4 PROJECT ALTERNATIVES

This *Chapter* contains a description of the alternatives that have been identified for the proposed Yara Dallol Potash Project to date.

Alternatives addressed include alternative mining methods, as well as the No-Go (i.e. no mining) alternative.

In addition to solution mining, alternative mining methods considered, include the following:

- Open Pit Mining;
- Conventional Underground Mining; and
- The use of an air blanket for solution mining.

These alternative mining techniques are presented below. Furthermore, this *Chapter* provides a discussion around the use of alternative water sources for the proposed Project.

4.1 OPEN PIT MINING

Open-pit mining, open-cut mining or opencast mining is a surface mining technique of extracting rock or minerals from the earth by their removal from an open pit or borrow. This form of mining differs from extractive methods that require tunnelling into the earth such as long wall or room and pillar mining. Open-pit mines are used when deposits of commercially useful minerals or rock are found *near the surface*; that is, where the overburden (surface material covering the deposit) is relatively thin or the material of interest is structurally unsuitable for tunnelling (as would be the case for sand, cinder, and gravel, for example). For minerals that occur deep below the surface - where the overburden is thick or the mineral occurs as veins in hard rock - underground mining methods are the most suitable and often the only economical option (Wikipedia, 2014).

This method of mining has been considered; however, for successful implementation open pit mining would require shallow potash deposits and a groundwater depth that is below the mineralised material member. The depth of mineralised material in the Project Area ranges between 75m and 600m. Although the upper deposits may be easily accessible by open pit mining, reaching to a depth of 600m in this area would prove costly by this method. Furthermore, to access the mineralised material a large volume of overburden would need to be removed. This increased effort to access the mineralised material, together with high overburden (waste material) to product ratio would result in the proposed Project not being financially feasible. Furthermore, the Project Area is prone to runoff from the western highlands, and as a result the salt plains (in which this mining technique would be

employed) would be regularly flooded, thus resulting in the flooding of open pit mining operations and the need for extensive dewatering. For these reasons open pit mining is not feasible.

4.2 *CONVENTIONAL UNDERGROUND MINING*

Conventional Underground Mining in this type of deposit would have been done using the Room-and-Pillar or continuous mining technique. Room and pillar mining is commonly done in flat or gently dipping bedded ores. Pillars are left in place in a regular pattern while the rooms are mined out. In many room and pillar mines, the pillars are taken out, starting at the farthest point from the mine haulage exit, retreating, and letting the roof come down upon the floor. Room and pillar methods are well adapted to mechanization, and are used in deposits such as coal, potash, phosphate, salt, oil shale, and bedded uranium ores (Wikipedia, 2014).

Conventional underground mining was employed in the Project Area by PARSONS in the 1960's. The use of this method for potash mining requires, contrary to underground mining of other commodities, a hydrologic protection layer between the mineralised material and groundwater bearing overburden. This protection layer prevents water and brine from entering the mine. In an underground mining operation for other commodities, underground workings can be dewatered; however, for potash mines, water entering the mine is saturated brine, and over time non salt saturated water will enter mine workings. Non saturated water dissolves salt bearing material, resulting in an increased dissolution process and increased water retention. Eventually water retention is so high that dewatering underground workings is not feasible. The conventional underground PARSONS mine had to be abandoned, due to excessive water inflows.

During the exploration phase of the proposed Project it became evident that the material overlying the Sylvinite Member is porous and that there is no adequate hydrologic protection layer above the Sylvinite Member. The absence of a hydrologic protection layer above the Sylvinite Member means that conventional underground mining is not feasible, and was therefore not investigated further.

As discussed in *Chapter* 2, solution mining was therefore selected as the mining method of choice.

4.3 *USE OF AN AIR BLANKET FOR SOLUTION MINING*

One alternative method of controlling cavern growth would be to use an air blanket instead of a diesel blanket. Air would rise to the top of the cavern and control the upward growth. Air blankets are used where the strength and integrity of the deposit allows it. In past experience in the Dallol deposit, air blankets have failed. It seems that the deposit does not have the strength nor

the integrity to allow for air to be used, therefore the project recommends using Diesel as the blanket substance.

4.4 ALTERNATIVE WATER SOURCES

A thorough Hydrogeological study was completed during the feasibility study. One alternative to using water from wells in the alluvial fans was to create a dam structure and capture rain water which periodically runs off the fans during flash floods events. The Hydrogeological study, combined with the Biodiversity study, showed the importance of these flash flood waters to the native plant species in the area, and as a result the blocking of runoff would be detrimental to the overall health of the area. As well, the frequency of these flash floods is such that the economics of a dam would not be positive.

4.5 NO-GO ALTERNATIVE

As per ESIA best practice, any comparative assessment of project alternatives must include a no-go option. For the purposes of this report the no-go alternative will be that the Yara Dallol Potash Project is not established in its entirety. In this alternative, no direct socio-economic advantages are anticipated. If Yara Dallol BV did not establish a potash mine in the area then other mining concession holders could. The key potential disadvantages associated with the no-go alternative include:

- Lost opportunity to supply an ever increasing global demand for SOP.
- Short-term loss of utilisation of significant potash bearing reserves in the Danakil Depression.
- Loss of the opportunity of employment and development of the Afar.
- Loss of revenue streams in Ethiopia, which in turn will affect local, regional and national government revenues.
- Loss of opportunity for private investment within Ethiopia, which is a key initiative by the Ethiopian Government.

The no-go alternative is a feasible option; however, if Yara Dallol BV did not establish a potash mine in the area then other mining concession holders could. As such, this alternative is not considered reasonable and will not be considered any further in this report.