started to be developed.

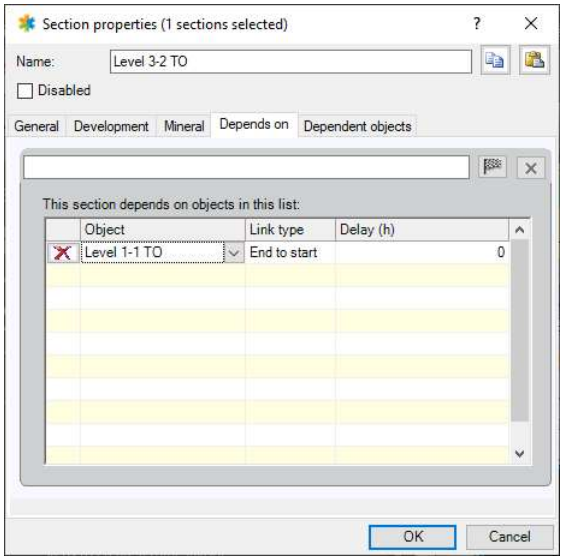


Figure 11-41 - Depends on

This shows all sections and objects this section depends on.

SEARCH/FILTER BOX

The search and filter box allow the user to search and only show sections and objects which fulfils the search criteria. This is useful to limit the number of objects shown in the list of possible dependent objects, when assigning a new dependency.

DEPENDENT TABLE

This table show one dependency per row. It contains the following columns:

- Remove column – Click the remove button to remove the dependency at that row
- Object – This shows the name of the object or section that the current section depends on. The type of dependency is found in the "Link type" column.
- Link type – This shows the type of dependency.
    - End to start means that the object/section in the table must end before the section for which the properties are shown can commence.
    - Start to start means that the object/section in the table have to start before the section for which the properties are shown can commence.
- Delay – This holds the delay, which is the time from when the section can commence according to the link type rules, and until it actually can start

Example: If delay is set to 10 hours, and all other values are as in the figure above, the section Level 3-2 TO can start 10 hours after the section Level 1-1 TO has been completed.

11.7.5 Dependent objects, section

This tab shows which objects and sections that depends on this section (the section whose properties are shown). It works like the "Depends on" tab, except

that is affects the objects that depends on this section instead of affecting which objects this section depends on.
If an object/section (section 1) is added to another section's (section 2) ***Dependent object*** tab, it means that in the properties for section 1, section 2 is listed under its ***Depends on*** tab, while in section 2's properties, section 1 will be listed under its ***Dependent objects*** tab

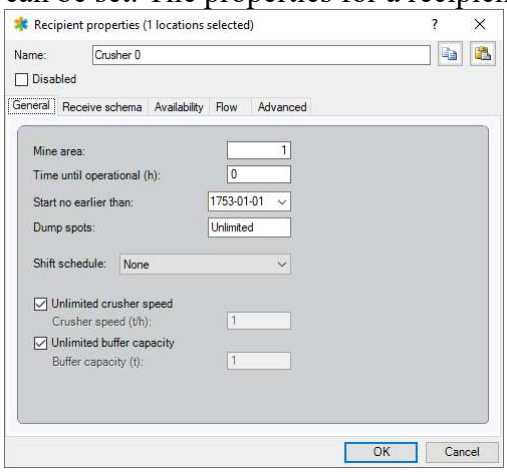
11.8 Object Properties

This part shows the property dialogs for the different objects that exist and explains their properties.
Each object's property window contains one or more tabs. Some tabs are common and have similar functionality independent of which objects they are shown for. These common property pages are described first, and only referenced from each object's property description.

11.8.1 Common properties

11.8.1.1 Object name and disabled state

The name for an object is always at the header of a property box. Therefore, independent of which object's properties are shown, its name and disabled state can be set. The properties for a recipient look as:



The tabs themselves contains properties for the recipient, but the heading of the property dialog contains the name and disabled state.
When an object is disabled, it will not be included in a simulation. An object will automatically become disabled if the section on which it is location is disabled.

11.8.1.2 Loading and transport properties

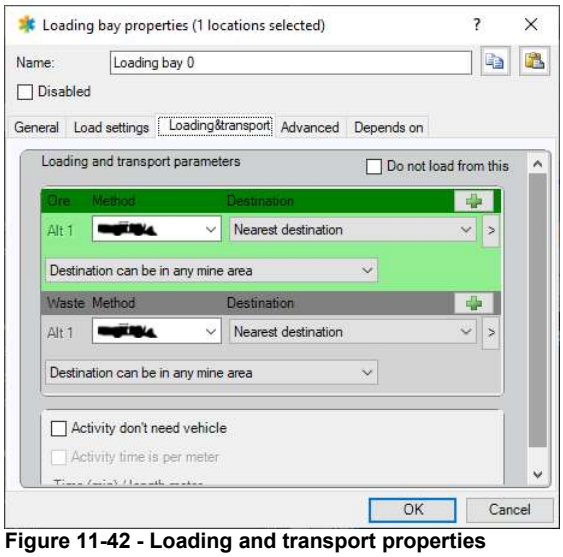


Figure 11-42 - Loading and transport properties

This control allows the user to set how the loading and transport will work. A detailed description of its controls and how it affects the loading and transport is described at Loading and transport on page 288. The most basic settings here are:

- Control which destination a certain rock type will have
- Set how the rock shall be transported from this location
- Set any special conditions for the destination, if the destination isn't a fixed destination (i.e. nearest ….)

11.8.1.3 Depends on settings

The depends on tab shows which objects and sections the selected object depends on. A dependency is when one object depends on another object or section in some way, for example that the dependent object must be completed before the current object can be operational.

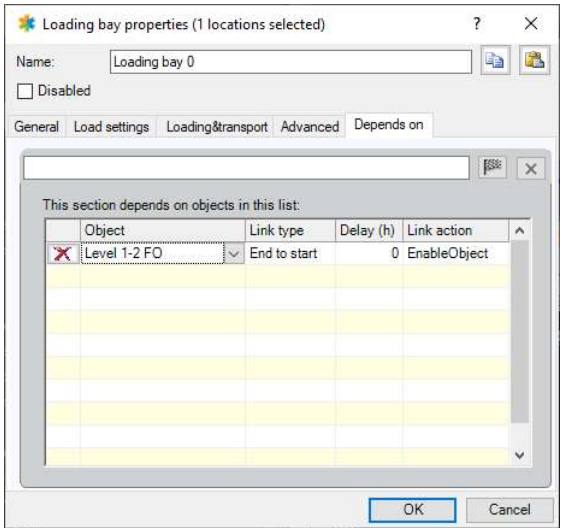


Figure 11-43 - Depends on

This shows all sections and objects this section depends on.

SEARCH/FILTER BOX

The search and filter box allow the user to search and only show sections and objects which fulfils the search criteria. This is useful to limit the number of objects shown in the list of possible dependent objects, when assigning a new dependency.

DEPENDENT TABLE

This table show one dependency per row. It contains the following columns:

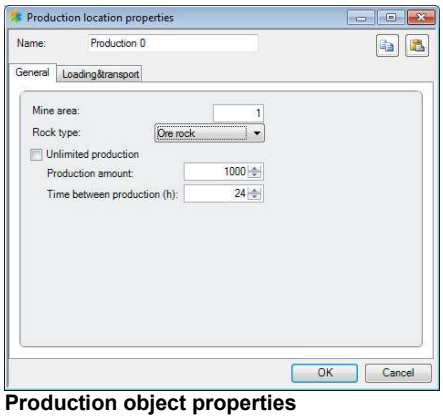
- Remove column – Click the remove button to remove the dependency at that row
- Object – This shows the name of the object or section that the current section depends on. The type of dependency is found in the "Link type" column.
- Link type – This shows the type of dependency.
    - End to start means that the object/section in the table must end before the section for which the properties are shown can commence.
    - Start to start means that the object/section in the table have to start before the section for which the properties are shown can commence.
    - Empty state changed, means that when a master object (which is the object that other objects depend on), becomes empty, then the slave object (the object which depends on master other objects) is allowed to have a transport destination. This can be used so a location can transport its material to a location as long as no other primary location has any rock. Otherwise, no rock can be transported from the slave object. This can for example be a stockpile, which will be used as a spare source for rock if there is no other rock in other selected locations). This option is not available for every location type.
- Delay – This holds the delay, which is the time from when the section can commence according to the link type rules, and until it actually can start
- Link action – Holds what will happen when the dependency is fulfilled.

11.8.1.4 Production object

The production object is a simple production location, which can produce a user defined rock type. It is very limited in how it can produce the rock – it hasn't any production schedule.

11.8.1.4.1 Functionality

This object has functionality for:
Set a rock type to produce
Unlimited / limited production.
The limited production only allows a user-defined amount each time period. The user can set the amount and time period.
Set loading and transport settings for how to transport any produced rock from the location



Production object properties

Name
This is the name of the location. This can be any user-supplied name.

Mine area textbox
This is which mine area the location belongs to.

Rock type drop down list
Type of rock to produce.

Unlimited production checkbox
This defines if the production object can produce an unlimited amount of rock, or if it will be limited. The limited amount is set in the "Production amount" text box, and the time span of this production in “Time between production” text box.

Loading and transport parameters
Drop down lists to define preferred handling for the production.

Activity don’t need vehicle checkbox
If your simulation does not include vehicles.
Set time for activity in different face profiles without using machine and machine properties.

11.8.1.5 Production plan object

The object simulates ore or waste production from where it is located in the layout, and at a specified rate. The object has an advanced production plan, which allows the user to specify in more detail the amount to produce, what to produce and when to produce it.

11.8.1.5.1 Functionality

A production plan has functionality for:
Loading properties for how the rock is loaded.
Where the rock will be loaded onto a truck, if a truck is used (at the location or nearest intersection)
Production plan functionality:
Set which rock type shall be produced
Set when the rock shall be produced
Set the amount of rock to be produced

Set exceptions, when no rock shall be produced.

The production plan functionality is provided by the receive plan function, which is described at Production plan properties on page 275. Instead of receive functionality it handles production functionality.

Name
This is the name of the location. This can be any user-supplied name.

Mine area textbox
This is which mine area the location belongs to.

Production plan option
A plan similar to the request plan at page Production plan properties on page 275.

LHD to Truck at location checkbox
To have loading of rock onto trucks at object.

Several LHD can be used textbox
If your simulation uses several LHDs.

Loading and transport parameters
Drop down lists to define preferred handling for the production.

Activity don’t need vehicle checkbox
If your simulation does not include vehicles.
Set time for activity in different face profiles without using machine and machine properties.

11.8.2 Crusher object

The crusher object is a recipient. It can receive rock, and send any incoming rock further. Its default settings don’t send incoming rock further. Received rock is then only recorded in its statistics.
A crusher can represent many objects in a mine simulation. Due to the reason that rock material flow could stop here, it can be used for all situations where the simulation will not simulate any rock material flow beyond a specific point. For example, this crusher object may be placed as a fill station to a conveyor, if the flow beyond that conveyor will not be simulated.

11.8.2.1 General tab

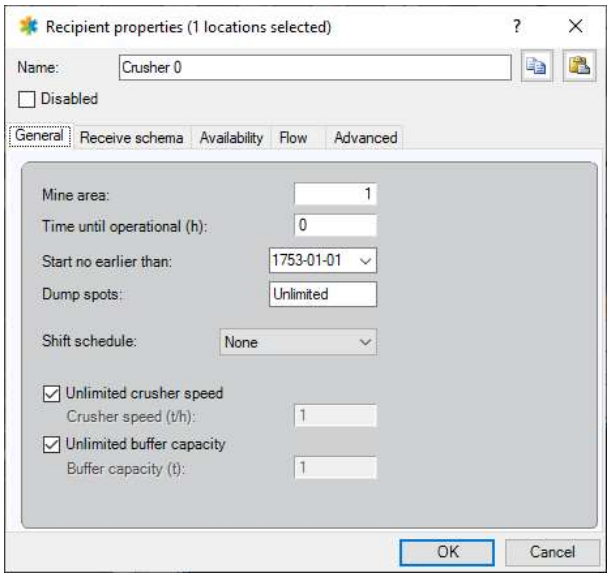


Figure 11-44 - Recipient general settings

NAME AND DISABLED STATE

Described in Common properties earlier.

MINE AREA

The mine area this location belongs to

TIME UNTIL OPERATIONAL

This is the time from the moment it gets available in the layout and until the location becomes operational. When the location is operational, ore or waste can be dumped in it. If the location is available in the layout at simulation start, this time is not counted.

START NO EARLIER THAN DATE

This date is the earliest date this location can become available. Default value is the minimum start date possible, which means that a normal simulation which is run in present time, will activate this location as soon as possible.

DUMP SPOTS

This is the number of available dump spots. -1 means unlimited dump spots. This reflects the number of vehicles that can dump into this recipient at the same time. If more vehicles arrive than the available dump spots, some vehicles must stand and wait until a dump spot becomes available.

SHIFT SCHEDULE DROP-DOWN BOX

This sets according to which shift this is operational. When assigned a shift, it will become unavailable during any off-shift time.

CRUSHER SPEED SETTINGS

The speed at which the incoming buffer is emptied. This impact how fast a full buffer can start to accept rock again. This will only affect the simulation if the incoming buffer is set to a limited capacity.

BUFFER CAPACITY SETTINGS

This controls the incoming buffer capacity. When a limited capacity is set, it might become full and stop further incoming rock until it has some free capacity again

11.8.2.2 Receive Schema tab

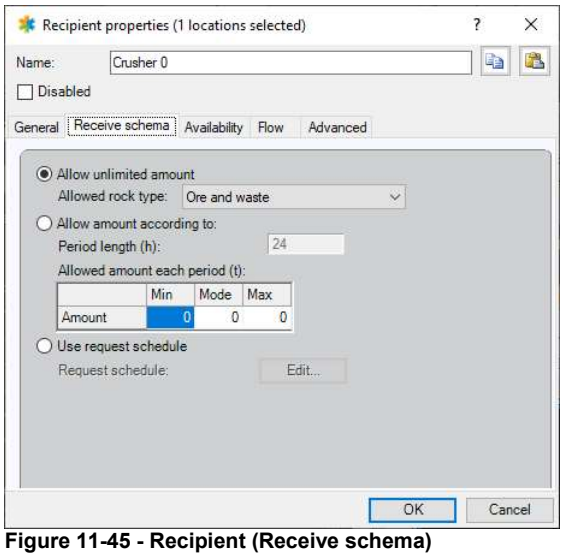


Figure 11-45 - Recipient (Receive schema)

This tab has properties to control what and how much of a rock that can be received.

ALLOW UNLIMITED AMOUNT

This allows unlimited amount to be received. A setting exists to control which type of rock is allowed.

ALLOW AMOUNT ACCORDING TO SETTINGS

This is a simple form to allow equal much rock at even intervals. You can control the interval length, number of intervals and how much is allowed during each interval

USE REQUEST SCHEDULE

This uses an advanced receive schedule. It is the same functionality as for a production plan, but instead of producing rock, this is requesting rock according to a plan. The production plan is described under Production plan properties on page 275, which will give a better description of which settings are available to control the request plan.

11.8.2.3 Availability tab

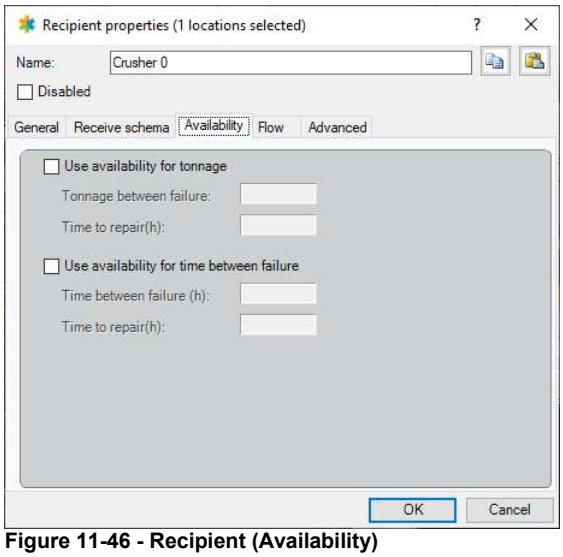


Figure 11-46 - Recipient (Availability)

This tab has properties to control the availability for the recipient. Availability can be set to depend on tonnage and time, where ton-based availability only causes the recipient to stop working if tonnes are dumped into it, while time-based availability can cause it to stop working at any time, independent of received tonnes.

11.8.2.4 Flow tab

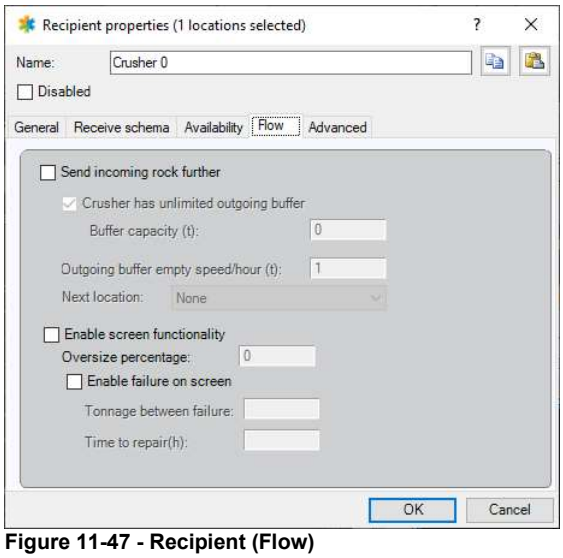


Figure 11-47 - Recipient (Flow)

This tab controls if incoming rock shall be sent further.

SEND INCOMING ROCK FURTHER

This must be checked to allow any incoming rock to be sent further, to any additional object. When this is checked, it will enable controls for outgoing buffer settings

CRUSHER HAS UNLIMITED OUTGOING BUFFER SETTINGS

This controls the buffer size for outgoing rock. When the outgoing buffer becomes full, the crusher will stop its operation. It will only stop to receive more rock when its incoming buffer becomes full.

OUTGOING BUFFER EMPTY SPEED

This sets how fast rock is processed and sent further from its outgoing buffer

NEXT LOCATION LIST

This is which location that will receive the rock processed by this recipient.

ENABLE SCREEN FUNCTIONALITY

The screen functionality simulates a screen which differs small-sized rock from oversized rock. Only oversized rock is dumped in the incoming buffer. Undersized rock will be transferred directly to the outgoing buffer. If screen availability is specified, only oversized rock affects the time until a breakdown of the screen.

OVERSIZE PERCENTAGE

The percentage of incoming rock which is treated as oversized. All oversized rock affects the time until a breakdown. Undersized rock is transferred directly to the outgoing buffer.

SCREEN AVAILABILITY

How often the screen will break down. Only oversized percentage affects this. When the screen breaks down, no more rock can be processed by it and the crusher will stop to accept rock when its incoming buffer fills up.

11.8.2.5 Advanced tab

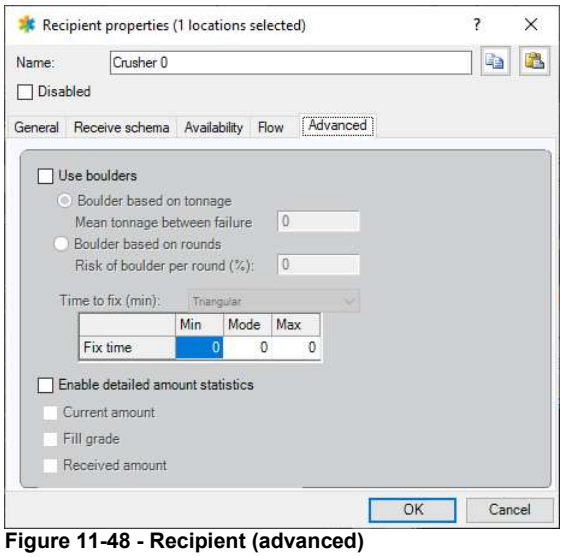


Figure 11-48 - Recipient (advanced)

This tab has advanced properties to setup boulders and statistics level for detailed amounts

USE BOULDERS SETTINGS

These controls how often boulders disturb the operation of the recipient, and how long time it takes to fix the boulder.

ENABLE DETAILED AMOUNT STATISTICS

This enables/disables detailed amount statistics to be collected for this object, which can be used to analyze the haulage in more detail. See Detailed loading and transport statistics on page 169 for how to analyze the detailed amount statistics.

11.8.3 Loading bay object

A loading bay can receive and store rock, until it is transported further. It can be set to hold an unlimited amount or a limited amount.
Its main functionalities are:

- Capacity (unlimited / limited)
- Only one rock type at a time can exist in a loading bay
- Advanced loading and transport control, which includes:
  - Only certain locations can have this as its destination
  - Time with no activity until vehicles will try to empty this
- Can hold backfill material

Its property box holds multiple tabs.

11.8.3.1 General tab

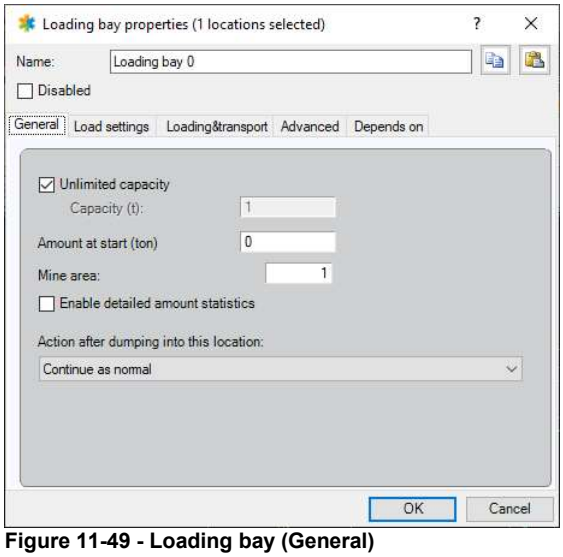


Figure 11-49 - Loading bay (General)

This tab has properties to specify capacity, mine area, statistics level etc.

CAPACITY SETTINGS

These controls the capacity for how much rock the location can store.

AMOUNT AT START

Sets the amount this contains at start of simulation

MINE AREA

The mine area this location belongs to

ENABLE DETAILED AMOUNT STATISTICS CHECKBOX

Enables/disables that this shall collect detailed statistics for rock amounts. See Detailed loading and transport statistics on page 169 for information about detailed amount statistics.

ACTION AFTER DUMPING DROPDOWN LIST

This allows you t specify which action shall be taken by a dumping vehicle. The options are:

- Continue as normal – nothing is done.
- Search new work – The vehicle will search for new work. This option is good in cases when a vehicle shall not complete its current work, but instead may switch to a more prioritized work location
- Search temporary backfill work – This can cause the vehicle to search for backfill work. When this option is selected, a maximum distance can be supplied telling the vehicle the maximum distance from the current location where it can search for temporary backfill work. Temporary backfill work is work which is done once, and then it will return to its old work. For the vehicle to search for temporary backfill work, an option in the vehicle's properties must also be set to allow the vehicle to search temporary backfill work.

11.8.3.2 Load settings tab

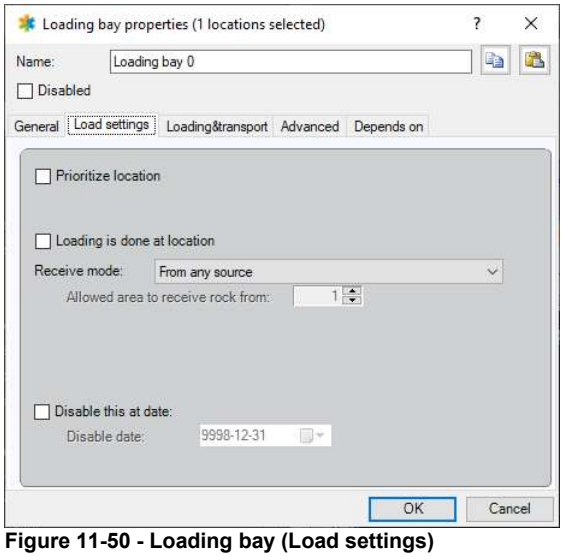


Figure 11-50 - Loading bay (Load settings)

This tab has properties to control how loading is allowed.

PRIORITIZE LOCATION

When this is checked, and it has rock, a loader can abort its current task and start to work at this location. A loader will not abort other prioritized work. The loader must also be specified as a loader which is allowed to abort non-prioritized work.

LOADING IS DONE AT LOCATION CHECKBOX

When this is set, it will only affect when a loader loads onto a truck. It means that the truck will be loaded at the location. The default load location for trucks are at the closest intersection.

RECEIVE MODE SETTINGS

These are used to control from where this location is allowed to receive rock.

DISABLE THIS AT TIME SETTINGS

This will disable this location to stop receiving rock when the time passes a certain time.

11.8.3.3 Loading and transport tab

This is described in the Loading and transport properties on page 228.

11.8.3.4 Advanced tab

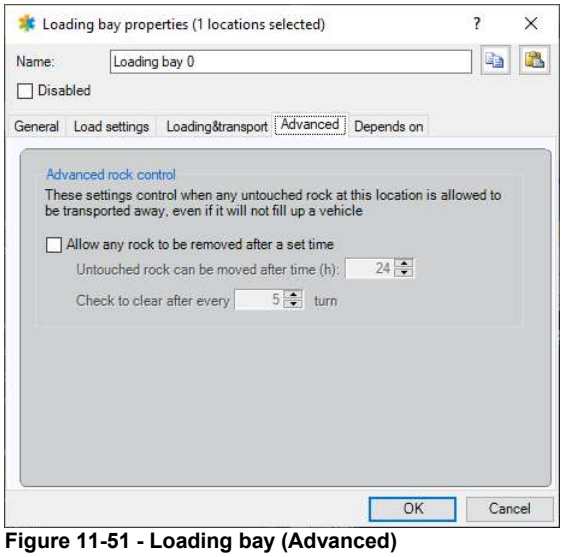


Figure 11-51 - Loading bay (Advanced)

This tab allows the user to specify how often the loading bay shall be emptied if no activity has been reported on it.
In SimMine, a truck or loader will only take work at a location if it can fill its box or bucket. If a location contains a small amount, which doesn't fill a box or bucket, no one will be assigned work at the location. Since a loading bay cannot have both ore and waste, such a situation can prohibit a different rock type to be transported. Therefore, these settings allow the location to be emptied.

UNTOUCHED ROCK CAN BE MOVED AFTER TIME X

This sets a time limit for when untouched rock can be moved from this location, even if it won't fill up a box or bucket. The time counter starts whenever rock is dumped or fetched from the location

CHECK TO CLEAR AFTER EVERY X TURN

This setting is a setting which releases some CPU utilization, and isn't a setting aimed for the simulation itself. Whenever rock is added or fetched, a check is made for if the time counter will be restarted until the location will be cleared. This forces this check so that it is done only every X time when rock is touched in the location.

11.8.3.5 Depends on tab

This is described in the Depends on settings on page 228.

11.8.4 Cement station object

The cement station object is a location where cement trucks (agitators) are refilled. This object is only required when it exist at least one cement truck which hasn't an unlimited capacity. This cannot receive nor produce any rock. Its main functionalities are:

- Breakdowns
- Simple work schedule.
- Fill speed when filling trucks.
- Support for several types of cement.

Its property box holds multiple tabs.

11.8.4.1 General tab

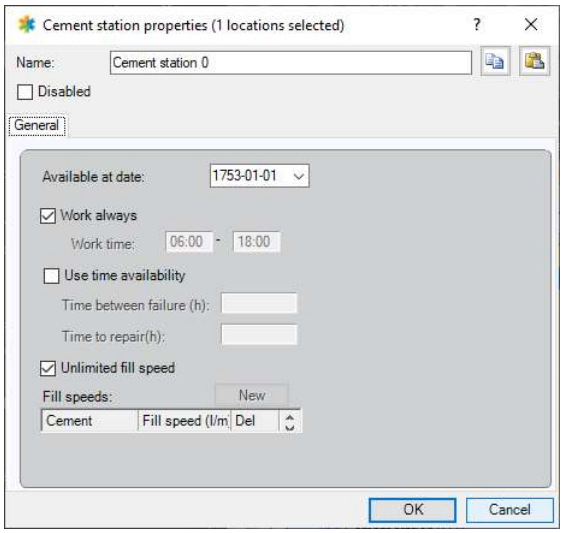


Figure 11-52 - Cement station (General)

AVAILABLE AT DATE

This date is the earliest date this location can become available. Default value is the minimum start date possible, which means that a normal simulation which is run in present time, will activate this location as soon as possible.

WORK ALWAYS CHECK BOX

This checkbox tells if the cement station shall work always – i.e. load cement onto trucks whenever they need it, or when unchecked, the times during which this location is allowed to work.

AVAILABILITY SETTINGS

This has settings to control time-based breakdowns of the location. When the location breaks down, it cannot fill cement trucks.

UNLIMITED FILL SPEEDS CHECK BOX

This setting allows any truck to be filled instantly. When unchecked, the fill speeds for different types of cement are entered in the table below.

FILL SPEEDS TABLE

This table holds the different fill speeds for different types of cement. To add a new cement type, click the "New" button above the table. This button will not be enabled unless "Unlimited fill speed" check box is unchecked.

11.8.5 Top transfer pass

The top transfer pass is a load point for a transfer pass (ore or waste). It can only receive rock.
A top transfer pass can represent many objects in a mine simulation which can receive rock and transfer the rock further to another object.
Its main functionalities are:

- Capacity of the transfer pass, from its end location to itself
- The end location to which all incoming rock is transferred.
- Mine area which it belongs to

Its property box holds multiple tabs.

11.8.5.1 General tab

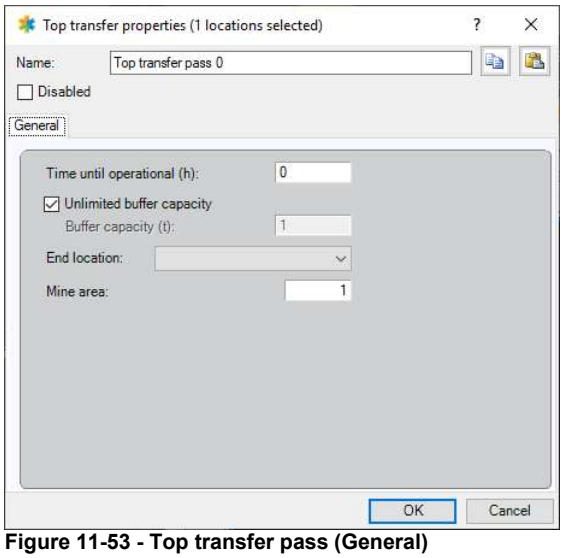


Figure 11-53 - Top transfer pass (General)

TIME UNTIL OPERATIONAL

This is the time from the moment it gets available in the layout and until the location becomes operational. When the location is operational, ore or waste can be dumped in it. If the location is available in the layout at simulation start, this time is not counted.

CAPACITY SETTINGS

This defines the total capacity, from its end location to itself.

END LOCATION

Drop down menu with available end locations. The available end locations are any location which can receive rock, plus a chute

MINE AREA

Which mine area it belongs to

11.8.6 Backfill plant location

This location is used when backfill shall be simulated. It is the only location which can create backfill material. It transports the backfill material to a backfill recipient locations.

Its main functionalities are:

- Production speed
- Number of simultaneous trucks or loaders which can be loaded
- Automatic fill properties

Its property box holds multiple tabs.

11.8.6.1 General tab

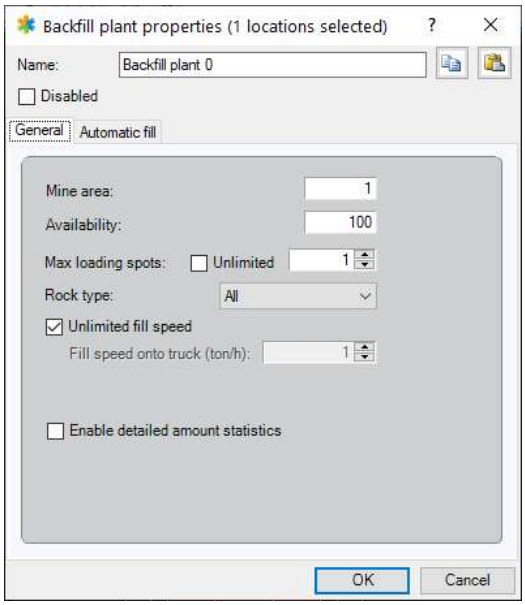


Figure 11-54 - Backfill plant (General)

MINE AREA

Which mine area it belongs to

AVAILABILITY

The availability of the object, which is the percentage of its total time it will be available for work.

LOADING SPOT SETTINGS

These are the number of loading spots, which affects the number of vehicles which can be loaded at the same time

ROCK TYPE

The rock type this creates as backfill. A backfill recipient can then set which rock type it accepts. In this way, certain backfill plants can only create backfill for certain backfill recipients.

FILL SPEED SETTINGS

These controls the speed at which this fills backfill onto a truck.

ENABLE DETAILED AMOUNT STATISTICS

This enables/disabled collection of detailed amount statistics for how much this location has hauled to backfill recipients. Both automatic amount, and amount transported by vehicle are counted.

11.8.6.2 Automatic fill tab

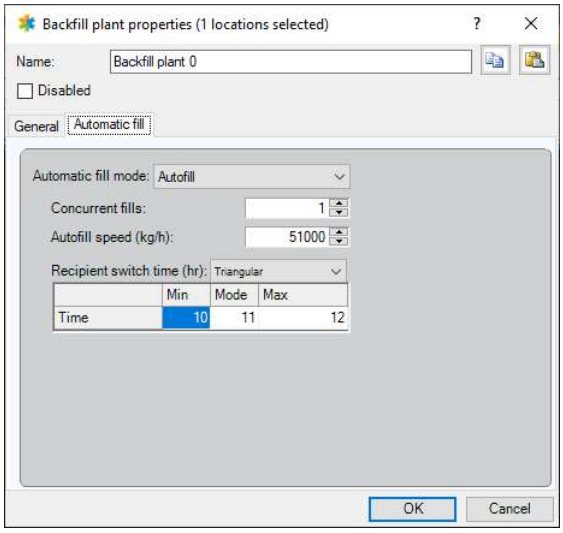


Figure 11-55 - Backfill plant (Automatic fill)

AUTOMATIC FILL MODE LIST

Holds if this supports autofill mode (i.e. that recipients can be filled automatically, without the need for a vehicle)

CONCURRENT FILLS BOX

The maximum amount of concurrent automatic fills that this plant support.

AUTOFILL SPEDD

The speed at which automatic fill is done. This setting is for each concurrent automatic fill, which means that if there are three automatic fills done at the same time, the total speed is three times this amount

RECIPIENT SWITCH TIME GRID

The time it takes to change the destination for automatic fills. This does only count after a finished automatic fill. It means that the first recipient that requests automatic fill does not get any time penalty. This is the time from the point when one automatic fill is complete, and until the next can commence. If several concurrent automatic fills is set, this time is for each fill channel.

11.8.7 Backfill recipient location

This location can only receive backfill, which either is waste or backfill material created by a backfill plant location.
Its main functionalities are:

- Set a rock type which it is allowed to receive

- Specify if it can be automatically filled
- The required amount of backfill
- Specify which backfill methods shall be used.

Its property box holds multiple tabs.

11.8.7.1 General tab

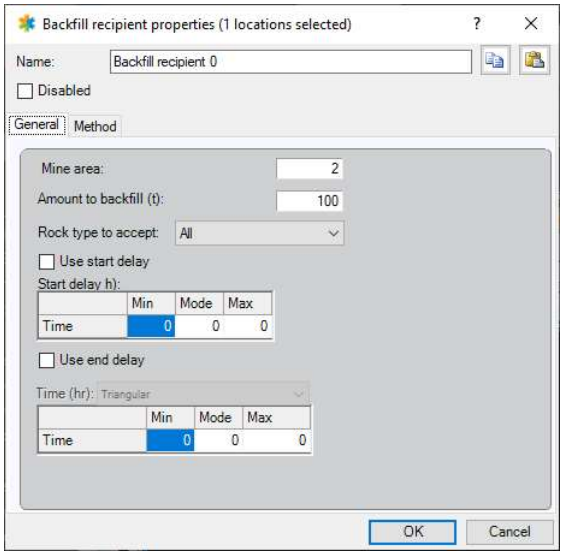


Figure 11-56 - Backfill recipient (General)

MINE AREA
Which mine area it belongs to

AMOUNT TO BACKFILL
Holds the amount that this object requires to be completely backfilled. When this amount has been dumped into this location, it is done and doesn't need any more backfill.

ROCK TYPE TO ACCEPT
The rock type that this location will accept. This is used to control from which backfill plant the backfill shall be taken. If multiple backfill plant exist, each backfill plant can be set to produce a specific rock type (treated as backfill). If the accepted rock type doesn't comply with a rock type produced by a backfill plant, that backfill plant won't be used to create backfill for this location. This is only used when the backfill method is set to paste fill (see the next tab)

START DELAY SETTINGS
Sets how long time it takes from the point when this location becomes available in the layout and until it will start to request backfill.

END DELAY SETTINGS
Sets how long time it takes from the point when this has been completely backfilled, and to the time when it is reported as completely done. This will affect any section or object which depends on this to become done.

(section/object dependencies, see Depends on settings on page 228 for more information)

11.8.7.2 Method tab

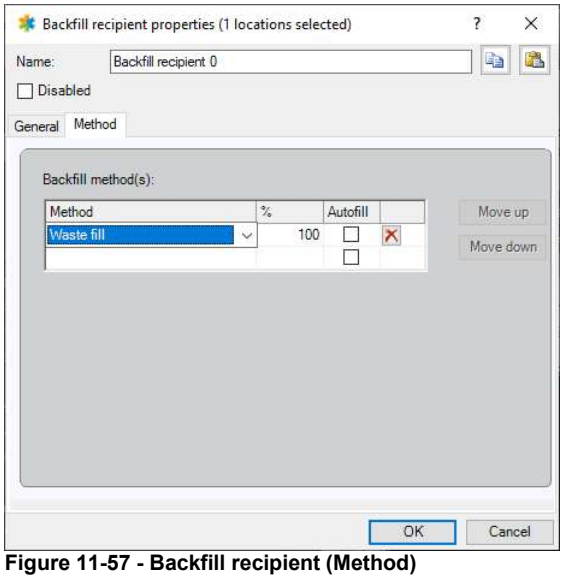


Figure 11-57 - Backfill recipient (Method)

BACKFILL METHODS

Holds which methods that shall be used to fill this location. It can hold multiple methods, in which each method is done in sequence. When backfilling is completed for one method, it will move to the next. This table has the following columns:

- Method – the backfill method, which can be either Waste or paste fill. When it is set to Waste, waste can be taken from anywhere in the mine. Paste fill requires a backfill plant.
- % - The percentage amount of the full amount (from the first tab), that this method will be used.
- Autofill – If the amount shall be automatically filled or not. When not autofill, trucks are required. This option is only used for paste fill method.
- Remove – removes the method.

11.8.8 Production object (for basic production)

This location is used for simple setup for production where its main purpose is to create rock. It only provides simple controls for specifying the rock to produce.

Its main functionalities are:

- Set a rock type to produce
- Specify a very simple schema for production
- Set how the produced rock will be hauled

Its property box holds multiple tabs.

11.8.8.1 General tab

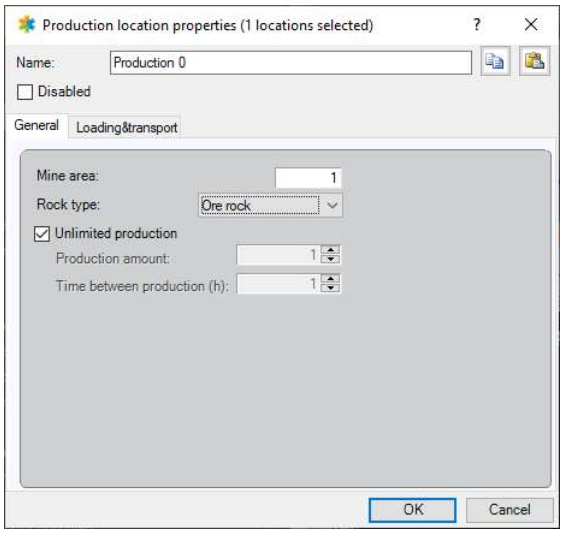


Figure 11-58 - Production (general)

MINE AREA
Which mine area it belongs to

ROCK TYPE
The rock type this will produce

PRODUCTION AMOUNTS SETTING
It can wither set to produce unlimited amount (to have a source with unlimited amount to test the transport capacity for example), or a production which produces a set amount at even intervals.

11.8.8.2 Loading and transport tab

This hold controls for how the loading and transport from this location shall be done. The loading and transport settings are described in Loading and transport properties on page 228.

11.8.9 Production plan object

This location is used for specifying a production plan, which will create rock at specific times and for specific amounts.
Its main functionalities are:

- Set one or more rock types to produce
- Specify the amounts and at which time to produce the rock
- Can specify loading and transport parameters for how the rock will be transported

Its property box holds multiple tabs.

11.8.9.1 General tab

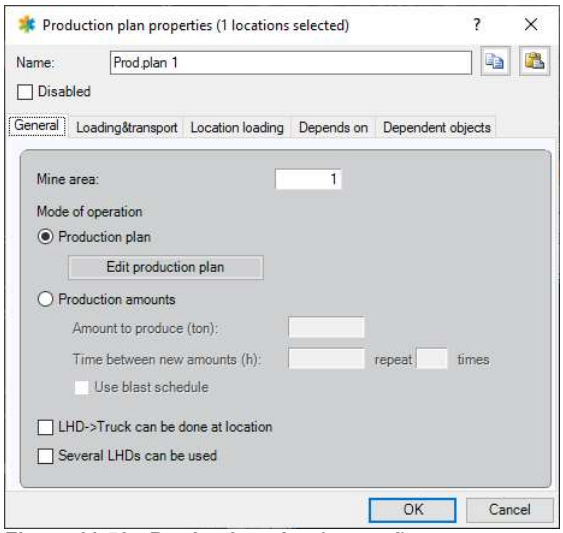


Figure 11-59 - Production plan (general)

MINE AREA
Which mine area it belongs to

MODE OF OPERATION
The production or rock can be done according to one of two production methods.

PRODUCTION PLAN SETTINGS
The production plan can be reached through the ***Edit production plan*** button. It is only available when mode of operation is set to ***Production plan***.

PRODUCTION AMOUNTS SETTING
When mode of operation is Production amounts, a simple production plan can be specified which produces a single rock type, at even intervals, with a fixed amount each time. The produced amount can be set to be produced during a limited time only.

LHD->TRUCK CAN BE DONE AT LOCATION
When loading and transport method is set to Loader to Truck (in the Loading and transport tab), the truck can be set to be loaded at either its default location, which is the closest intersection, or at a specific location. When it shall be loaded at the nearest intersection, this checkbox will override its setting so that the truck will drive all the way to this location to be loaded.

SEVERAL LHDS CAN BE USED
This allows multiple loaders to load from this location at once.

11.8.9.2 Loading and transport tab
This hold controls for how the loading and transport from this location shall be done. The loading and transport settings are described in Loading and transport properties on page 228.

11.8.9.3 Location loading tab

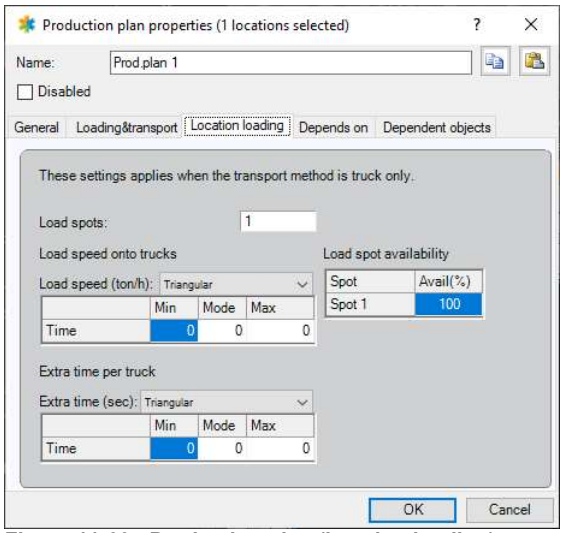


Figure 11-60 - Production plan (location loading)

These settings are used if loading and transport method is truck only. These settings then control how long time it takes for the truck to get fully loaded.

LOAD SPOTS

The number of load spots this location has. This controls how many trucks that can be loaded simultaneously.

LOAD SPEED ONTO TRUCK SETTINGS

This specifies the speed of loading, which is ton/h.

EXTRA TIME PER TRUCK SETTINGS

This allows an extra time per truck to be set. The extra time is a time in addition to the load time. This will occur simultaneously independent of the number of load spots if several trucks work at this location.

LOAD SPOT AVAILABILITY

This controls the availability of a load spot. When a load spot becomes unavailable, no truck can be loaded for that load spot. When all load spots are unavailable, no truck can work at the location.

11.8.9.4 Dependency tabs

This holds which object this depends on, or is dependent upon. Its functionality and usage are described in Depends on settings on page 228.

11.8.10 Chute object

The chute is an object which resides at the bottom of a shaft. It shall be connected to another location which can receive rock. Any rock received by a connected location will come to the chute. The connection to other locations is done in the property dialog for the other locations. Not all location types can be connected to a chute.
Its main functionalities are:

- Connected with one or more locations which can receive rock.
- Can operate according to a schedule

- Can use availability
- Can set a limited amount it is allowed to receive during a specific period.

Its property box holds multiple tabs.

11.8.10.1 General tab

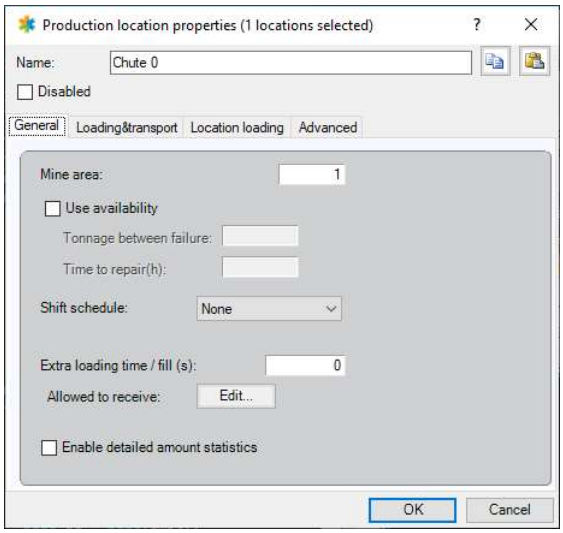


Figure 11-61 - Chute (General)

MINE AREA
Which mine area it belongs to

AVAILABILITY SETTINGS
Controls the availability of the chute. When it breaks down, rock can still be added, but no one can work at it to haul rock from it.

SHIFT SCHEDULE
When set, it specified during which hours the chute is operational. When it is not operational, no one can work at it, but it can still receive rock.

EXTRA LOADING TIME
This is the amount of extra time each fill will take. This is in addition to any extra time or fill time specified in the Location loading tab, which is the place where load time is specified.

ALLOWED TO RECEIVE BUTTON
This opens up a dialog box where you can set how long time, and from where that this location is allowed to receive rock from. It allows the user to set that a may be allowed to receive waste during certain times, and ore during other times.

ENABLE DETAILED AMOUNT STATISTICS
This enables the collection of statistics for detailed amounts. Its statistics can then be viewed in the LT_Statistics tab (see Detailed loading and transport statistics on page 169 for more information regarding detailed amount statistics)

11.8.10.2 Loading and transport tab

This hold controls for how the loading and transport from this location shall be done. The loading and transport settings are described in Loading and transport properties on page 228.

11.8.10.3 Location loading tab

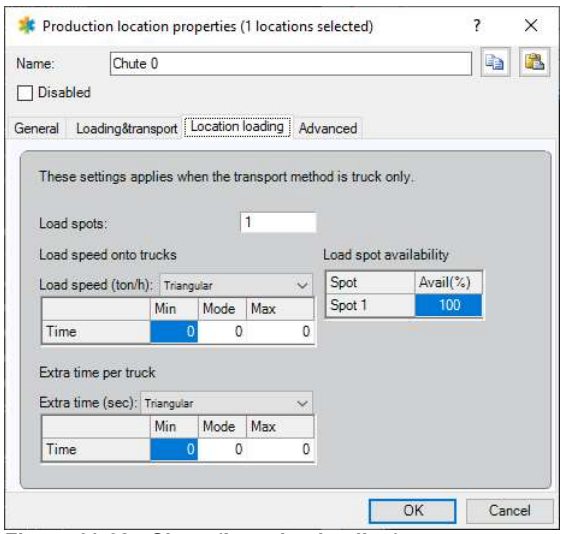


Figure 11-62 - Chute (Location loading)

These settings are used if loading and transport method is truck only. These settings then control how long time it takes for the truck to get fully loaded. Its functionality is the same as for the production location, which is described at page 246.

11.8.10.4 Advanced tab

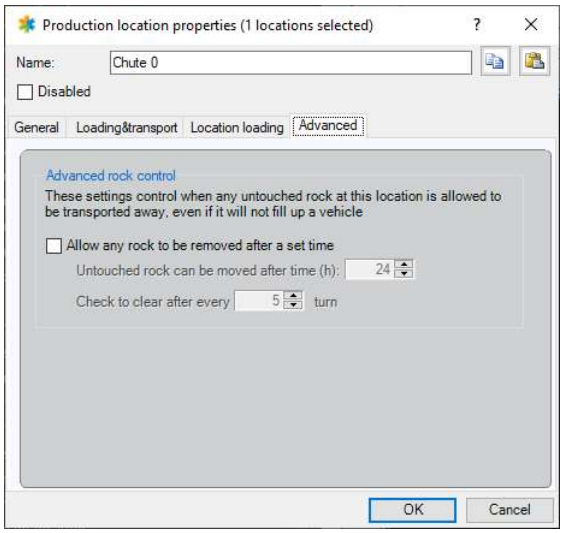


Figure 11-63 - Chute (Advanced)

This tab allows the user to specify how often the location shall be emptied if no activity has been reported on it.
In SimMine, a truck or loader will only take work at a location if it can fill its box or bucket. If a location contains a small amount, which doesn't fill a box or

bucket, no one will be assigned work at the location. Since a loading bay cannot have both ore and waste, such a situation can prohibit a different rock type to be transported. Therefore, these settings allow the location to be emptied.

UNTOUCHED ROCK CAN BE MOVED AFTER TIME X

This sets a time limit for when untouched rock can be moved from this location, even if it won't fill up a box or bucket. The time counter starts whenever rock is dumped or fetched from the location

CHECK TO CLEAR AFTER EVERY X TURN

This setting is a setting which releases some CPU utilization, and isn't a setting aimed for the simulation itself. Whenever rock is added or fetched, a check is made for if the time counter will be restarted until the location will be cleared. This forces this check so that it is done only every X time when rock is touched in the location.

11.8.11 Production main object

The production main object is a location for long hole drilling production methods. It can be used stand-alone or connected with a Production secondary object.
Its purpose is to perform one or more production activity cycles, which works in the same manner as for development, with the difference that no face drilling activity is allowed, and instead a long hole drilling activity can be used.
It can create rock from its production, which can then be handled be trucks and loaders.

11.8.11.1 General tab

This shows general settings for the main production location.

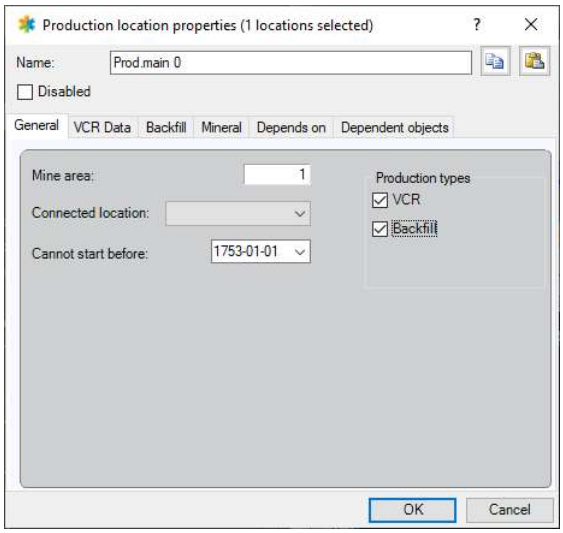


Figure 11-64 - Production main (General)

MINE AREA

Which mine area it belongs to

CONNECTED LOCATION DROPDOWN LIST

This is which secondary production location this is connected to. The main production location can be stand-alone (without any connected secondary locations). When it is connected to a secondary location, activities can be specified to be done in parallel and also where they shall be performed (main or secondary).

CANNOT START BEFORE TEXTBOX

This is the time when this location is allowed to commence its operation. If this is earlier than the start simulation time, it can commence its operations directly, assuming that it is available in the layout.

PRODUCTION TYPES CHECKBOXES

These checkboxes assign which production that shall be done at the location. When a check box is checked, a new tab for that production method will show up in the property box.
VCR (Vertical Crater Retreat) sets that a long hole drilling production shall be done.
Backfill – Backfilling shall be done.

11.8.11.2 VCR tab

This tab contains VCR production settings and is only visible if the VCR checkbox in the general tab has been checked.

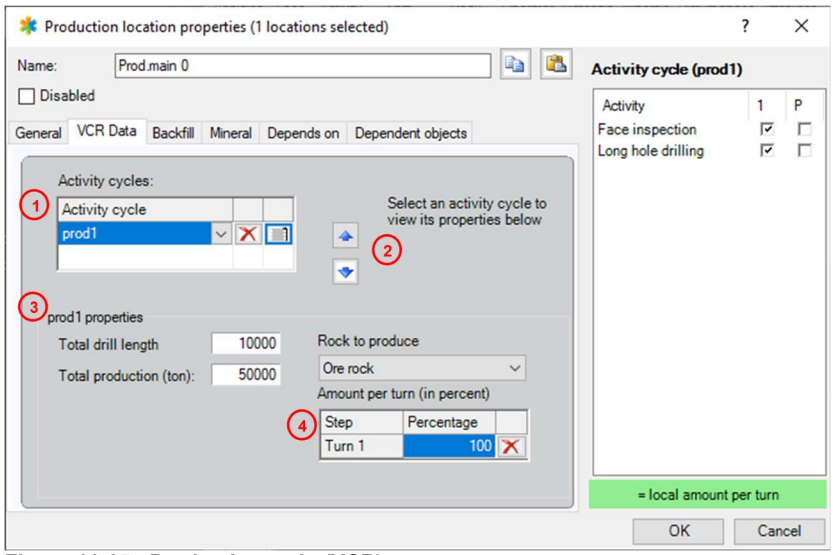


Figure 11-65 - Production main (VCR)

This tab holds properties for the long hole drilling production method.

ACTIVITY CYCLES LIST (1)

These are the activity cycles that shall be done at the location. Each cycle is done in turn – when the first cycle is completed, the second cycle can start. When all cycles are completed, the location is completed (no more work at the location). The activity cycles which can be selected among are activity cycles defined as Production activity cycles (see Activity cycles on page 60 for more information)

UP/DOWN ARROWS

This will move the selected activity cycle from table (1) up or down.

ACTIVITY CYCLE PROPERTIES (3)

This holds all properties for the selected activity cycle from list (1). It contains:

- Total drill meters – This is the total drill meters that shall be done for long hole drilling for the selected cycle
- Total production – This is the tonnage that will be created from the blast in the selected cycle.
- Rock to produce – This is the rock which will be produced during a blast
- Amount per turntable – This table holds the amount per turn for the cycle. The cycle will be performed once for each row in this table. When this only holds one entry (100%), the cycle will be done once.

AMOUNT PER TURN TABLE (4)

This specified how much of the full cycle which will be performed at each round. If this only contains one row, with 100%, the cycle will be done in one round. If multiple entries are specified, with for example 60% and 40%, the cycle will be done twice. The first round, it will be done 60% of its stated drilling/production, and the second time, it will do the remaining 40%.
The sum of all entries in this table must be 100%.

ACTIVITY CYCLE CONTENT

The list to the right shows the activities in the currently selected activity list from list (1). This part can be shown/hidden by clicking the list symbol at each row in the activity cycle table (1).

11.8.11.3 Backfill tab

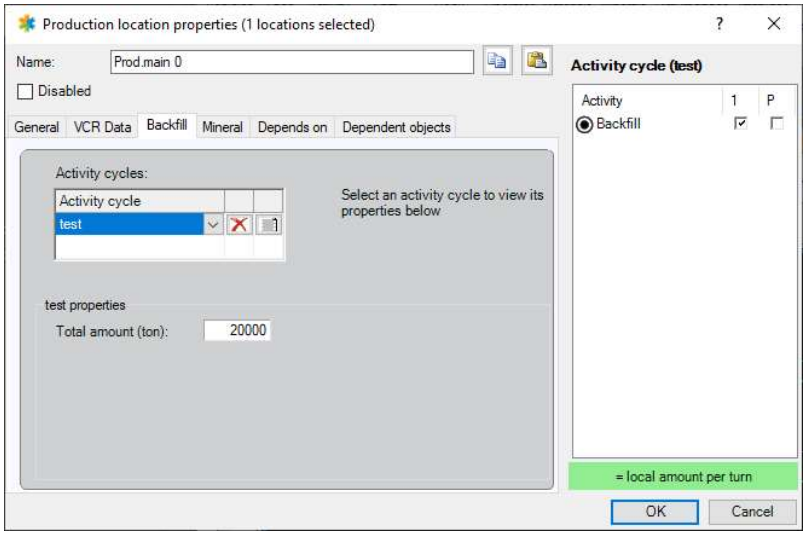


Figure 11-66 - Production main (backfill)

This tab holds properties for backfilling and will only show if Backfill is checked in the General tab

ACTIVITY CYCLES LIST

These are the activity cycles that shall be done at the location. Each cycle is done in turn – when the first cycle is completed, the second cycle can start. When all cycles are completed, the location is completed (no more work at the

location). The activity cycles which can be selected among are activity cycles defined as Production activity cycles (see Activity cycles on page 60 for more information)

BACKFILL PROPERTIES

This contain the amount to be backfilled and shows the properties for the currently selected activity cycle from the activity cycle list. Its properties will only be enabled when the selected activity cycle contain a backfill activity.

ACTIVITY CYCLE CONTENT

The list to the right shows the activities in the currently selected activity list from the activity cycle list. This part can be shown/hidden by clicking the list symbol at each row in the activity cycle list table.

11.8.11.4 Mineral tab

This shows which minerals that this location contains. It will result in mineral statistics that can be seen in the Mineral statistics tab on page 180. Its functionality is the same as described for a section and can be viewed in Mineral tab, section on page 225.

11.8.11.5 Dependency tabs

This holds which object this depends on, or is dependent upon. Its functionality and usage are described in Depends on settings on page 228.

11.8.12 Production secondary object

The production secondary object is a location for long hole drilling production methods. It can only be used connected with a Production main object and doesn't have its own properties.
Production secondary object have the same properties as the Production main object it is connected with.

11.8.13 Silo object

This object can receive and store rock. It can then be served by an LHD to be emptied. It reassembles the loading bay, even though it has some extra functionality not found at a loading bay.
Its main functionalities are:

- Unlimited / limited capacity
- Any incoming rock can be transferred directly to another location.
- Loading properties for how the rock is loaded and transported from it.

11.8.13.1 General tab

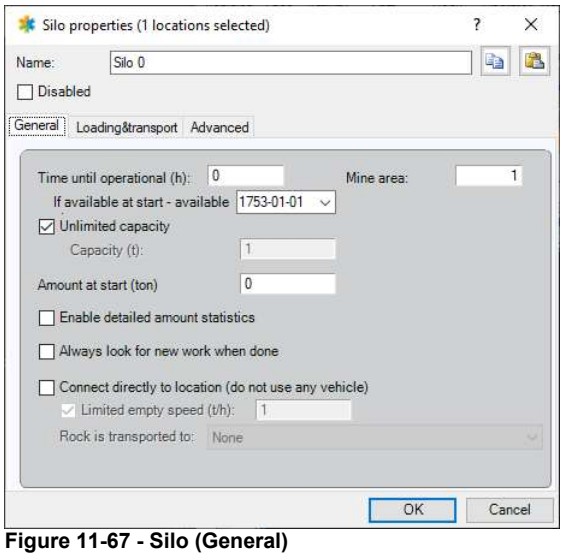


Figure 11-67 - Silo (General)

MINE AREA
Which mine area it belongs to

TIME UNTIL OPERATIONAL
The time, from the point when it becomes available in the layout and until it can start to accept rock. If the location is available in the layout at start of the simulation, it will become available at once, if the earliest start date isn't set

EARLIEST START DATE
This is the date at which it can earliest become available.

CAPACITY SETTINGS
The capacity for the silo.

AMOUNT AT START SETTING
This is the amount this silo contains at start of the simulation.

ENABLE DETAILED AMOUNT STATISTICS
This enables/disables detailed amount statistics to be collected for this object, which can be used to analyze the haulage in more detail. See Detailed loading and transport statistics on page 169 for how to analyze the detailed amount statistics.

ALWAYS LOOK FOR NEW WORK WHEN DONE CHECKBOX
When this is checked, any loader working here will check for new work after each scoop. In normal cases, when a loader has work, it will continue until that location has become empty. This allows it to look for better work more frequently. When it is loading onto a truck, it will fill the truck before looking for other work.

CONNECT DIRECTLY TO A LOCATION SETTINGS

When this is checked, the silo will transfer all its rock to a connected location. It will in this case not require any vehicle. As long as the destination location has free capacity, it will transfer any rock directly to it.

11.8.13.2 Loading and transport tab

This hold controls for how the loading and transport from this location shall be done. The loading and transport settings are described in Loading and transport properties on page 228.

11.8.13.3 Advanced tab

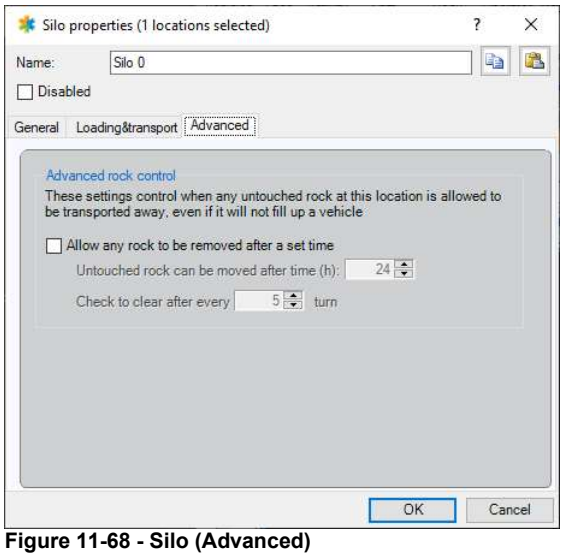


Figure 11-68 - Silo (Advanced)

This tab allows the user to specify how often the location shall be emptied if no activity has been reported on it.
In SimMine, a truck or loader will only take work at a location if it can fill its box or bucket. If a location contains a small amount, which doesn't fill a box or bucket, no one will be assigned work at the location. Since a loading bay cannot have both ore and waste, such a situation can prohibit a different rock type to be transported. Therefore, these settings allow the location to be emptied.

UNTOUCHED ROCK CAN BE MOVED AFTER TIME X

This sets a time limit for when untouched rock can be moved from this location, even if it won't fill up a box or bucket. The time counter starts whenever rock is dumped or fetched from the location

CHECK TO CLEAR AFTER EVERY X TURN

This setting is a setting which releases some CPU utilization, and isn't a setting aimed for the simulation itself. Whenever rock is added or fetched, a check is made for if the time counter will be restarted until the location will be cleared. This forces this check so that it is done only every X time when rock is touched in the location.

11.8.14 Conveyor object

This object is either the end location at a conveyor, or a spot along the conveyor where new rock can be loaded onto it (either the conveyor's start location, or a location in the middle of the conveyor). The conveyor's end location can be connected directly to other recipients, like another conveyor or a crusher.
Its main functionalities are:

- Unlimited / limited capacity in form of amount of rock at the conveyor
- Shift schedule for work hours of the conveyor
- Set which object will receive the transported rock when it comes to the end of the conveyor.
- Speed settings for conveyor belt.
- Availability

11.8.14.1 General tab

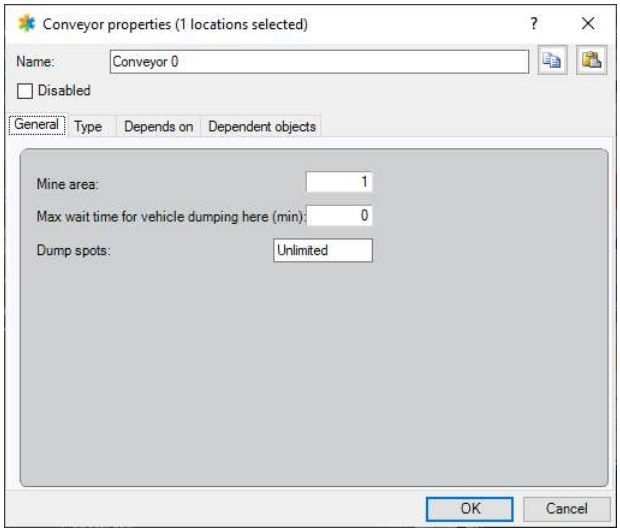


Figure 11-69 - Conveyor (General)

MINE AREA

Which mine area it belongs to

MAX WAIT TIME FOR VEHICLE DUMPING HERE

The maximum time a vehicle can wait to dump onto the conveyor. When this time has passed, the vehicle will search for another dump location or return the rock to where it loaded it from if no destination is found.

DUMP SPOTS

The number of dump spots at this location. This defines how many vehicles that can dump into this location at the same time.

11.8.14.2 Type tab

In the type tab, the conveyor type is set, which guides if this is the end location, or a dump location along a conveyor. Only the end location can define the speed and other common properties for the conveyor. The available properties differ depending which type of conveyor location it is set to be.

11.8.14.2.1 Start conveyor location

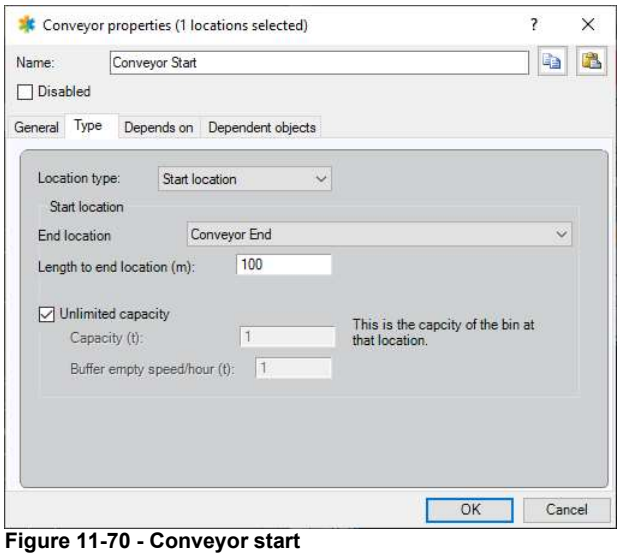


Figure 11-70 - Conveyor start

LOCATION TYPE DROPDOWN LIST

Contains the type of conveyor. In this case a start location where rock can be dumped

END LOCATION

The end location this is connected with. This list contains all conveyor locations which are set as end locations, or which are unconfigured.

LENGTH TO END LOCATION

The length to the end location. This, in combination with the speed of the conveyor affects the time until any dumped rock will enter the end location. The conveyor speed is set for an end conveyor type.

CAPACITY SETTINGS

The capacity for this location only, such as a small buffer at the dump spot. This is not the conveyor capacity. When this becomes full, this spot stops to accept any more incoming rock.

11.8.14.2.2 End conveyor location

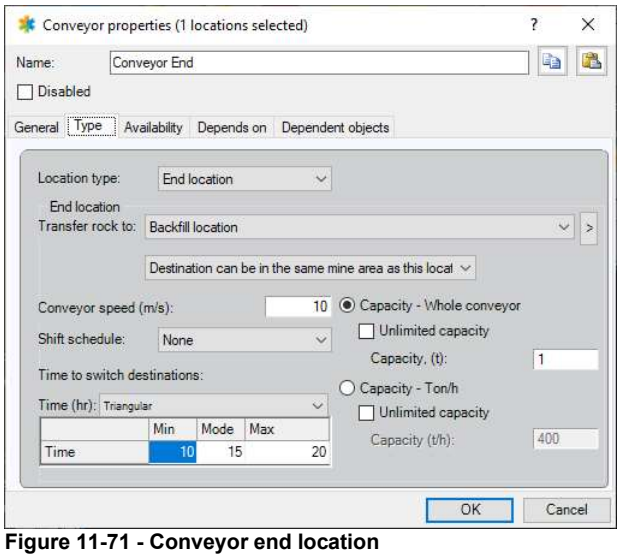


Figure 11-71 - Conveyor end location

LOCATION TYPE DROPDOWN LIST

Contains the type of conveyor. In this case an end location where rock can be dumped into, and also transfer any incoming rock further.

TRANSFER ROCK TO CONTROLS

This holds the location where the rock shall be transferred to, as well as controls to specify rules for the transfer to-location. Valid transfer-to locations that can be set here are :

- Crushers
- Silos
- Nearest destination
- Nearest Backfill recipient

A generic destination for any “Backfill recipient” can also be set. When a generic transfer-to location is selected, some additional rules for how the transfer-to location is selected can apply. A more in-depth description of how the transfer-to location is selected is described at Direct transfer of rock properties on page 287. When the location to transfer rock to becomes unavailable, the conveyor stops. Any conveyor start location will still be able to receive rock until its maximum capacity is reached. When a generic destination is selected, a switch to another transfer-to location is done when the current one becomes done (i.e. no more work at it). When a switch is commenced, it will takes bit of time until the conveyor can start to transfer rock to the next destination according to the switch time settings.

CONVEYOR SPEED

The speed of the conveyor, which affect the time until dumped rock at a start conveyor location will reach the end conveyor location.

SHIFT SCHEDULE

A shift schedule which the conveyor will work according to. When the shift time is off shift or meal break, the conveyor will stop to transport rock. Its connected conveyor start locations will still accept rock until their incoming buffers has reached their maximum capacity.

CAPACITY SETTINGS

There are two capacity settings methods you can use:

- Method 1, which allows you to specify the total capacity in tons for the whole conveyor. When this capacity is reached, the conveyor doesn't allow any more rock onto the conveyor until it has been transferred to the next location.
- Method 2, which sets the capacity as ton/h. The maximum conveyor capacity is then calculated based on speed, length and this setting. When the maximum conveyor capacity the conveyor doesn't allow any more rock onto the conveyor until it has been transferred to the next location.

TIME TO SWITCH DESTINATION SETTINGS

Whenever the current destination which rock is transferred to becomes done and requires no more work, a time to switch to the next destination commences. Until that time has passed, no more rock can be transferred from the conveyor. Even if no destination is currently available when the switch time commences, a destination will still be selected as soon as the switch time has passed.

11.8.14.3 Availability tab

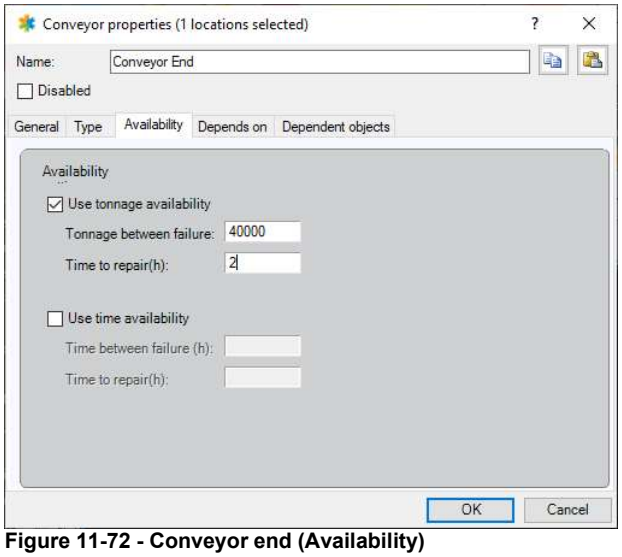


Figure 11-72 - Conveyor end (Availability)

This tab is only visible when the conveyor type is set to an end conveyor in the ***Type*** tab.

AVAILABILITY SETTINGS

The availability settings here will cause the whole conveyor to stop working. When this happens, its connected conveyor start locations will still accept rock until their incoming buffers has reached their maximum capacity. Availability can be set as based on tonnage transported and/or time based (i.e. it can break down even if no rock is transported).

11.8.14.4 Dependency tabs

This holds which object this depends on, or is dependent upon. Its functionality and usage are described in Depends on settings on page 228.

11.8.15 Workshop object

This object is the location where vehicles can be repaired in. When a vehicle breaks down, it can either be repaired at the face, or in a workshop. This is controlled by the REPAIR IN WORK SHOP CHANCE
Setting, described on page 264. When no work shop exist in a layout, the vehicle will not go anywhere when it becomes broken. However, if its settings tell it to be repaired in a workshop, it will release the face or work location, but not travel anywhere.

11.8.15.1 General tab

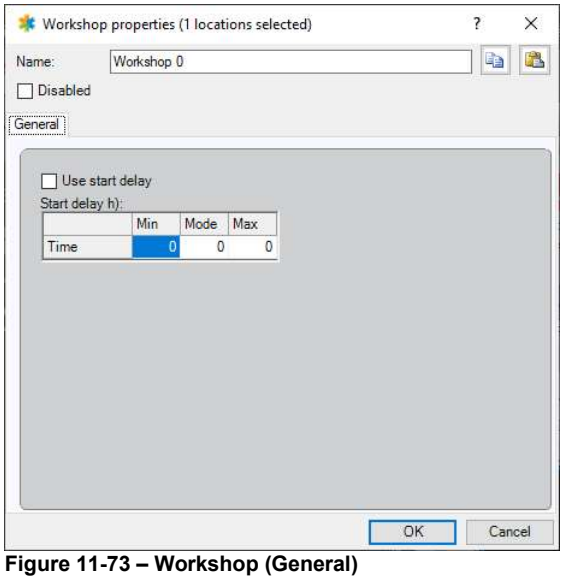


Figure 11-73 – Workshop (General)

START DELAY SETTINGS
This is the time from the point when it becomes available in the mine layout and until it can be in operation.

11.8.16 Meeting point object

This object acts as a meeting spot. When it is placed in the layout, vehicles are allowed to meet at it. The meeting spot functionality will only affect the simulation if the section's meeting settings are set as ***At intersections only***. See MEETING MODE
on page 220 for information about meeting settings for a section.

11.8.16.1 General tab

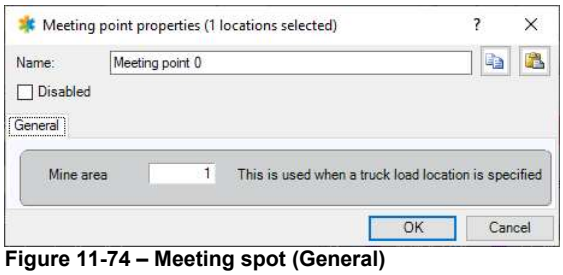


Figure 11-74 – Meeting spot (General)

MINE AREA

Which mine area it belongs to. This is used when the meeting spot is used as a truck load location. In this case, the settings for loading and transport can specify that the truck loading location must be in a specific mine area, which is this setting. When the meeting spot acts as a normal meeting spot, this is not used.

11.9 Vehicle properties

Vehicle properties does not have a property window. They are directly changeable through the properties to the right in the Fleet input form. There are two sets of properties:

- Basic properties visible in the grid in the fleet form
- Additional properties visible when the vehicle has been selected in the Fleet form.

The part will list and describe the properties shown when a vehicle is selected. Each vehicle has similar properties shown. For some vehicles, there exists vehicle specific properties. The example below shows the properties shown when a drill rig is selected:

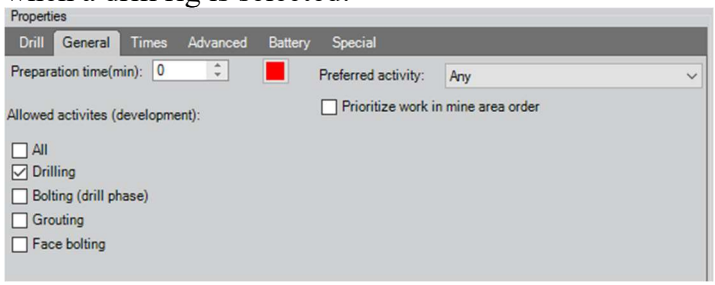


Figure 11-75 - Vehicle properties

The properties contain multiple tabs according to:

- A vehicle specific property page (in the figure above it is named ***Drill*** for the drill rig.
- General – General settings which handles setup time and which activities the vehicle is allowed to perform.
- Times – The activity times for the allowed activities
- Advanced – more advanced settings
- Battery – Properties for battery operated vehicles. For diesel vehicles, this tab is not used.
- Times (prod) – Activity times for allowed production activities

11.9.1 General properties

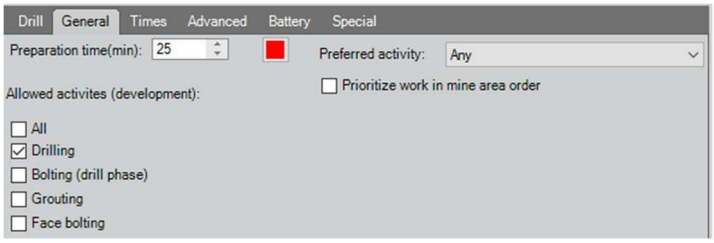


Figure 11-76 - General vehicle properties

PREPARATION TIME

This is the preparation time, which is the from when the vehicle arrives to the work location, and until it can commence working.

COLOR BUTTON

This allows you to set a color on the vehicle. The vehicle will be displayed as a cube with the set color.

ALLOWED ACTIVITIES (DEVELOPMENT)

This shows all activities which the vehicle can perform. A checkbox in any of these activities allows the vehicle to perform the activity. The time to perform each of the allowed activities is done in the ***Times*** tab

ALLOWED ACTIVITIES FOR PRODUCTION (NOT VISIBLE)

This works in the same manner as for allowed activities for development but shows only activities for production. This is not visible in the above figure. It will only be visible if a license for production is available, and if the vehicle can perform production activities

PREFERRED ACTIVITY DROPDOWN LIST

With this, it is possible to select a preferred activity. When two or more faces with the same priority is available for work, the vehicle will first select the activity which is preferred.

PRIORITIZE WORK IN MINE AREA ORDER CHECKBOX

With this, it is possible to specify in which order work is searched. This has no effect for vehicles which can work in all mine areas, or that only one mine area is specified. When multiple mine areas are specified (in the vehicle list, described in Change basic properties for a vehicle on page 140), When the order in which the allowed mine areas are specified, becomes the order in which available work is searched in

11.9.2 Work times properties

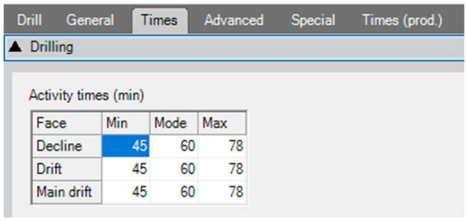


Figure 11-77 – Activity times properties

ACTIVITY TIMES GRID

This grid holds the time to perform a certain activity. For each allowed activity (from ***General*** tab), a corresponding section exist under this tab. In the figure above, this is for Drilling, which means that the table contains activity times for drill activity. The parts in the activity times above are

- A caption, which tells if the times in the table is per meter or not. When it states that the times are per meter, the total activity times depends on how many meters has been done.
    - Example: If a drill rig has drilled a 4-meter round, and the bolter arrives. Its times states that it will take 30 minutes per length meter. The total time in this case will then be 4*30 minutes = 120 minutes.
- The table contain several rows, one row for each possible face profile. A face profile is assigned to a section in the layout. When the drill rigs whose properties are shown in the above figure, will start to work at a section, it looks which face profile is assigned. It then uses the times for that face profile from the activity times table above.
- Columns in the grid. These holds which values each column will hold and depends on the current work time distribution selected in the ***General settings*** tab. See General settings tab on page 79

11.9.3 Advanced properties

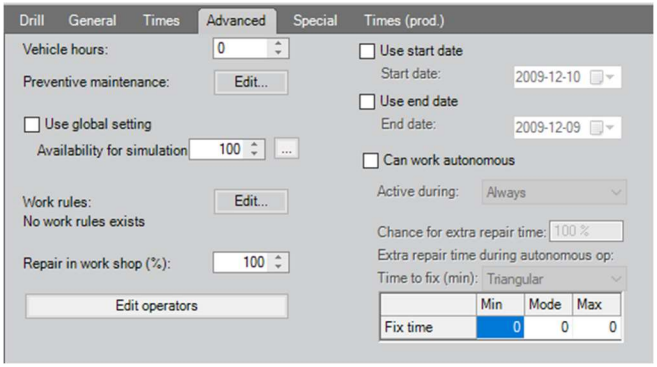


Figure 11-78 – Advanced properties

VEHICLE HOURS

This allows the user to specify the current amount of engine hours for the vehicle. This can affect the current mechanical availability and preventive maintenance settings if they are set to depend on vehicle hours.

PREVENTIVE MAINTENANCE BUTTON

This opens up the settings for preventive maintenance. See Preventive maintenance (PM) on page 280

Availability for simulation settings

The availability for simulation allows the user to configure that the vehicle can be unavailable from time to time. Here it can be specified that the global value for this availability shall be used, or that a locally specified setting shall be used. The Availability for simulation setting is described Availability for simulation setting on page 200

Work rules button

This opens up the settings for work rules, where it can be specified how long time before a break the vehicle need to work before being assigned to a work location. I.e. if there will only be a small amount of time before a lunch break or off shift period, the vehicle may not be assigned to the work if these rules are set.

Repair in work shop chance

This holds the chance that when a breakdown of the vehicle occurs, that the vehicle will be repaired in a workshop. A value of 100 means that every breakdown will be repaired in a workshop. If no workshop exists in the layout, the vehicle will not move from its current location. If the vehicle will be repaired in a workshop, the vehicle will release the work location for someone else to start working at it, independent if any workshop exists or not. If a vehicle will not be repaired in a workshop, it will be repaired at the current work location. It will not release the work location, so when it has been repaired, it will continue its work.

Edit operators button

This button will open up the operator's requirements settings for the vehicle. It is only visible if a license for operators is available.

Start time settings

These controls when the vehicle is first taken into operation. When the checkbox for ***Use start time*** is unchecked, the vehicle will be start at once when the simulation starts.

End time settings

These controls the last date for the vehicle. If the end date is used, the vehicle will not work longer than the specified date.

Autonomous work settings

These controls autonomous work for the vehicle. It consists of several settings as:

- Enable/disable autonomous work checkbox
- Active during… checkbox. This allows the user to specify a shift schedule during which the vehicle is allowed to work autonomously
- Extra repair time grid – This is used to specify any extra time needed when the vehicle breaks down during autonomous work. This simulates

that when no operator is operating the vehicle, it might take longer until any repair guy can assist.

11.9.4 Special properties

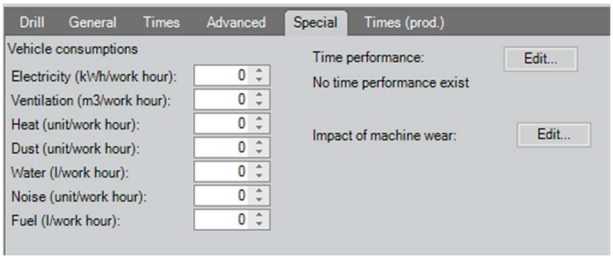


Figure 11-79 – Special properties

VEHICLE CONSUMABLES VALUES

These specifies how much of each consumable that a vehicle consumes per hour of operation. The statistics for these cannot be viewed in any tab in the current version of SimMine. It can only be exported from SimMine.

TIME PERFORMANCE BUTTON

This opens up time performance settings, which allows the user to specify how much the performance of the vehicle is affected by time. It can for example be that a new machine performs not at 100% of its capacity during a while before it ramps up to 100% of its stated capacity.

IMPACT OF MACHINE WEAR BUTTON

This opens up the settings for the machine wear impact. In there it is possible to specify the machines capacity in percentage of its stated capacity due to the age of a vehicle. For example, that a vehicle will only perform at 80% of its stated capacity when it reaches a certain age.

11.9.5 Production times properties

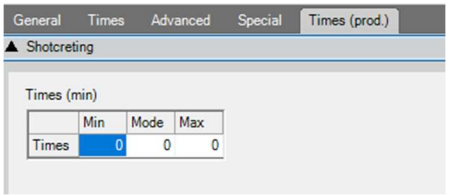


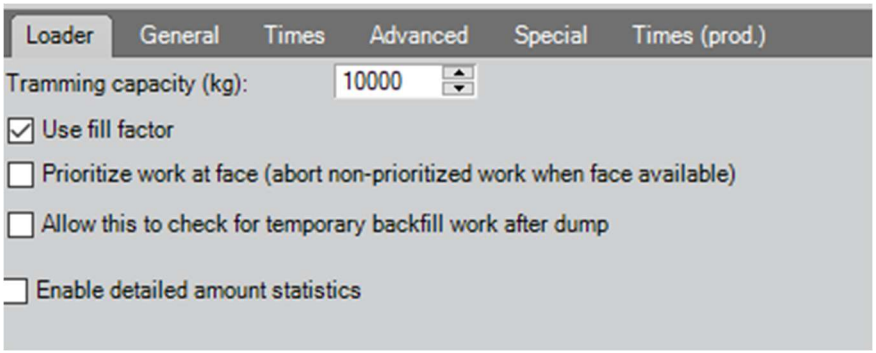
Figure 11-80 – Production times properties

This works in a similar manner as for the Times tab. This tab contains properties for activities which can be done for production (i.e. long hole drilling methods). The above figure shows properties for a shotcrete rig, since the drill rig doesn't support any production activities.

11.10 Properties for specific vehicles

Each vehicle may have unique properties which do not apply to any other vehicle, such as loading capacity for loaders, which doesn't apply to other vehicles (except trucks). This part shows specific properties which can be found for certain vehicle types.

11.10.1 Loader



The properties for the loaders include these options:

Capacity

The capacity, in ton, the loader has.

Use fill factor checkbox

This enables/disables that any fill factor shall be taken into consideration when the vehicle loads. The fill factor is properties for the rock property, and whenever a loader or trucks loads that specific rock type, the rock property's fill factor can be used. If the fill factor is set to 60%, and the loader's capacity is 25000kg, the total amount for that rock type is only 15000kg.

Prioritize work at face checkbox

This will allow the loader to abort any non-prioritized work location whenever a high prioritized face gets available for loading or cleaning activities. There is a similar checkbox in the properties for the section which sets it as a high-priority work location.

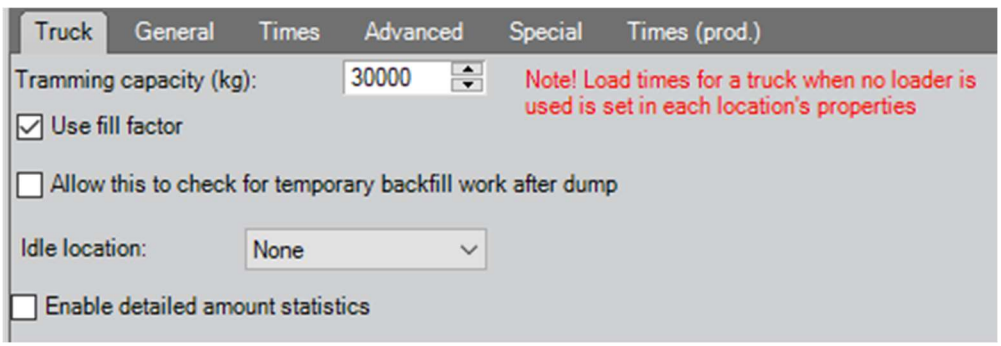
Allow to search for temporary backfill work checkbox

This will allow the vehicle to search and take temporary backfill work after it has dumped to a location. It will only search temporary backfill work if this is stated at the location it dumps to.

Enable detailed amount statistics check box

This enables/disables detailed amount statistics to be collected for this vehicle, which can be used to analyze the haulage in more detail. See Detailed loading and transport statistics on page 169 for how to analyze the detailed amount statistics.

11.10.2 Truck



The properties for the trucks include these options:

Capacity
The capacity, in ton, the truck has.

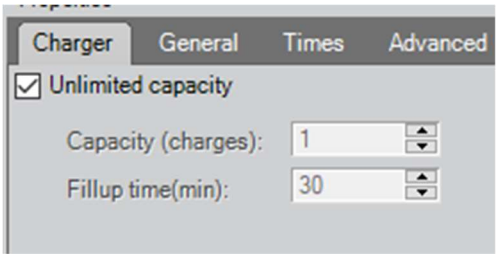
Use fill factor checkbox
This enables/disables that any fill factor shall be taken into consideration when the vehicle loads. The fill factor is properties for the rock property, and whenever a loader or trucks loads that specific rock type, the rock property's fill factor can be used. If the fill factor is set to 60%, and the truck's capacity is 50000kg, the total amount for that rock type is only 30000kg.

Allow to search for temporary backfill work checkbox
This will allow the vehicle to search and take temporary backfill work after it has dumped to a location. It will only search temporary backfill work if this is stated at the location it dumps to.

Idle location
When this is set, the truck will travel to that location whenever it becomes idle. It does not estimate the length of the idle period and will start travel towards it the first moment it becomes idle. Therefore, use it with a bit of caution since it might increase the amount of travel the truck will do.

Enable detailed amount statistics check box
This enables/disables detailed amount statistics to be collected for this vehicle, which can be used to analyze the haulage in more detail. See Detailed loading and transport statistics on page 169 for how to analyze the detailed amount statistics.

11.10.3 Charger



The properties for this vehicle type include these options:

Unlimited capacity
The unlimited capacity will cause the vehicle never to fill up any explosives. Have this checked if the vehicle refill process is not a bottleneck or an issue for which you wish to examine the effects of refilling in more detail

Capacity
The number of charges the vehicle can hold before it needs to refill

Fill-up time
The time it takes to refill the vehicle. During refill, the vehicle will not travel to any refill station. It will simply be unavailable for work during the refill time.

11.10.4 Concrete truck

The properties for this vehicle type include these options:

UNLIMITED CAPACITY

The unlimited capacity will cause the vehicle never to fill up any cement. Have this checked if the vehicle refill process is not a bottleneck or an issue for which you wish to examine the effects of refilling in more detail

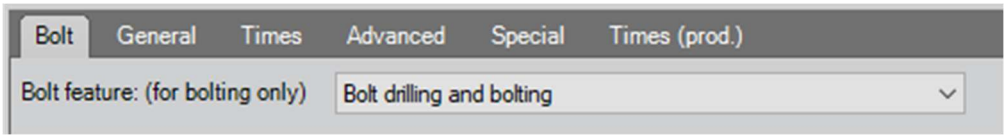
TANK VOLUME

The amount of cement this vehicle can hold. The properties for shotcreting specify how much amount of cement shotcrete will require, and thus affect how much each cement fill will last for.

MAX TIME UNTIL CLEAN TANK

The time from the moment the cement is filled, until it needs to be cleaned. This may happen when the vehicle doesn't have enough work to use all its cement. During the fill process, the vehicle will travel to a nearby cement station. A cement station is required in the layout when at least one cement truck doesn't have unlimited capacity.

11.10.5 Bolter

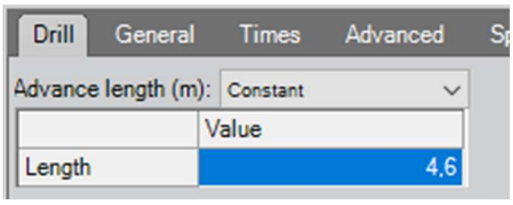


The properties for this vehicle type include these options:

BOLT FEATURE

The feature the vehicle can perform.

11.10.6 Drill rigs



The properties for this vehicle type include these options:

THE ADVANCE LENGTH

The length the face will advance after each drill of the vehicle. The length can be set to vary according to a distribution as well.

11.10.7 Water vehicle

The properties for this vehicle type include these options:

UNLIMITED CAPACITY

The unlimited capacity will cause the vehicle never to fill up any water. Have this checked if the vehicle refill process is not a bottleneck or an issue for which you wish to examine the effects of refilling in more detail

FILL TIME

The time it takes to refill the vehicle. During refill, the vehicle will not travel to any refill station. It will simply be unavailable for work during the refill time. The vehicle will be refilled after each activity it performs.

11.11 Import

Import of data is done when data of different data shall be imported into SimMine, whether it is global data, simulations, or layouts that shall be imported.
The import function is found in the ***Settings/Data*** tab, under the ***Import/Export*** group (see Figure 4-1 Main window on page 20 for information about the ribbon)

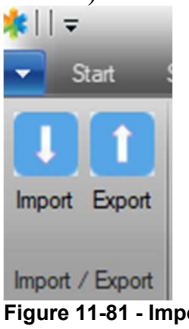


Figure 11-81 - Import and export buttons

When Import is clicked, an import wizard will show, which holds different import options. The number of options depends on the license.

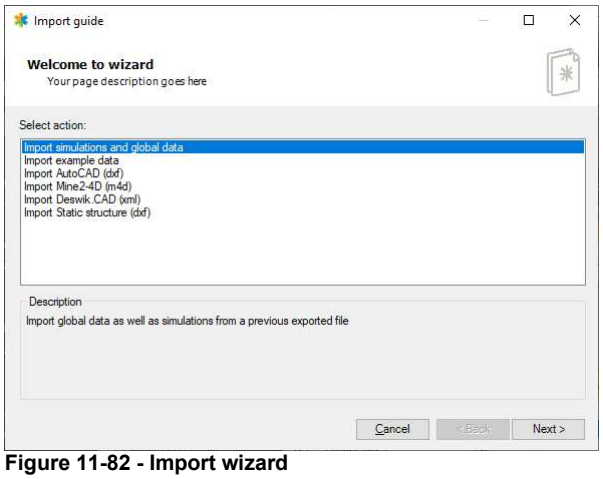


Figure 11-82 - Import wizard

The imports that are possible (depending on license) are:

Import simulations and global data	Imports a previously exported file from SimMine into the current database, and can be used to transfer data between databases.
Import example data	Import example data into the current database. Any simulation or global data which already exist will be overwritten, so use this when you have an empty database. When this is complete, more simulations models exist in the database which can be examined and played with.
Import AutoCAD	This will import a DXF file which contains a layout. The layout which is imported is treated as centerlines, independent of its real representation in the file. This will create a strange layout if you are importing an ore body or a 3D tunnel drawing with this option, since all lines are treated as center lines.
Import Mine2-4D	This allows you to import Mine2-4D layout, which can include more information other than the layout itself. The data is imported directly from the Mine2-4D save file.
Import Deswik	This allows you to import Deswik files and use the imported data as centerlines. Deswik files can contain more information other than the layout itself, which makes this a better solution. See Deswik import below for more information regarding the Deswik import. The import is done from files exported from Deswik, which requires some export settings in Deswik to match the required settings read by SimMine.
Import static structures	This allows static structures to be imported from a DXF file. Static structures can be building, ore bodies etc., which doesn't add any function to a layout, other than the esthetics in the animation and layout.

11.11.1 Deswik import

Deswik import files can be used to import more settings other than the layout itself. It supports to import the following:

- The layout, in the form of centerlines
- Rock properties
- Face profiles
- Dependencies between sections

The Deswik import wizard has the following steps:

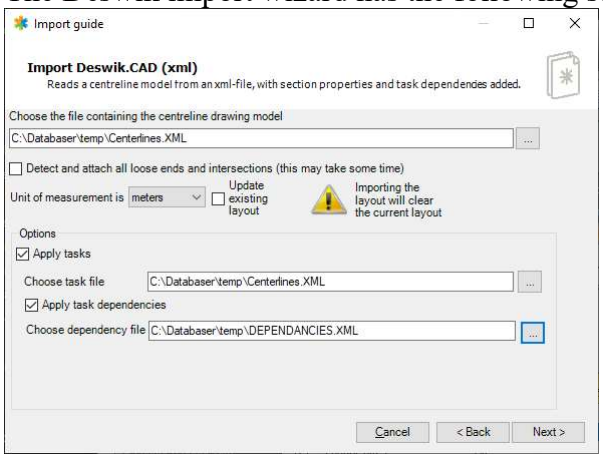


Figure 11-83 - Deswik import, step 1

In step1, the different import files are specified. The requirements for these files are found below.

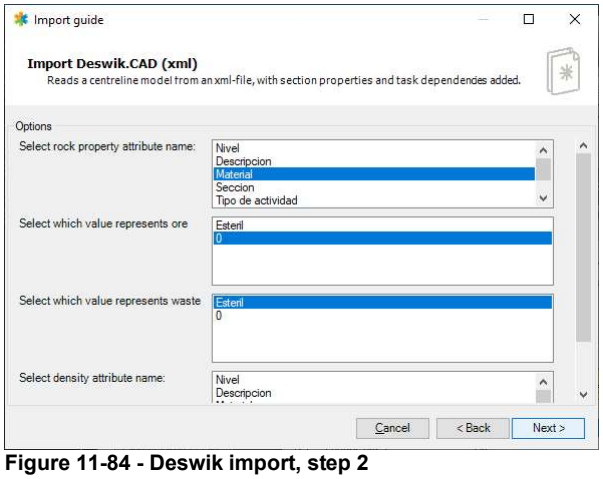


Figure 11-84 - Deswik import, step 2

In this step, it is possible to specify which property in the file that shall be used to define the rock type, and its density.
It is also possible to set which unit the density will be read in (ton/m^3, or kilos/m^3)

The following settings and requirements exist for the files:

11.11.1.1 Center line file

The main file to import is a center line file. Its content is treated as centerlines, independent of its actual content. Of that reason, do not try to import a file containing 3D tunnel profiles, since it will create a layout which has strange center lines. Each centerline (i.e. polyline) will be created as its own section.

Each centerline in the centerline file can be decorated with properties, found in the XProperties tag in the file. Each property can be named. The supported properties for the centerline file are:

Name	The name of the section which is created from the imported centerlines
Width	The width, in meters of the section
Height	The height, in meters of the section. The width and height are used to create the correct face profile for the section.

11.11.1.2 Tasks file

A task file is used to import additional properties for a layout, such as rock properties, face profiles, and also allow for dependencies to be imported.
A task file divides the layout into tasks, where each task can have its own rock property, its face profile and act as an object for dependency between objects.
The task file can either be the same file as the centerline files, in which case each center line imported from the center line file will have its own properties for rock and face profiles. A task is a center line in this case.
A task file can also contain areas, which contains the center lines. The areas in the file (which must contain at least 4 corners), must be at the same plane as the centerlines due to that otherwise, no centerline can be found inside an area. Each area will be assigned their own properties for rock and face profiles. A task is one or more centerlines in this case.
The task file contains properties for each task in the file. These properties are applied to the layout if a task contain at least one centerline. The properties in the task file comes through the XProperties tag in the import file. The XProperties can contain zero or more properties for each task, where each property is named. The supported properties are:

ID	This sets a unique ID for a task, which is required if dependencies shall be imported, since dependencies rely on task ID
Description	If it does exist, will override any Name property from the centerline file and replace the name of the created section

In the XProperties for the task file, there can also be properties for rock type and density. The name of these properties can be set during import (see next import step)

11.11.1.3 Dependency file

The dependency file contains task dependencies, which specifies which tasks depends on each other, as well as the dependency type. This file can contain a number of polylines, but none of the polylines are used in the import. However, each polyline has a number of XProperties, in the same way as the centerline and tasks files. These XProperties has a number of properties which are used to create the dependencies.

The XProperties supported are:

Link From ID	This is an ID which corresponds to a task ID read from the tasks file (the ID property). This is the dependency master object
Link To ID	This is an ID which corresponds to a task ID read from the tasks file (the ID property). This is the dependency slave object
Link Delay	The delay of the link, which is the time from the point when the master object is triggers the link, and until the link itself will signal to the slave object to proceed.
Link Type	The type of link. The supported values for this property are: • FinishStart, which means the master object shall finish before the slave object can commence • StartStart, which means that the master object must commence before the slave object is allowed to commence.

11.12 Export

Export of data is done when data of different data shall be exported to another application for reading, whether it is global data, simulations, or results that shall be exported.

The export function is found in the ***Settings/Data*** tab, under the ***Import/Export*** group (see Figure 4-1 Main window on page 20 for information about the ribbon)

Figure 11-85 - Import and export buttons

When Export is clicked, an export wizard will show, which holds different export options. The available options depend on the current license.

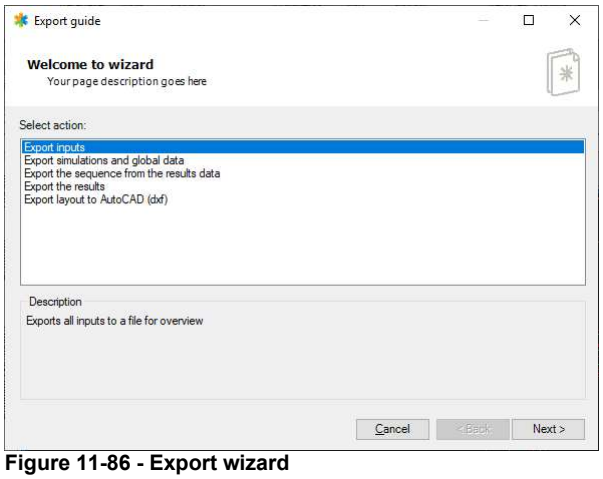


Figure 11-86 - Export wizard

The possible options are:

Export inputs	Exports the inputs used in the model to an excel spread sheet. The excel spread sheet can then be used to get a better overview of all data in the model, and compare for example section properties.
Export simulations and global data	Exports one or more simulations, together with global data for transferring to another database.
Export sequence	This export the sequence of activities, together with information regarding each activity to an excel file. See below for definition of exported info.
Export the results	Exports the results from the output tabs to excel. Not all results are exported. The exported data contains the most frequent used data to be examined and compared in excel.
Export layout to AutoCAD	Exports the current layout to a DXF file, so it can be read by external cad tools.

11.12.1 Export sequence

When the sequence is exported, it will be saved in an excel file with one sheet, with the following column:

- Section name
- Round – a round index starting from 1. This specifies in which activity cycle round the activity is performed in.
- Activity – the activity which is performed
- Resource – The resource (i.e. vehicle) which has performed the activity. This is nothing if the activity doesn't require any vehicle.
- Start time – the start time of the activity
- End time – The end time of the activity. The time span between the start and end times includes all breaks, off shift times etc.

11.13 Other dialogs

Other dialogues hold minor dialogs which can be found in different places throughout SimMine.

11.13.1 Production plan properties

The production plan properties contain settings which controls how a production plan shall generate rock, which rock type, during which days etc. The production plan settings are also used for a request schedule. A request schedule has the same basic functionality as a production plan with the difference that a request schedule requests rock according to a plan, while a production plan produces rock according to a plan.
The description here is the description for a production plan, but it can also be applied for a request plan or request schedule.

The receive/production plan is not an object itself. It is used as part of another object. It may for example be used by a crusher, to specify the amount that this crusher is allowed to receive for different periods.

The receive plan is a plan for how much a recipient can receive. The properties for a receive plan is edited through the receive plan properties, which could be accessed from the crusher for example.
A production plan is a plan for how much a production location produces for each period.

The main functionality for a production plan is:

- Set for which period the plan is valid
- Set the plan period length (month, days etc.)
- Set any day or date exceptions during which no amount can be produced.
- Specify which rock types that will be produced for which periods.
- Set the amount to produce for each period within the receive plan periods

The production plan dialog contains multiple tabs:

11.13.1.1 Rock types

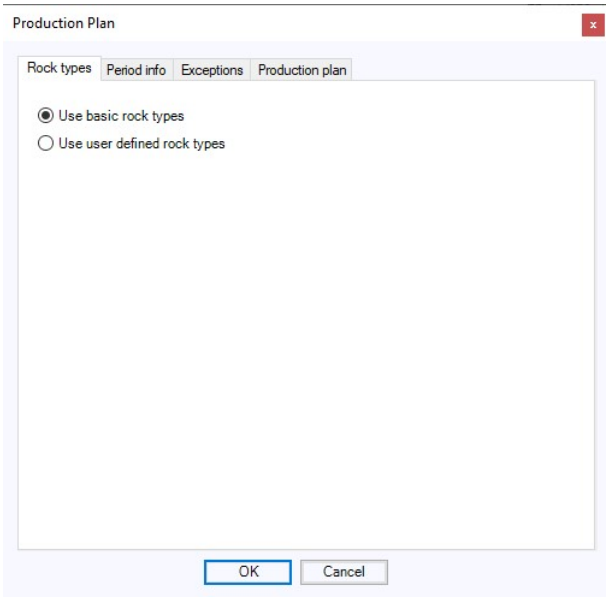


Figure 11-87 - Production plan (rock types)

The types of rock which will be able to set production for in the production plan. When this is set to basic rock types, only ore and waste are available. When set to user defined rock types, all rock types defined in the global settings can be produced.

11.13.1.2 Period info tab

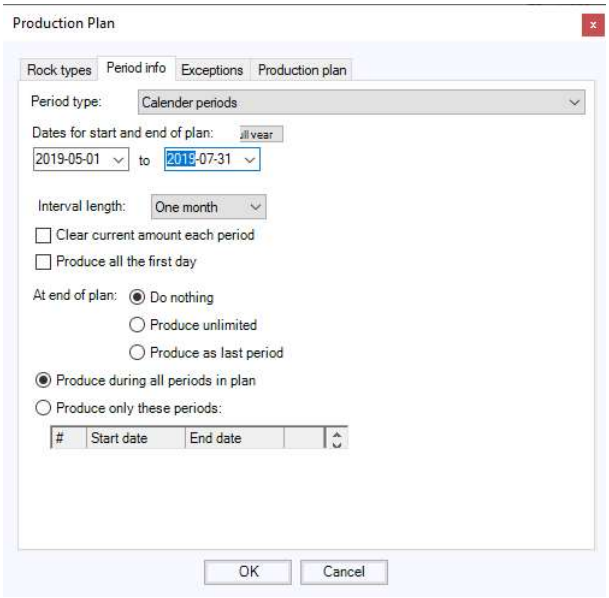


Figure 11-88 - Production plan (Period info)

The properties in this tab are:
Period type
This controls how the periods in the production plan are handled. Two options exist:

- Calendar periods – Each period in the production plan correspond to a fixed calendar period (i.e. 2019 January etc. if Interval length is set to one month)
- Period numbers – Each period in the production plan is just a period with the length specified by Interval length setting. Each period is not fixed to a specific calendar period. The production will always start at period 1, independent of when the plan is activated.
    - Example: Interval length is one month, and Period type is Period numbers. The production plan holds that ore shall be produced 1000 tonnes in period 1 and then nothing more. If the plan is activated 10th of January, the period will be from 10th of January to 9th of February. If the plan is activated 6th of June, the production will start in June instead.

The controls in this tab depends on in which mode it operates – Calendar periods or Period numbers.

11.13.1.2.1 Calendar type mode

DATES FOR START AND END OF PLAN

These are the start and end dates during which the plan can holds production data.

INTERVAL LENGTH

This is the length of each period in the production plan

CLEAR CURRENT AMOUNT AT EACH PERIOD CHECKBOX

When this is checked, it will clear any remaining amount at the location. For example, if the previous month production hasn't been hauled from the location, it will be cleared when this is checked when the next month production is created.

PRODUCE ALL THE FIRST DAY CHECKBOX

When this is checked, the full amount for the period will be produced the first day in the period. When this is unchecked, the produced amount will be divided evenly between the possible production days during each production period.

AT END OF PLAN OPTIONS

This determines what will happen when the last period in the production plan has finished. The options are:

- Do nothing – the plan will stop
- Produce unlimited – An unlimited amount will be produced.
- As last period – The production plan will continue forever, and produce the same amount as the last period in the plan

PRODUCE DURING ALL PERIODS IN THE PLAN OPTIONS

These options determine if the plan shall only produce during a specific period. This option is if the plan contains many periods, but a test or check will only be done during a specific period during the simulation

11.13.1.2.2 Period number mode

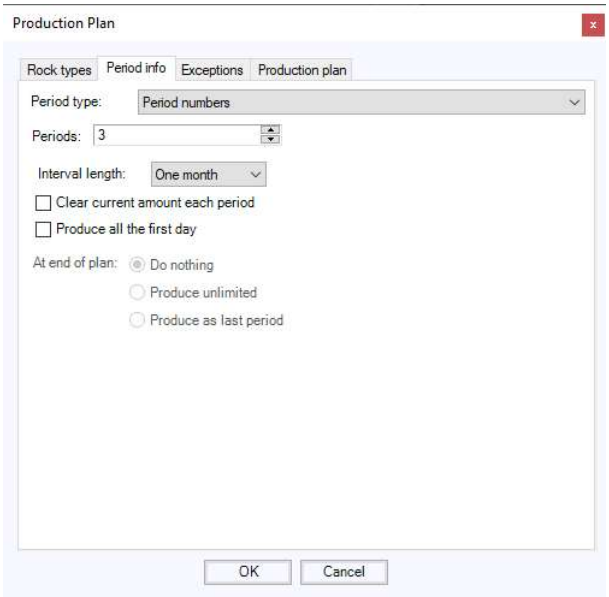


Figure 11-89 - Production plan with period numbers

This mode is when the periods in the production plan is not fixed to a calendar period, but instead numbered periods, where production always starts at period 1, independent at which time the production plan is activated

PERIODS

This is the number of periods that shall exist in the production plan

INTERVAL LENGTH

This is the length of each period in the production plan

CLEAR CURRENT AMOUNT AT EACH PERIOD CHECKBOX

When this is checked, it will clear any remaining amount at the location. For example, if the previous month production hasn't been hauled from the location,

it will be cleared when this is checked when the next month production is created.

PRODUCE ALL THE FIRST DAY CHECKBOX

When this is checked, the full amount for the period will be produced the first day in the period. When this is unchecked, the produced amount will be divided evenly between the possible production days during each production period.

AT END OF PLAN OPTIONS

This determines what will happen when the last period in the production plan has finished. The options are:

- Do nothing – the plan will stop
- Produce unlimited – An unlimited amount will be produced.
- As last period – The production plan will continue forever, and produce the same amount as the last period in the plan

11.13.1.3 Exceptions tab

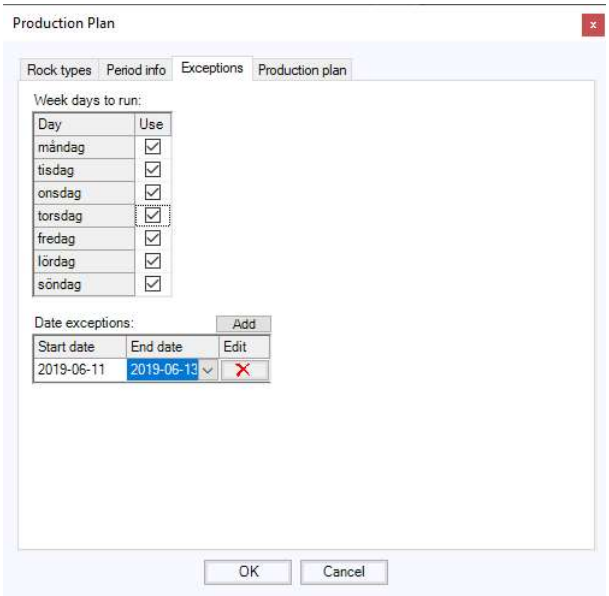


Figure 11-90 - Production plan (exceptions)

This holds exceptions to which days the production plan is allowed to produce rock. It can be specified that only some days during each week can produce rock, and also that certain periods in time will be excluded (i.e. no production during these periods)

11.13.1.4 Production plan tab

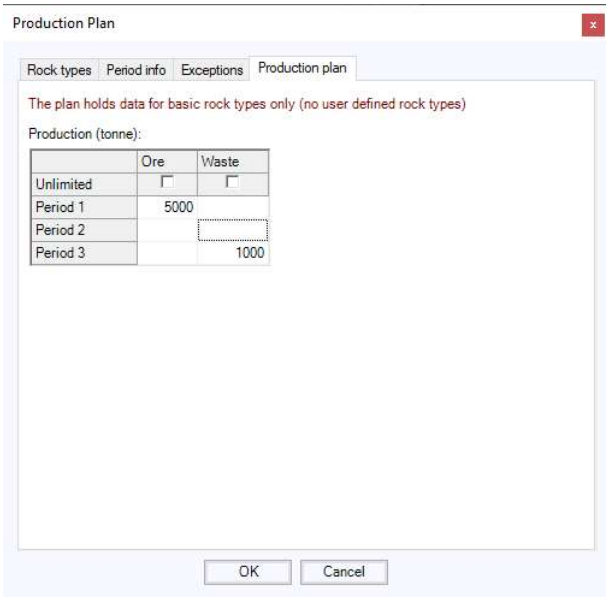


Figure 11-91 - Production plan (production data)

This holds the actual production plan where the amounts to produce are entered.

11.13.2 Availability properties

This property dialog shows and allows editing of advanced availability, which means that the user is allowed to specify mean time between failure, mean time to repair etc., to have full control of the settings.
This can be opened from the ***Fleet*** form, when advanced availability mode is set. In the availability column, the ***Edit*** button will open up these properties:

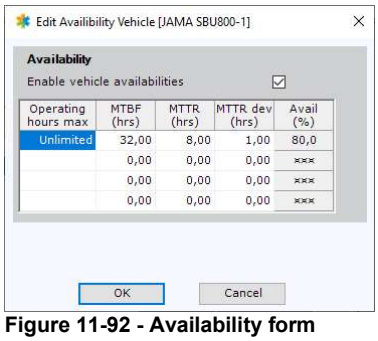


Figure 11-92 - Availability form

Check the box ***Enable Machine Availabilities*** to enable the vehicle availability and allow changes in this form.
The form contains a grid which has the following columns:

- Operating hours max – This is the maximum operating hours for the vehicle, for it to use the settings on the same row. You can set different availabilities for different intervals in vehicle hours. For example, enter 1000 in the first row to set availability for 0 – 1000 machine hours. Enter 5000 in the second row to set availability for 1000 – 5000 machine hours. If you do not want the functionality for different availabilities for different intervals, set “unlimited” in this column.
- MTBF – the mean time between failure. Mean time between failure follows the exponential distribution
- MTTR – Mean time to repair. Mean time to repair follows the log normal distribution.
- MTTR dev the mean time to repair deviation value. This is used together with the MTTR value for the log normal distribution.

Note! If you have entered different maximum engine hours for a vehicle, but the last row with numbers doesn’t contain unlimited as the maximum limit, the vehicle will not break down at all after its engine hours have passed the last entered value in the maximum engine hours column.

11.13.3 Preventive maintenance (PM)

The settings for preventive maintenance can be opened from the vehicle properties (under ***Advanced*** tab). Press “Edit” in the properties to open preventive maintenance properties.

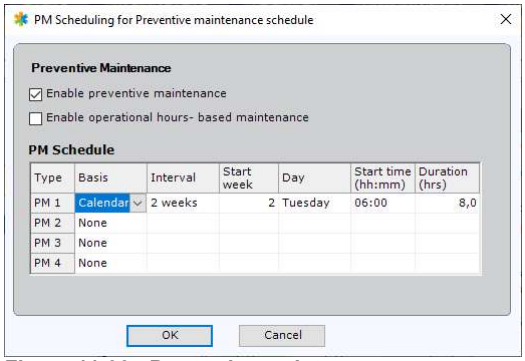


Figure 11-93 - Preventive maintenance

This dialog box shows the properties when a normal preventive maintenance schedule is used. Its controls are:

ENABLE PREVENTIVE MAINTENANCE CHECKBOX

This will enable the preventive maintenance for the current vehicle. It allows changes to be made in this form.

ENABLE OPERATION-HOUR BASED PREVENTIVE MAINTENANCE CHECKBOX

This will enable different preventive maintenance schedules to be specified, each for a different period in time during the life-time of the vehicle. When this is checked, additional settings appear. See Enable multiple schedules based on vehicle hours below for more info.

PM SCHEDULE GRID

This holds the different preventive maintenance schedules. It contains one preventive maintenance setting per row. It can hold 4 different preventive maintenance settings. A preventive maintenance will never abort any work. If it triggers in the middle of a work, the preventive maintenance will start directly when the work has finished. When two settings are triggered at the same time, the total time for the maintenance is the sum of all duration times. Example: If there is a 500 hour, and a 1000-hour maintenance interval, and the vehicle has worked for 1000 hours, both the duration for the 500-hour maintenance and the 1000-hour maintenance will be used.

It has the following columns:

- Type – which preventive maintenance setting has data per row
- Basis – The schedule basis. It has two settings, Calendar based, or Hour based. Calendar-based means the preventive maintenance will be done at fixed calendar days, while hour-based means that it will be based on the number of hours for the vehicle. Depending on the preventive maintenance basis entered here, the other columns could be locked for editing.
- Interval – The interval between each maintenance. For Calendar based, this is a number of weeks. For hour-based maintenance, enter the number of hours between its maintenance.
- Start week. This is only available in Calendar based mode and is the week number the maintenance will be done in. This must be equal or lower than the interval length. Example: If maintenance interval is set to 3 weeks, all vehicles will have their maintenance done the same week (the first week in simulation), then after 3 weeks, they will once again have their maintenance during the same week. If this is set to 2 or 3, the vehicle will have its maintenance during week 2 or 3 in the 3-week maintenance interval.
- Day. This is only available in Calendar based mode. It is the day during the week the vehicle will have its maintenance.
- Start time. This is only available in Calendar based mode. This is the time during the day when the vehicle will start its maintenance.
- Duration – the duration of the maintenance.

11.13.3.1 Enable multiple schedules based on vehicle hours

To enable a more advanced schedule for maintenance, you can allow different schedules for different intervals for a vehicle, such as having one set of

maintenance intervals when the vehicle is below 5000 hours, and another set when it has more than 5000 hours.

To enable this mode, check the checkbox Enable operational hours-based maintenance. An additional grid will show as seen in Figure 11-94 - Preventive maintenance with intervals below.

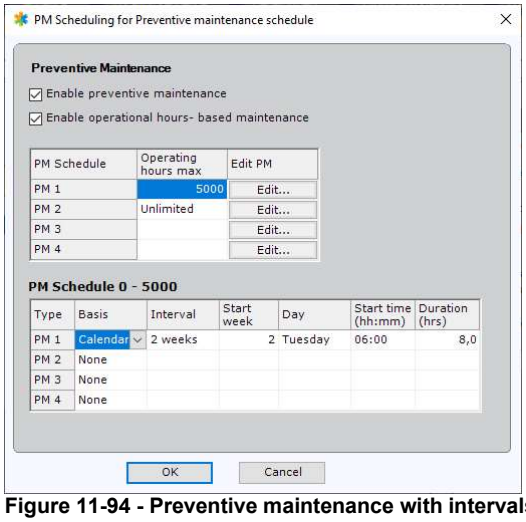


Figure 11-94 - Preventive maintenance with intervals

The first grid allows you to enter the intervals. For each row, there is an edit button, which allows you to edit the preventive maintenance schedules during that interval. The editing is the same as without interval handling described above. When using interval-based preventive maintenance, the interval is printed above the PM Schedule grid as seen in Figure 11-94 - Preventive maintenance with intervals above.

11.14 Animation view

The animation view allows the user to view the progress of a simulation more visually. It shows the vehicle movements, development progress, state of locations etc.

The animation itself doesn't affect any results. To use animation, mark the ***Use animation*** button in the ***Simulation*** group under the Start tab in the ribbon.

When this is marked, the animation window will show when the simulation is started. The simulation will not start immediate.

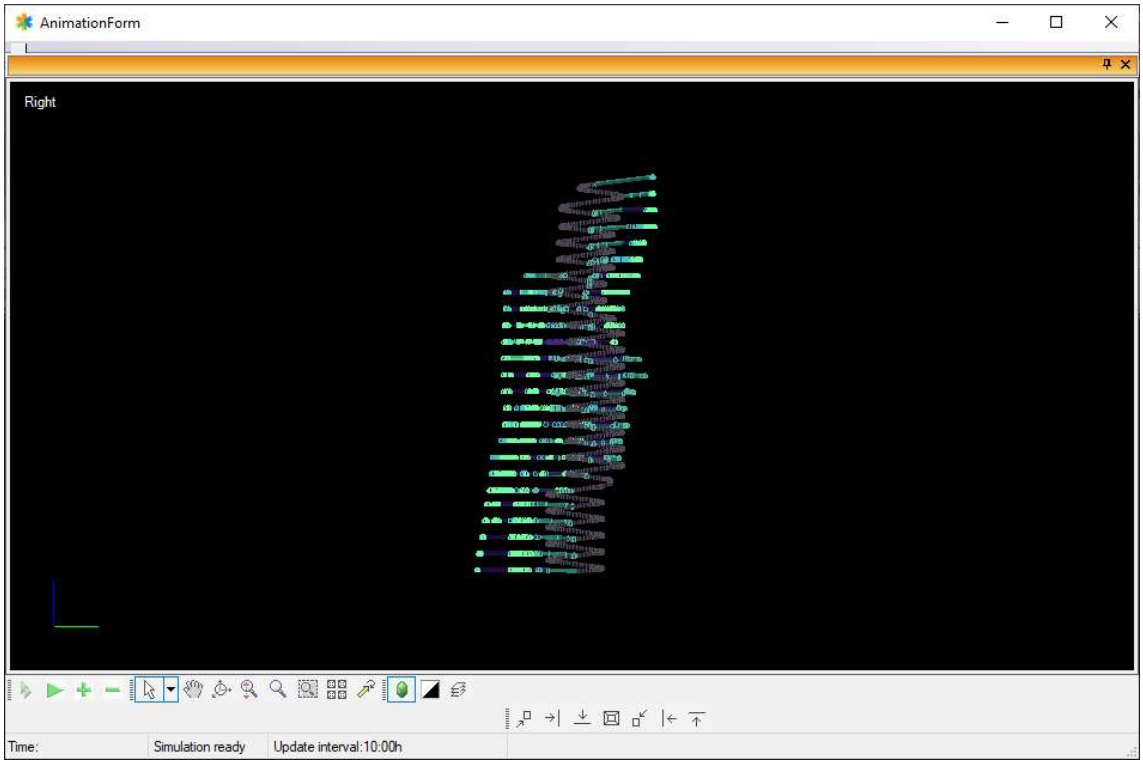


Figure 11-95 - Animation window

To start the simulation, click the Start simulation button close to the bottom left corner of the screen. You can also see the current simulation time as well in the status bar of the animation window.

To increase the simulation speed, use the '+' or '-' buttons:

The pace at which the simulation runs is shown in the bottom status bar:

The update interval of 10 hours means that for every 10 hour in the simulation, the animation view will be updated with the current state of the simulation (i.e. update where headings are, update the positions of vehicles etc).

12 Appendix C– Functionality descriptions

This appendix contains descriptions of different functionalities found within SimMine. These are how different things work and behave, which isn't found in any setting. It can also hold descriptions for the application itself, and not specifically for the simulation.

12.1 SimMine components and their dependencies

This explains and shows which components and communications that SimMine requires

SimMine contains three main components:

10. SimMine application.
11. Database
12. License functionality

These parts are installed and exchange information with each other according to the following schema:
SimMine application is the main application which is installed on each computer where SimMine will be used. This is the user interface the user sees and interacts with.
Its install requires around 100MB of free disk space
SimMine uses other components to work. These components are found in the requirements file which can be downloaded from www.simmine.com and contains the following:

13. SlimDX – a direct 3D driver for the graphics in SimMine to work
14. Microsoft SQL Server, which is a Microsoft database that provides data storage. Any data saved from SimMine is stored in a SQL Database.
15. Microsoft .NET framework 4.51. This is often included in windows. If it is not, it needs to be installed.
16. Sentinel hardware lock drivers. The driver is for communication with the license key and used for SimMine to be able to run and to get which features and functions that shall be available in the SimMine application.

12.1.1 License functionality

The license functionality is not used in SimMine student version. For all other versions, SimMine uses a sentinel HASP driver to communicate with the license key. The license key can be installed locally (in the same computer which runs SimMine), or on a remote license server. The license server allows or denies the end user access to features and functionality in SimMine.
The license server will have a USB hardware key attached to one of its USB ports. The hardware key contains the licenses. The license server can exist on the same pc as SimMine is installed or on a dedicated pc.
Communication with the license server is done over UDP port 1947.
The license server only consists of the sentinel driver, and requires around 20MB of free disk space. The same driver is installed on each end user's computer (where SimMine is installed), so that the sentinel driver component on the client PC can communicate with the sentinel driver component on the license server.

The license server for SimMine can be installed either locally (on the same pc that will run SimMine), or on a remote pc or server. The local license server is required when the hardware key (USB dongle) is not a network license key. The network keys are red.
When using a network key (red USB key), SimMine and its components works according to the picture Figure 12-1–Work functionality overview when the license server is installed remotely.

For local license keys (black keys), the key needs to be inserted into the same pc which shall run SimMine. Figure 12-2 - Work functionality overview for local install shows the communication overview when using a local license server.

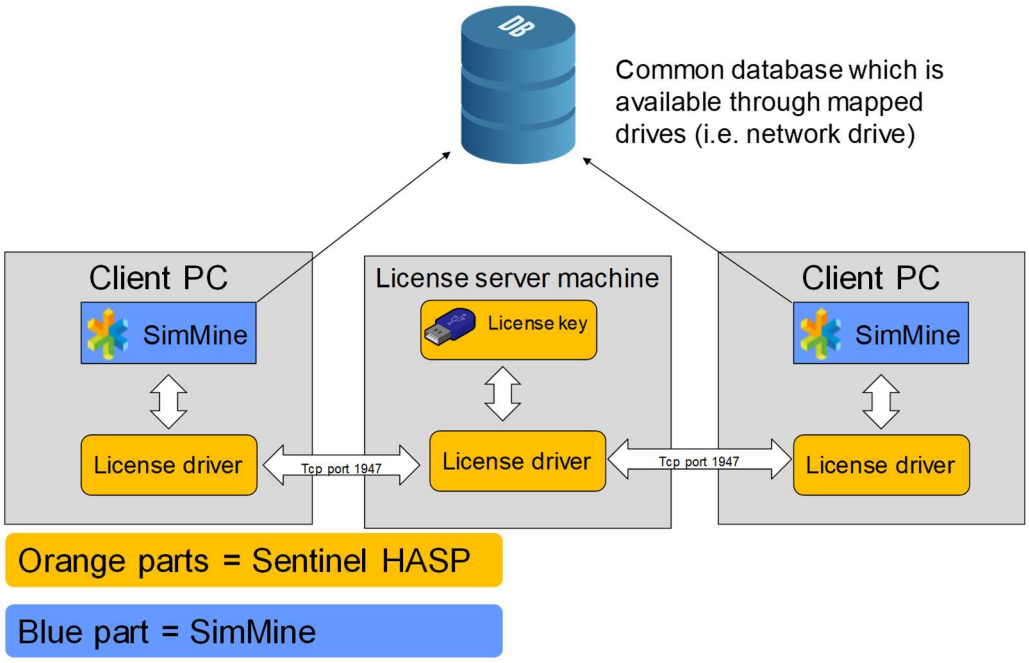


Figure 12-1–Work functionality overview for remote license server

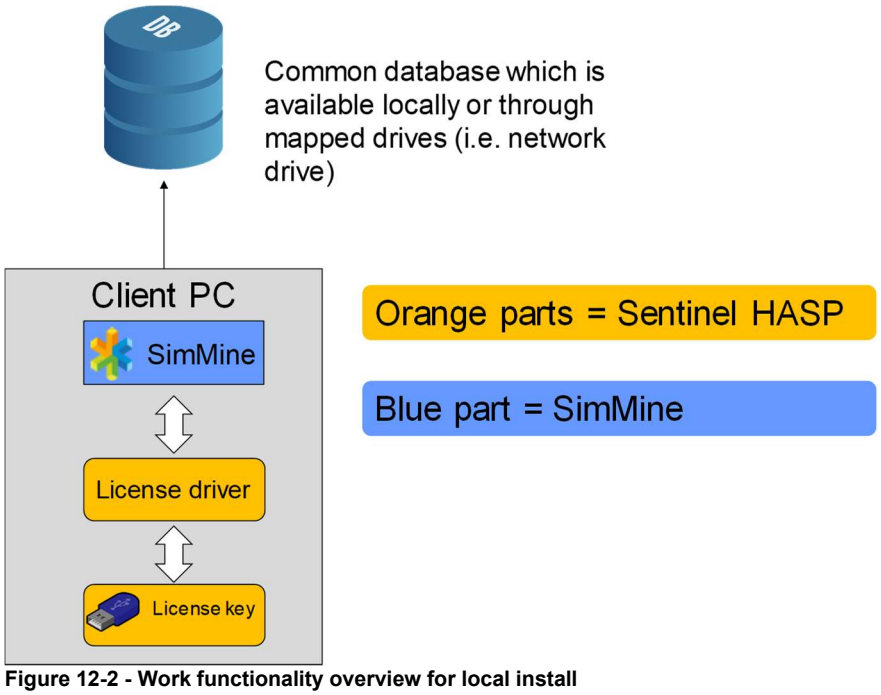


Figure 12-2 - Work functionality overview for local install

The client PC and license server machine can be in the same physical machine. For single user licenses which are using the black license keys, this is a requirement. For network licenses, the USB key (that contains the licenses) can be attached to any computer running the sentinel driver.
Multiple client PCs can exist which communicates with the same license server. In this case, a network license key is required (red key). The license server can be a dedicated machine, or one of the client PCs that has the sentinel driver

installed. The machine acting as the license server must be on and have TCP port 1947 open for communication. Otherwise, the license server cannot give access to the user to run SimMine.

The only network communication that will occur are:
Communication with the license server. This is only done if the license server is on another physical machine that the one which will run SimMine. The communication works that SimMine communicates with the driver for the license key, which is the driver provided by Sentinel. The driver will automatically discover any working license server in the same network, as long as port 1947 is open for communication over TCP.
Communication with the database.
In the database, all simulation models are saved.
The database itself is only a file. A database file can be placed on each computer where SimMine is installed. In that case, no network communication is required, but each SimMine gets its own unique database, which isn't shared by other installed instances of SimMine.
If the database is placed on a network drive, the user must have change permissions on the database file. This is due to that when SimMine need to save a simulation model, the database is changed, and thus, change permissions are required.

12.2 Direct transfer of rock properties

Some locations have functionality to directly transfer their rock to a location. The functionality and settings for how the direct transfer location is found reminds much how the destination location for loading and transport is found. The control for direct transfer looks as the picture below:

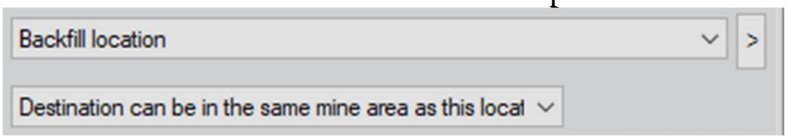


Figure 12-3 - Direct transfer properties

Parts in the above figure:

Destination

The destination where the rock shall be transferred to. In this list, there will be all locations in the layout that can receive rock from the source location. There can also exist some generic destinations:

17. Backfill location – the nearest available backfill location

Destination area option

This holds options for which mine area the destination is allowed to be within. A mine can be divided into several mine areas (see Mine areas on page 295). The destination mine area option is only possible to change when the selected destination is a destination type rather than a fixed destination. Example: Backfill location, will select the nearest backfill location from the source object, that fulfils the destination mine area option. Based on the mine area of the source location, the options for allowed destination mine areas are:

18. Destination can be in any mine area
19. Destination can be in the same mine area as the source location
20. Destination can be in any of the specified mine areas. This option will show a text box, where allowed mine areas can be entered (in a comma-separated list).

12.2.1 Destination selection process

When the direct transfer location is set to a non-fixed destination (Backfill location or similar), the destination is selected based on the following rules:

21. A destination is selected if it can receive any rock from the mine area the source location is within.
    - When there is no rock at the source location (the location for which a direct transfer location shall be found), no checks are done if the destination can or cannot receive any specific rock type.
22. Directly when the location becomes available in the layout, a direct transfer location is found.
23. The direct transfer location is only changed when the direct transfer location is completed (i.e. no more work is required at the location)
    - This way of switching destination differs from the way that normal loading and transport works.

12.3 Loading and transport

The loading and transport logic are used in several parts of SimMine. The configuration of loading and transport works in the same way independent of which object or section it is configured.
The main principle for loading and transport is shown in the figure below:

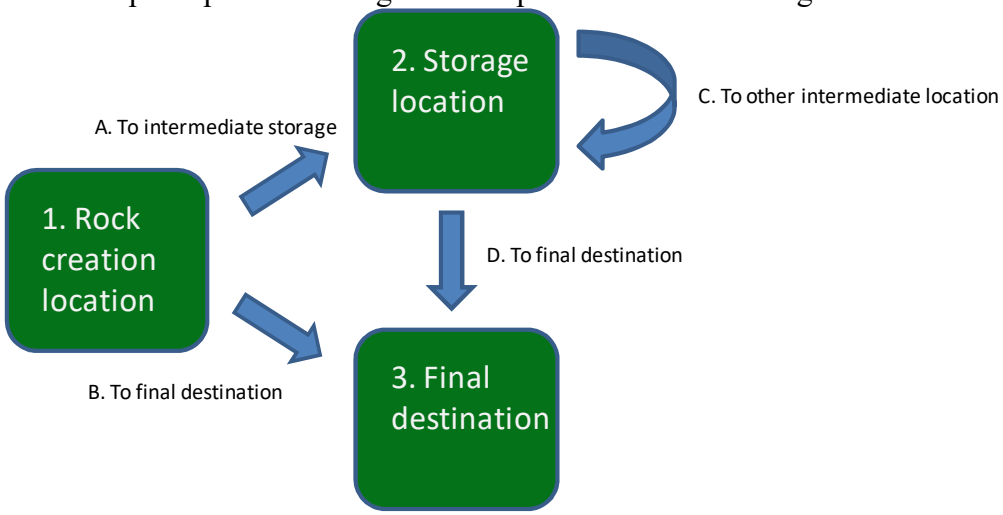


Figure 12-4 Loading and transport principle

The steps involved in loading and transport are:

1. Rock is created at a location (1). This can be a development face, a production location or similar
2. The rock is then transported further to either an intermediate location (A), such as a loading bay, or directly to a final destination (B).
3. Rock at an intermediate location (2), can be transported further, either to another intermediate location (C), or to the final destination (D)
4. Rock which is dumped into the final destination (3) is not transported further.

For rock to be created, a development face or a production location can generate the rock. When the rock is created, it will flow through the mine between objects placed in the layout. It can be transported directly to the final destination, where the flow stops, or through one or more intermediate objects, such as loading bays, to the way to the final destination. Objects (i.e. locations) are places in the mine where rock handling can be done. Objects are placed in the layout from the ***Planning*** tab in the main interface (see Planning on page 86)

Each object or section which can handle loading and transport, has properties for how the loading and transport shall be done. Its properties look like the figure below:

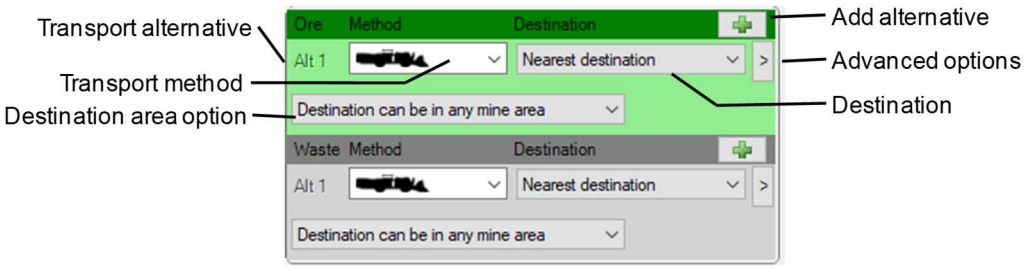


Figure 12-5 Transport settings

Terminology in the following explanation

24. Source object – the object which holds the loading and transport settings shown above.
25. Destination – the destination location which the rock shall be transported to

The loading and transport settings have two parts – one part for ore settings (green) and one part for waste settings (gray). When ore exist at the source location, the settings in the green part is used, and when there is waste, the settings in the gray part is used.

Parts in the above figure:

Transport alternative

There can be up to two different alternatives. Another alternative can be added by clicking the '+' button (Add alternative)
A transport alternative is a set of settings which tells how and where rock shall be transported. If the alternative 1 cannot be chosen, alternative 2 is tested if that alternative exists. When no alternative is chosen, there will be no transportation of rock from the source object. The factor that makes a transport alternative valid is if the destination is valid and can accept the rock at the source object. Alternative 1 is checked before alternative 2.

Transport method

The method by which the transport shall be done. Not all source objects will have all methods. For example, the loading bay will not have truck only method, since a loader must exist to load from the loading bay. The methods that exist are:

26. Loader only – the rock is loaded, transported and dumped by a single loader.
27. Loader to truck – The rock is loaded by a loader and dumped into a truck. The truck transports the rock to the destination. In this case, the truck will wait at the nearest intersection from the source location.
28. Truck only – There are no loaders involved. The truck(s) load the rock themselves and transports it to the destination

Destination area option

This holds options for which mine area the destination is allowed to be within. A mine can be divided into several mine areas (see Mine areas on page 295). The destination mine area option is only possible to change when the selected destination is a destination type rather than a fixed destination. Example: Nearest loading bay, will select the nearest loading bay from the source object, that fulfils the destination mine area option. Based on the mine area of the source location, the options for allowed destination mine areas are:

29. Destination can be in any mine area
30. Destination can be in the same mine area as the source location
31. Destination can be in any of the specified mine areas. This option will show a text box, where allowed mine areas can be entered (in a comma-separated list).

Add alternative

This adds another transport alternative.

Advanced options

This button opens up additional properties which allow more advanced options to be set. The advanced options include more settings for trucks. See below for the descriptions of the Advanced transport settings

Destination

The destination where the rock shall be transported to. In this list, there will be all locations in the layout that can receive rock. There are also generic destinations:

32. Nearest loading bay or pass – the nearest available loading bay or ore/waste pass
33. Nearest destination – any destination which can receive the rock from the source object
34. Nearest end destination – the nearest crusher destination. This is often where the flow of rock ends, which it is named “end destination”

12.3.1 Truck loading

When trucks are used in the simulation model to haul rock, their behavior and location where they will be loaded follows these rules:

35. The default behavior will load the truck at the nearest intersection from the work location
36. In some properties, there is a checkbox which states ***Loading to truck is done at work location***. When this is checked, the truck will be loaded at the work location, which means that the loader will not travel to the location where the truck will be loaded – they are at the same location.
37. The properties for advanced loading and transport contains settings for where a truck will be loaded. This setting can any placed Meeting spot in the layout as a location where trucks are loaded.

12.3.2 Advanced transport settings

The advanced loading and transport settings allow more controls of how trucks behave, but also sets how many destinations to check when the destination is set to “Nearest...”. The dialog box looks as:

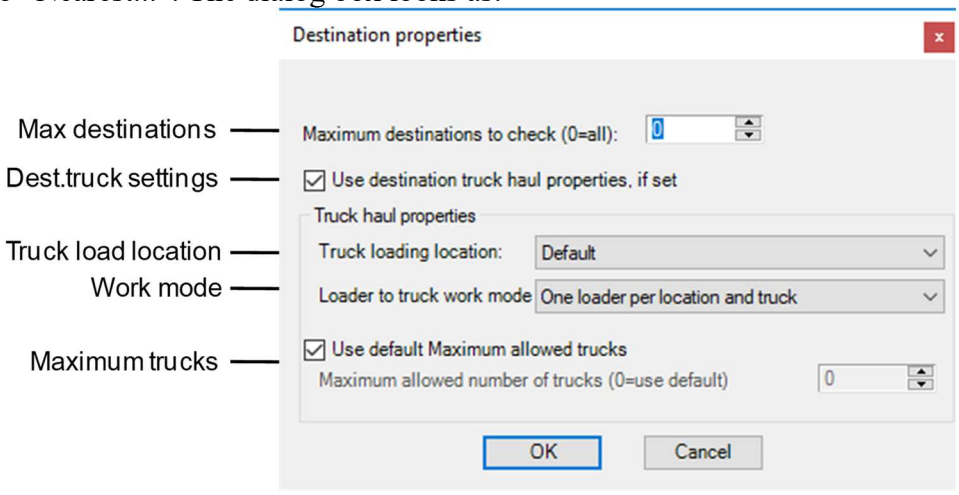


Figure 12-6 Advanced loading and transport settings

Parts in the above figure:

Max destinations
This is the number of destinations to check. When this is 0, all possible destinations are checked. Otherwise only the x nearest are checked, where x is the number entered here.

Destination truck settings
This is only used when loader only method is used (no trucks), and that the destination is a loading bay. When this is set, a loader which shall dump to the destination loading bay will check the destination's setting for where to dump. If the destination's setting for Work mode is set to an option other than "One loader per location and truck ", then the loader will dump onto a waiting truck, if there is one. Otherwise it will dump to the location.

Truck load location
This is only enabled when loader to truck method is used. This specifies which location a truck shall be loaded at. When ***Default*** is set, the truck will be loaded at the nearest intersection. Otherwise, the truck will be loaded at the specified location, which can be any meeting point location placed in the layout.

Work mode
This is only enabled when loader to truck method is used. This specifies how the truck can be loaded. The options that exist are:

38. One loader per location and truck – this is the default setting and allows only one loader to dump onto a waiting truck. That loader is always the loader which works at the same location as the waiting truck (i.e. loader and truck shall work at the same location)
39. Any loader dumping here can dump onto waiting truck – Any loader which shall dump into the location with this setting will dump onto a waiting truck. This allows several loaders to dump into the same truck. This requires that the source location's advanced setting has the checkbox **Destination truck setting** set. This option can only be set for loading bays.
40. One loader both dumps to location and trucks at this location – One loader both dumps to the location and to a waiting truck. This is a bit like the previous option, with the difference that no loader can work at this location when there are loaders that shall dump into this location. This requires that the source location's advanced setting has the checkbox **Destination truck setting** set. This option can only be set for loading bays.

Maximum trucks
These are only enabled when loader to truck method is used. This holds the maximum number of trucks that can be assigned to work here at the same time. The checkbox holds if the default setting shall be used (found in Model options in the general settings. (See Model options settings on page 203 for further info). To override the default setting, uncheck the checkbox and set a value for this location only

12.3.3 Loading and transport configurations

To configure loading and transport, the properties needs to be set correctly so that the flow of rock will be correct. This part lists some examples of how to configure the loading and transport based on some scenarios. All settings which are references in these examples are found in either the loading and transport settings (see Figure 12-5 Transport settings), or the advanced settings for it (see

Figure 12-6 Advanced loading and transport settings). In all examples, ore is used as the rock type, but the same applies to waste. The source object in this case can be any location where ore is either created (face or production location), or where it is stored (loading bays, silos etc.).

12.3.3.1 All ore shall be transported to loading bay "LB1" by a loader only

In the ore settings, set **Transport Settings** to Loader. In the destination, select the LB1 location. No advanced settings are needed.

12.3.3.2 Load ore from a face to nearest loading bay, and from the loading bay to the surface stockpile

Loading from the face shall be done by a loader only. The face will have high priority, which means that when loading exists at the face, a loader shall abort any ongoing work which isn't prioritized.
Loading from the intermediate loading bay shall be done by loader to truck, and the truck will transport the ore to the surface stockpile.
At the stockpile, no further loading will be done.

This requires that the following locations exist in the layout:

41. A development face with ore
42. At least one loading bay
43. A surface stockpile, which can be a crusher or a loading bay.

Since the stockpile can be represented by a crusher or a loading bay, both configurations are shown here.
At the development face, open the section properties and set the following settings:

44. Ore loading method is set to a loader only.
45. Set the destination to nearest loading bay. In the **Destination mine area** list, leave it as Any mine area. *1
46. Set the checkbox for ***Prioritize face for loading & transport and face cleaning***. This option is under the development tab. This option can cause a loader to abort any other work when loading and transport or face cleaning becomes the current activity at the face.

For the loading bay, open up its properties and switch to Loading & transport tab:

47. Set the ore loading method to loader to truck
48. Set the destination to the Surface stockpile.

For the surface stockpile, nothing needs to be done if it is a crusher. The crusher's default settings are that the flow of rock will stop, and statistics for received ore will be recorded. If the stockpile is set to a loading bay, settings must be set so that the flow of rock stops at the stockpile. Otherwise, a loader might start to load from the stockpile.
If the stockpile is a loading bay, open up its properties and switch to Loading & transport tab:

49. Check the checkbox "Do not load from this". This prohibits that any ore will leave the stockpile.

*1 If the stockpile is a loading bay, the setting at the development face, to allow loading to any mine area, could cause ore to be loaded directly to the stockpile from the development face. This will cause a substantial longer activity cycle at the face since the loader will travel all the way from the face to the

stockpile. To prohibit this, the same method as described in Transport the ore to the nearest loading bay which is located on the same level as the source location. Loader to truck shall be used. can be used.

12.3.3.3 Transport the ore to the nearest loading bay which is located on the same level as the source location. Loader to truck shall be used.

In the ore settings, set **Transport Settings** to Loader to truck. As the destination, set “Nearest loading bay or pass” in the **Destination** list. For the functionality to work that it shall only select a loading bay within the same level as the source location, some changes need to be done on all loading bays at the same level as the source location. Changes might be necessary at the source location as well. This involves setting Mine area numbers, which is further explained at Mine areas on page 295). Decide one or a few mine area numbers which will represent the current level in the mine, for example number 10. It is important that all locations in the mine layout follow a given mine area schema, so that no other locations on other levels will be assigned mine area 10.
When the mine areas have been set, open up the loading and transport properties for the source location, and select “Destination can be in any of the specified mine areas” from the **Destination mine area** list. A textbox appears where you shall enter all allowed mine areas. Enter number 10 here. If the source location also has mine area 10, then you can select the “Destination can be in the same mine area as the source location” option from the **Destination mine area** list. In this case, no textbox appears.

12.4 Operator cost calculations

The operator costs are calculated based on the shift schedule used, either a shift schedule assigned for the vehicles, or a shift schedule assigned to the operator, which is used be a vehicle. The total operator costs are calculated equal independent on how shifts are assigned, but the costs associated to a vehicle is done differently depending on how the shifts are used by the vehicles. The operator costs are calculated differently depending on the shift mode which is used.

12.4.1 Vehicles without any operator pool

For vehicles that do not use any operator pool at all, the shift, and operator cost assigned to each vehicle is used to calculate operator costs.
There exist two modes, easy shift scheduling and advanced shift scheduling. This shift mode is set in General settings (see Set the kind of shift schedule to use on page 79 for more information about shift mode)

12.4.1.1 Easy shift scheduling:

The shift schedule is entered as hours per shift and shifts per week.
The operator cost is entered as cost per hour.
In this mode it is not possible to specify different costs for different times during a week. To specify that operators are more expensive during weekend, this must be done in advanced shift schedule mode.
The total operator cost per vehicle is calculated as:
weeks = number of total weeks the simulation has run.
hours per week = the total work hours schedule per week
total cost = weeks * hours per week * cost per hour

12.4.1.2 Advanced shift scheduling

In this mode, a predefined shift schedule is assigned to a vehicle. This shift schedule can contain different work times during each week, vacation periods etc.
A predefined operator cost schema can be assigned to a vehicle. This schema defines the hourly cost for an operator during different times of a week. The operator can be made to cost more during weekends for example.
In this mode, it is calculated how much each vehicle is scheduled to work during each cost period for the operator, and then the operator cost is assigned to these hours.
The exact number of work hours and when during a week is used to get a more exact cost figure.
(For example: Assume an operator costs 200 SEK/h during 6AM to 6PM, and 300 SEK/h all other time. In this example, we have the same time and cost during weekends.
A vehicle has a shift assigned that it will work from 6 AM to 10 PM each Monday to Friday. It will also have a scheduled break between 2PM and 3PM. Each day, the vehicle will work 11 hours between 6AM and 6PM (with a one-hour break), and 4 hours between 6PM and 10PM
This makes the total cost for each working day set to: 11 * 200 + 4 * 300 = 3400 SEK per day.)

12.4.2 Vehicles with operator pools assigned

When a vehicle uses an operator pool, operator costs are calculated based on operator costs and shift schedules assigned to the operator pool.
The vehicle may still have an assigned shift schedule, which it runs according to, but its operator costs are taken from the operator pool configuration, and not the vehicle shift and operator costs.
In this mode it also exists an easy shift mode and an advanced shift mode.
Each operator pool can work according to 3 modes:

1. Run always - Each operator works 24 hours a day
2. Run according to pool's schedule - One schedule is assigned to the pool, where each operator in that pool will run according to this schedule
3. Own schedule - Each operator runs according to its own schedule

Independent of shift mode, the operator costs for the vehicles are calculated based on their relative work amount between all vehicles which are using an operator pool.
For example: One operator pool exists, which has one operator only. The total operator cost for this operator pool is 1000 SEK.
2 vehicles exist which uses this operator pool. Vehicle 1 has worked 500 hours. Vehicle 2 has worked 1500 hours. The costs associated with each vehicle is:

50. Vehicle 1: 500/2000 * 1000SEK = 250 SEK
51. Vehicle 2: 1500/2000 * 1000SEK = 750 SEK.

Easy shift mode is only used when using shift mode 2 above.

12.5 Mine areas

The mine can be split into several mine areas. The user assigns a mine area to each section/object where it is used. The mine area is only a number, and each section or object which have the same mine area number belongs to the same mine area. It is up to the user to keep track on which mine areas are used, and their purpose.
Mine areas can control work areas, loading and transport etc. Statistics is often shown per mine area as well.
It is of good practice to have a system for the meaning of different mine areas. This can for example be that any production area will be assigned mine areas between 10-19. In this case, the mine area tells the user which kind of area it is, and at the same time, it allows multiple mine areas within the production so that vehicles for production can be allowed to some parts but prohibited in other parts.
Shaft(s) should be in a separate mine area, so that vehicles can be controlled if they can work in shafts during the development phase of the shafts.

12.6 Development length version center line length

In a mine layout, the center lines connect the layout. When the development is done, the length to develop will differ versus the length of the center lines according to the Figure 12-7 - Development length vs center line length below

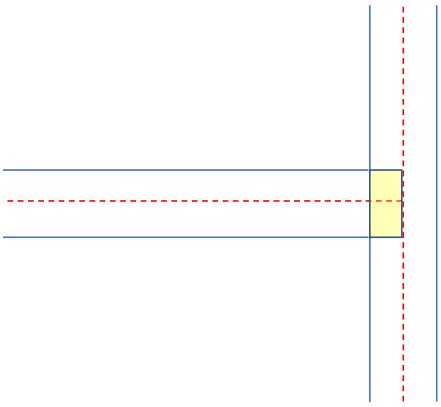


Figure 12-7 - Development length vs center line length

In the figure above, the light-yellow part will be developed if the development is done in the section to the right first. When development then is done in the horizontal part, the yellow part is already developed, and thus, the total length to develop will be shorter than the length of the center line.

The option to take this into account must be activated. Otherwise the development length and the development length will be the same. Activate it through the Use real development length button on page 195.

12.7 Dependencies

In the layout there can exist dependencies between sections and objects placed in the layout. The natural dependencies, i.e. the order in which the sections in the layout needs to be developed due to how the layout looks like, doesn't need to be specified. This can for example be that section B cannot be done until section A is complete due to that section B starts where section A ends.
Other dependencies, which are not caused by how the layout looks like, must be explicitly configured. This may for example be that all sections on level B must be completed before any work can be commenced on any section on level C, even though that these sections aren't directly connected with each other in the layout.
The dependencies are configured in the properties for the section or object for which the dependency shall apply.

12.8 3D Layout items

The 3D layout components are the components that build the whole 3D layout, and can be either objects or sections.
A mine layout can contain different objects and sections. The components it can contain are:

1. Sections
    a. This is a logically defined part in the mine layout. This part can be everything from a single line to the whole mine - it is up to the user to define these sections.
    b. A section is often the smallest object to which unique properties can be set. For example, you can only assign one speed limit to each section, even if that section consists of the whole mine.
    c. Each section contains one or more segments.
2. Segments
    a. This is a section in the mine that has no intersections.

   b. It can be between 2 intersections or between an end point and an intersection.
   c. A section contains one or more segments
   d. A segment contains one or more lines.
   e. Unique properties, which do not depend on its section can be assigned
      i. Development direction
      ii. User priority.
      iii. Start activity (which activity it has as its start activity). This must be one of the activities from the activity cycle assigned to its section.
3. Lines and points
   a. This is the lines and points that are contained within the mine layout.
   b. Each segment can contain one or more lines.
   c. Each segment will contain two or more points.
4. Objects
   a. These are the objects that are placed by the user.
   b. This can be crushers, loading bays etc.
   c. Objects are locations at which some kind of activity can occur.

13 Appendix D– Database structure

This appendix describes the structure of how the data is organized in the database. This will assist when extracting data from the database, either input data, or results from a simulation. The extracted data can then be used to create external reports, from tools like PowerBI.

13.1 Detail Design for DataStorage

The DataStorage module saves and loads data for simulation to/from a SQL database. The structure of the tables inside the database defines how the tables are related to each other, and which kind of data that it holds.

13.1.1 Database design

This describes the structure and dependencies in the database tables. It also describes the columns in each database table and which kind of data they hold.

Each table in the database has one or more primary keys, which uniquely identifies a row in the table. This is marked with PK in the table diagrams.

Strong linking: Some tables have a foreign key, which is a database enforced link to a master table. This ensures that rows within a table which has a foreign key to another table (the master table) is maintained, so you cannot insert an item in the foreign table without the master table containing an entry with the same primary key as the foreign key which is inserted into the foreign table. The foreign key must point to a primary key in another table.

Example: The History table contains the different models saved in the database. It has the primary key set to an automatically generated number (which can be seen as the save ID). The VehicleBase table, which holds basic data for vehicles, has a column named SaveID which is a foreign key to the History table. It means that if there is no entry in the History table with ID=5, you cannot insert a vehicle which has the SaveID set to 5. It also ensures that the entry in the History table cannot be deleted unless all entries from the VehicleBase table with SaveID=5 are also removed. This mechanism ensures that linking between tables are accurate.

Loose linking of foreign keys: There exist tables in the database which holds data for different objects, which causes the data in the table to relate to multiple tables. In those tables, there are in all cases a column named ForeignType or ForeignTypeId, but not both. The ForeignType is a short string identifier, which identifies which table it is related to and which kind of data it relates to, without that a foreign key (a database enforced link) exists. The same apply to the ForeignTypeId column, but instead of a string identifier, it is a number which represents the data type it relates to and holds. In many of those cases, there is also a column named ForeignID or other similar identifier, which is an identifier which relates to an identifier in the master table. The foreign table in this case is determined by the value of the column ForeignType.
To see which ForeignType values that exist, and which tables it is linking, as well as which ForeignTypeId values that exist, and which tables it is linking to, see **.

Example of the loose linking of foreign key: One table holds statistics for amount per period, which consists of the following values:

- Foreign ID for which entity the statistics belongs to
- Value, which is the actual statistics value, such as 10 000, which could mean 10 000 kilos (the table holds amounts of some kind)
- Period, for which period the Value holds data for.

Now, this table can hold these statistics:

- Developed meters per period. In this case the master table (the table for which this relates to) is the section table. The foreignID is the ID of the section for which it holds data (. The ForeignType value is “devm” to symbolize it holds developed meters for sections. “devm” in this case specifies the master table, as well as the type of data stored (in this case, development meters for sections)
- Produced amount per period. In this case the master table is the production location table. In this case, the foreign ID value is the ID of the production location, and the ForeignType value could be “prod” to symbolize that it holds production statistics for locations.

The loose linking is described in **, where it is described which ForeignType values exist, and which foreign tables they relate to.

13.1.2 Database overview

The database holds simulation data for SimMine. The important tables are:

Table	Description

DatabaseInformation	This table has only one row. It contains information for which database format the current database has. For example, it can contain that the database has database format 10. It defines which tables that should exist, and their columns. It is also used to determine if one version of SimMine can be used towards a database or not.
History	This holds information about all models which have been saved in the database. Each row in the history table represents one simulation model. It has several important columns, which are described in more detail under the History table description (see History on page 34)

13.1.2.1 Different data for different models

In the database, each table except the History table have a column named SaveID. This save ID corresponds to the ID value in the History table. In this way, all values in a table that belongs to one simulation model share the same save ID value.

13.1.2.2 Owner ID

In many tables which has a ForeignID column, they refer to which owner that owns the data stored in that table row. The owner, which is represented by the ForeignID, can be any of the types:

- Vehicle, where ID is the VehicleID column in the VehicleBase table for input data, or the VehicleID in the veh_Result_VehicleBase table for result data.

- ElementID, which is the ID of either a section in lay_SectionData table, or the ID of a location in lay_LocationData table for input data. For result data, the ElementID is the ID of a section in table lay_ResultSectionData or for a location in the lay_ResultLocationData table.

    - Each location and section have a unique ID, which means that no location will have an ID which a section has.

    - In many cases, when data can belong to both locations and sections, there is a ForeignType column, whose value indicate if the data belongs to sections or locations. (see Loose linking of foreign keys on page 298)

- Nothing, which indicate that there is no specific owner and the data is data for the model rather than for a specific item.

13.1.2.3 Results in database

Simulation models are saved so that each table is linked to the history table's ID column, which is the ID of the saved data. When results are saved to the database, two history entries are created. One entry holds all input data, and the other entry holds all results. The results that are saved can be seen as its own saved model in the database since it is represented by one entry in the history

table, and all tables which contains results are linked to that history table entry by their SaveID value. However, the model which contains the results is linked to the entry in the History table which represents the model's input data. This is done with loose linking in the LinkedTo column in the History table. If that contains a number, it means it is linked to another entry in the history table.

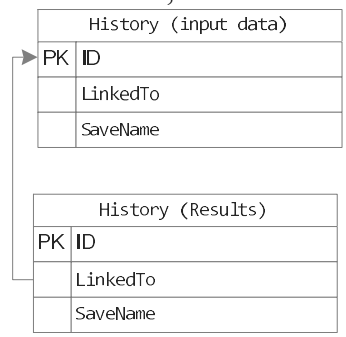


Figure 1 - History table with result

13.1.3 Table legend

The table descriptions will be shown one by one, with a description of the columns it contains, as well as which column(s) is a primary key (the unique identifier of the row). It also describes which columns are used as foreign keys, either with strong linking (enforced through the database itself), or with loose linking (enforced by SimMine).
A table view has multiple parts as shown in the table below:

Table 1 - Table legend

Activity		
Type	Column name	Description
PK	SaveID	The save ID
	ActivityCycleID	The ID of the cycle this belongs to
	ActivityID	The ID of this activity, which is a unique ID of an activity[1)]
	ActivityName	The name of the activity

The parts in the table legend are:

- Table name. This is which name the table has in the database
- Type. For some columns, there can be a key type, which is:
  - PK – Primary key. A row in this table can be uniquely identified by the value in this column. There can be more than one primary key, in which case the combination of them is unique.
  - FK – Foreign key. This value references a primary key in another table. There can be multiple foreign key columns in which case the combination of them will be the foreign key. When a foreign key exist, it is strong linking (link enforced by database)
  - Blank – A normal column with data
- Columns. The columns in the table.

The Type column is missing from the table descriptions. It is instead described in the table descriptions which table they link to.

13.1.4 Table Links

Each table holds data for a certain piece of information from the simulator. The data is saved in a relational database, where tables are linked to each other, either strong links (with foreign keys, supported by the database itself), and loose links (supported and maintained by SimMine). A table's links, either to

other tables, or from other tables (foreign tables) is in many cases provided below the column description of the table as the example below shows:

Table 2 - Table linking

Table linking	
Parent tables and columns	Foreign tables and columns
lay_LocationData(SaveID, ElementID)	lay_LocationData(SaveID, DependentID)

The table links list contains two columns:

- Parent tables: This contains which parent tables this has links to. These links can either be strong links, or loose links. It also contains information which columns in the current table that links to the parent table. The parent table's column names can differ from the names in the current table. Often a table can contain a column named ForeignID, which links to an ID value in the parent table. The parent table can then have a column named ElementID or similar.
- Foreign tables: This contains which tables that links to the current table, together with information which columns in the current table that the foreign table links to. The names of the foreign columns don't necessarily have the same names in the current table.

In cases where either the current table, or the foreign table has a column ForeignType, it is specified which value in the ForeignType column that must exist for the entries that will be linked to the current table.
Information about the exact links and which type of data is contained in a database row when a ForeignType column exist, can be found in the ** document.

For example, with example links just to explain how loose linking is done: Statistics for meters developed is saved in Meters done table. This table is linked to section table (through loose linking, enforced only by the application using this module). In the meters done table, it has a ForeignID column, which is linked to the ElementID column in the Section table by loose linking. The ForeignType column in the meters statistics table is also required to be a specified value for the link to be valid. For example 'devm', since the meters statistics table can also contain number of meters bolted at the section. In this case, both statistics for developed meters, and bolted meters belongs to the same section object, and both statistics are saved in the same table. Therefore, meters done with ForeignType = 'devm' and 'boltm' belongs to different statistics for the section.
For each table, a description which tables it has links to exist.
An overall database diagram shows some of the existing links (either strong or loose links).
There are two main categories of data – Vehicle data and layout data. Tables which exclusively holds data for either of those types, are named veh_[tablename], and lay_[tablename] for vehicles and layout data. Therefore, if you will search for data related to a layout object, you can search for these beginnings.

13.1.5 Loose linking description

Loose linking is when the database itself doesn't keep track of the relationship in the database. It is used to store multipl data sets in one table. Most of the loose linking is accomplished with a ForeignType column in the child table. The value in that column defined which master table it is linked to, and which type of data it holds. It is further described in Loose linking of foreign keys.
The table below shows which loose linking that exist.

NOTE! SOME LOOSE LINKS ARE NOT DESCRIBED HERE FOR THE INPUT DATA CURRENTLY)

TABLE MISSING**

13.1.6 Relationships

The part describes some of the many relationsships which exist in the database to form one single entity. It can for example be Area availability in the mine. The Area availability is saved across many tables, each with their relationship to other tables. All tables involved in storing data for the area availability are needed to construct the area availability in its entirely, with correct relationship, so that in the end, the area availability can be saved and loaded to/from the database. This part shows these relationships for different data types

13.1.6.1 Area availability in the layout

Area availability consists of mean time between failure, mean time to repair, and for which areas a given configuration is valid for. It is saved in the database as:

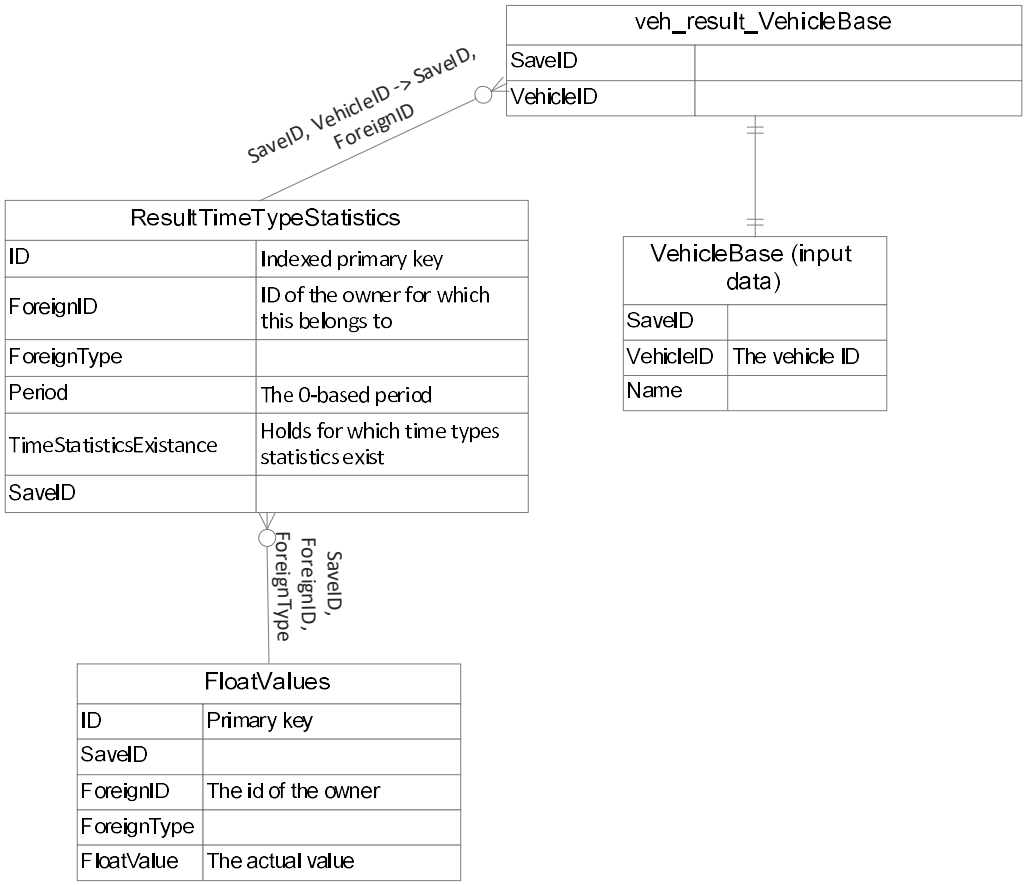


Diagram 1 - Area availability

13.1.6.2 Vehicle time statistics

Vehicle time statistics is statistics for time spent in different states for the vehicle, such as work time, idle time etc. The time statistics contains two categories:

- State times, which are times for main states, such as work, idle, broken etc
- Sub state times, which are times such as travel time, wait time etc.

The time statistics are saved in a compressed format to save time and space when saving the data to the database.

The database diagram looks like:

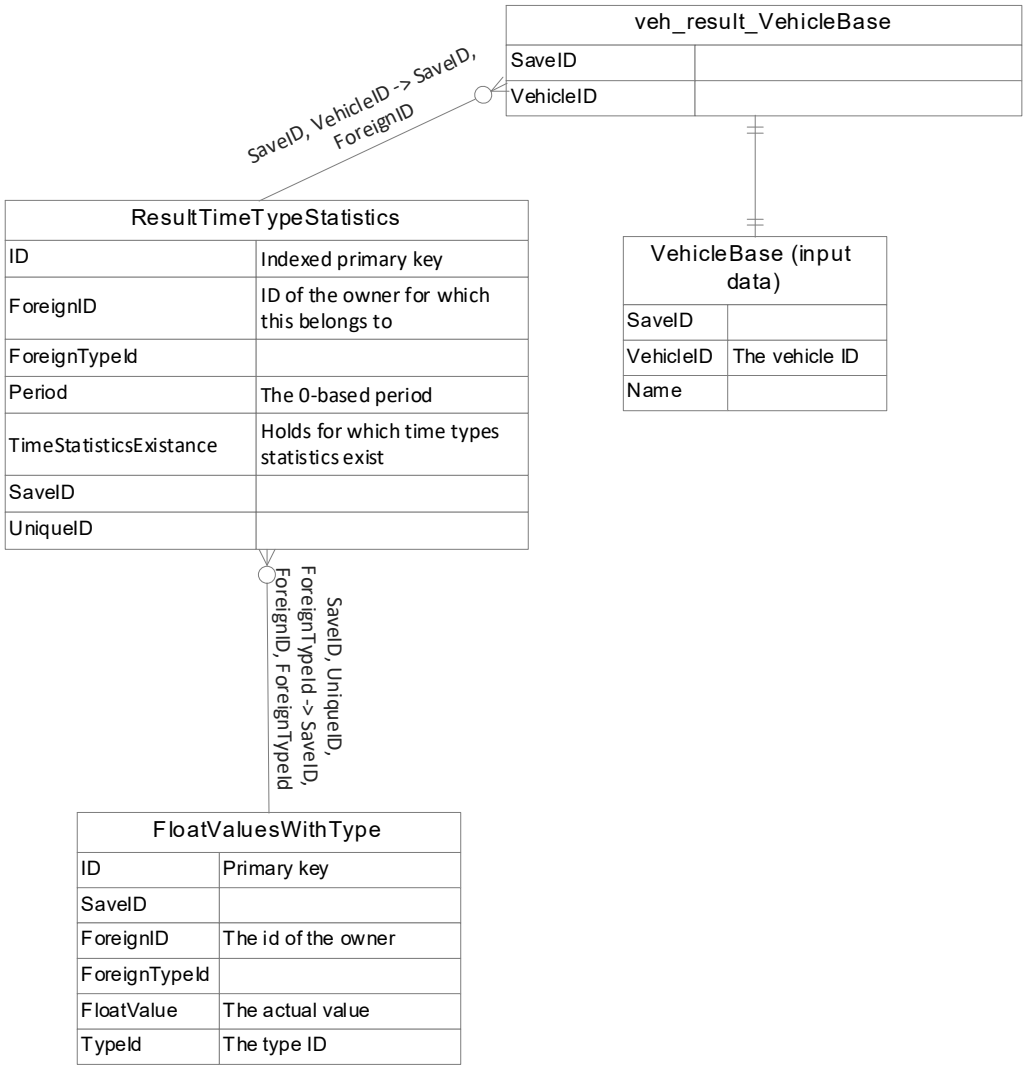


Diagram 2 - Vehicle time statistics

Each time statistics is linked to a vehicle by the link between the ResultTimeTypeStatistics and veh_Result_VehicleBase tables. The name of the vehicle for which the statistics is stored is not saved in the veh_Result_VehicleBase and must be retrieved by linking that table to the VehicleBase table from the input data (which is linked through the History table – see Results in database on page 299)

The time statistics store a time spent in each vehicle state. The vehicle states are seen below
To retrieve a time spent in different vehicle states, the TypeId column in the FloatValuesWithType table can be used.

13.1.6.2.1 Vehicle states

Vehicle states consists of the states:

1. Idle
2. Meal break
3. off shift
4. work
5. vehicle specific

6. broken
7. preventive maintenance
8. boulder handling

Each of these states has a value according to the list above (4 = work state etc)

13.1.6.2.2 Statistics types

Time statistics consists of statistics for main time types as seen above, as well as sub states, such as travel time, wait time etc. All of these statistics are saved in the same tables, where the ForeignType column determines the statistics type. Example: When managing times for main states, the ForeignTypeId is 10, and when managing times for sub states, it is 11. The ForeignTypeId value is found in all linked tables exist the main vehicle base table. It means that both the ResultTimeTypeStatistics table and the FloatValuesWithType table (which stores the actual time spent in each state) contains the same value in the ForeignTypeId column (i.e. loose linking include the ForeignTypeId between these tables)

13.1.6.3 Activity start and stop statistics

The statistics for when each activity has started and stopped can be found in multiple tables as seen below:

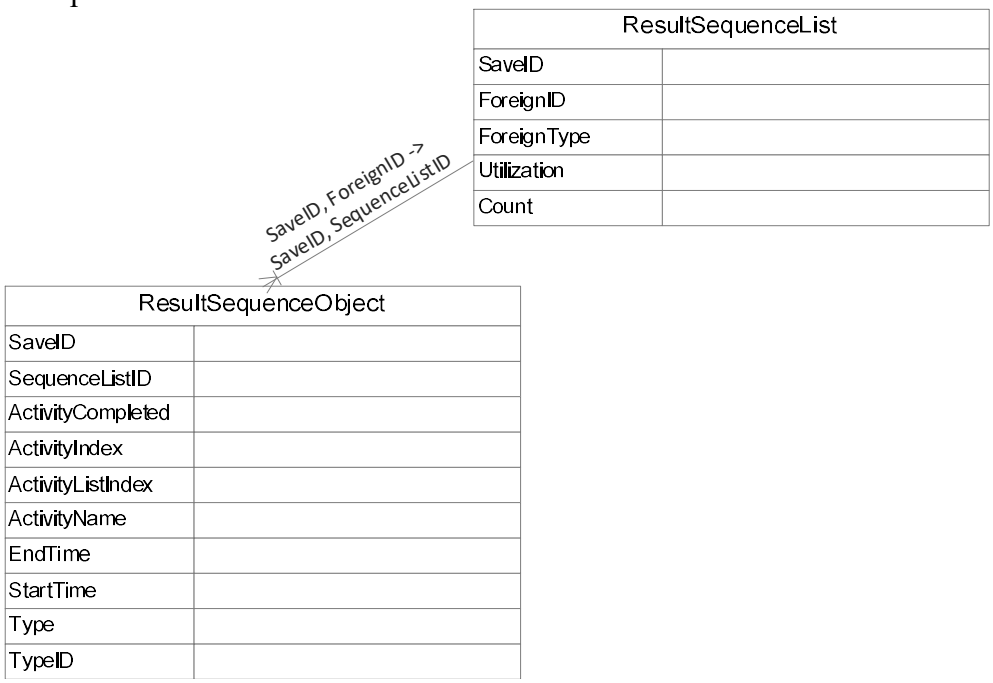


Figure 13-1 - Activity start & stop database structure

The main table, the ResultSequenceList, holds overall statistics for the utilization based on the performed activities. It is also linked to the owner object, which owns the data for start and stop times.
The ResultSequenceObject table holds all start and stop times for each activity performed at the owner of these objects. The important fields in the table are:

ActivityCompleted	Holds the state of the completion of the activity. This holds multiple values for which phase and its completion state that has been done. Each activity can have multiple phases, such as bolting, which has the bolt

	drilling, and bolting. Many activities only have one phase. The values in this field can be: • 1-9 = The activity has been completed. The number is which phase was the last one • > 10. The single digit number is which phase has been completed, and the 10-digit is which phase will come next. A number greater than 10 means the full activity has not yet been completed • < 0. The phase is not completed. The activity will continue later. The number is which phase has been performed
ActivityIndex	The index of the activity within its activity cycle
ActivityName	The name of the activity
StartTime	The start time, in seconds from simulation start
EndTime	The end time, in seconds from simulation start

Each activity can contain one or more entries in the ResultSequenceObject table. The activity is completed when the ActivityCompleted is between 1 and 9.

13.2 Result data dictionary

The results from a simulation are stored in multiple tables. Each set of results can be stored in multiple tables, where data from all those tables are required to be able to load/save the data correctly.
This part lists result types and which main table the result is stored in. To get further info regarding any sub table, please refer to the table description for that table, where its table linking are described.

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