

3. Project Alternatives

This chapter describes various alternatives to the Project, or to components of the Project, that were considered during Project planning and design.

Project alternatives were considered for:

- ▶ not proceeding with the Project;
- ▶ the preferred approach to mining;
- ▶ the transport of concentrate from the mine site to the Adnera Loadout Facility;
- ▶ rail loadout;
- ▶ site selection for mine site Project components;
- ▶ power supply;
- ▶ water supply;
- ▶ access road crossing of Stuart Highway;
- ▶ waste rock dump;
- ▶ tailings storage facility; and
- ▶ management of the final pit void.

3.1 Not Proceeding with the Project

Not proceeding with the Project would result in the following:

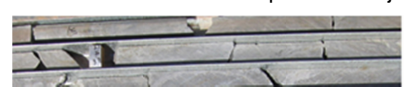
- ▶ up to 1.8 Mtpa of magnetite concentrate would not be produced. When processed the concentrate would produce 19,700 tpa of vanadium pentoxide flake (12% of world demand), 292,000 tpa of pigment grade titanium dioxide (3.5% of world demand) and 856,000 tpa of pig iron ingots;
- ▶ loss of capital expenditure during construction of the mine of approximately \$310 million;
- ▶ loss of expenditure during operation of the mine of approximately \$2 billion;
- ▶ loss of up to 225 direct construction jobs and 170 jobs direct operation jobs;
- ▶ the loss of business opportunities from sourcing of goods and services, with some coming from local suppliers in nearby communities; and
- ▶ loss of royalties over the life of the Project to the Commonwealth and Territory Governments.

In addition, if the Project did not proceed the proposed Darwin Refinery would not be built with the loss of capital expenditure of approximately \$1.5 billion and total revenue in excess of \$27 billion.

3.2 Mining

The mine is essentially an iron ore mine. A traditional approach to mining was selected which included:

- ▶ the mine being open-cut. The uniform nature of the orebody does not lend itself to underground mining methods and underground mining would be cost prohibitive;
- ▶ a truck and shovel operation as typically used in the iron ore industry; and
- ▶ out of pit dumping of waste rock.



3.3 Product Transport and Export

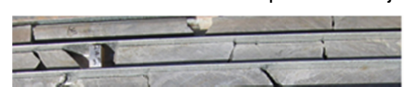
3.3.1 Product Transfer from the Mine Site to the Adnera Loadout Facility

Two options were considered for the transfer of concentrate from the mine site to the loadout facility:

- ▶ Option 1 – slurry of the concentrate to the loadout facility. This would require construction or establishment of the following:
 - a mixing tank at the process plant to slurry the concentrate;
 - slurry pumps;
 - a 90 km pipeline to allow the concentrate to be slurried to the loadout facility;
 - a duplicate backup pipeline in the event that the primary pipeline failed;
 - a number of pump stations along the pipelines;
 - facilities (e.g. filter press) to dewater the slurry at the loadout facility;
 - water dam to contain slurry dewater at the loadout facility;
 - pumps and a return water pipeline (with possibly a duplicate backup line) to convey dewater back to the process plant for reuse; and
 - an easement to accommodate the pipelines, an access track and a power supply.
- ▶ Option 2 – truck transport of the concentrate to the loadout facility. This would involve the movement of concentrate 24/7 from the mine site to the loadout facility by triple road train. Trucking would be via the site access road with the only new piece of infrastructure needed being an underpass at Stuart Highway to allow concentrate trucks to be kept separate from highway road users.

Option 2 was selected as the preferred option for the following reasons:

- ▶ the capital cost is approximately \$50 million less than Option 1;
- ▶ operation costs are similar for both options. The primary operation costs associated with truck transport are diesel consumption, wear and tear on vehicles and an increased cost of road maintenance. Operation costs associated with slurry transport include pipeline maintenance and replacement costs due to abrasion by the concentrate, maintenance and parts for the filter press, power cost (pumps, filter press), and the cost of additional water supply. Labour costs for the two options would be similar;
- ▶ Option 1 carries significantly higher risk due to the potential for the slurry pipeline to block;
- ▶ for Option 1 the easement carrying the pipelines, access track and power supply crosses large areas subject to flooding from the Hanson River. Flood immunity would need to be provided for the pipelines with sections either buried or supported above the level of inundation;
- ▶ Option 1 also has greater potential to impact species of National Environmental Significance; and
- ▶ Option 2 has lower power and water use.



3.3.2 Rail Loadout

Magnetite concentrate delivered to the Adnera Loadout Facility by truck will be loaded into rail wagons for transport to Darwin. Two options were considered for loading the rail cars (Figure 3-1):

- ▶ Option 1 – loading of a static train set by front-end loaders. This would require a spur line of approximately 1.8 km in length to accommodate a train length of 1.5 km; and
- ▶ Option 2 – loading a shunted train set from a static loadout bin. This would require a spur line of approximately 3.24 km in length to accommodate a train length of 1.5 km on either side of the loadout bin without impacting through traffic on the main line.

Option 1 was selected as the preferred option for the following reasons:

- ▶ the capital cost is approximately \$3 million less than Option 2;
- ▶ it has a smaller development footprint; and
- ▶ it provides a shorter turnaround time for train loading through the use of several front-end loaders compared to the single point loading of Option 2.

At a national, territory, regional and local level there are no significant differences between the options.

There are no significant differences between the options over the short, medium and long term.

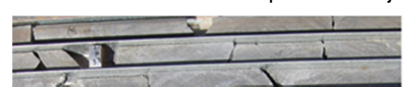
There are no differences between the options on Matters of National Environmental Significance.

3.4 New Infrastructure and Facilities

3.4.1 Site Selection for Mine Site Project Components

The location of Project components is dictated by the location of the orebody and the surrounding general topography. The orebody is fixed and, to minimise costs associated with haulage of materials, infrastructure and facilities need to be located as close as possible to the orebody. The location of the waste rock dump, processing plant and tailings storage facility recognise the topographic and environmental characteristics of the area. In particular:

- ▶ the mine site lies between Murray Creek and Bloodwood Creek and there is a need to ensure that infrastructure is located above the flood extent of these creeks. Surface water modelling has demonstrated that all key Project components will not encroach into these creeks;
- ▶ the location of infrastructure avoids any vegetation of conservation significance. A flora and vegetation survey did not identify the presence of conservation significant species or associations. A fauna survey also identified that the mine site has less value to conservation significant fauna;
- ▶ key infrastructure is located remote from any Sites of Conservation Significance (SOCS). The closest SOCS is Mud Hut Swamp, approximately 7.7 km from the mine site;
- ▶ the mine and associated infrastructure is located near the boundary of Stirling Station, avoiding any significant impact to station operations. There are also no stock watering points in this area so its value to the Station is less than in areas where a water supply is provided;
- ▶ the location of the waste rock dump and processing plant close to the mine minimises material haul distances, minimises haul costs and minimises emissions associated with consumption of diesel fuel. The location of the tailings storage facility adjacent to the processing plant minimises tailings pumping distances and reduces energy costs.



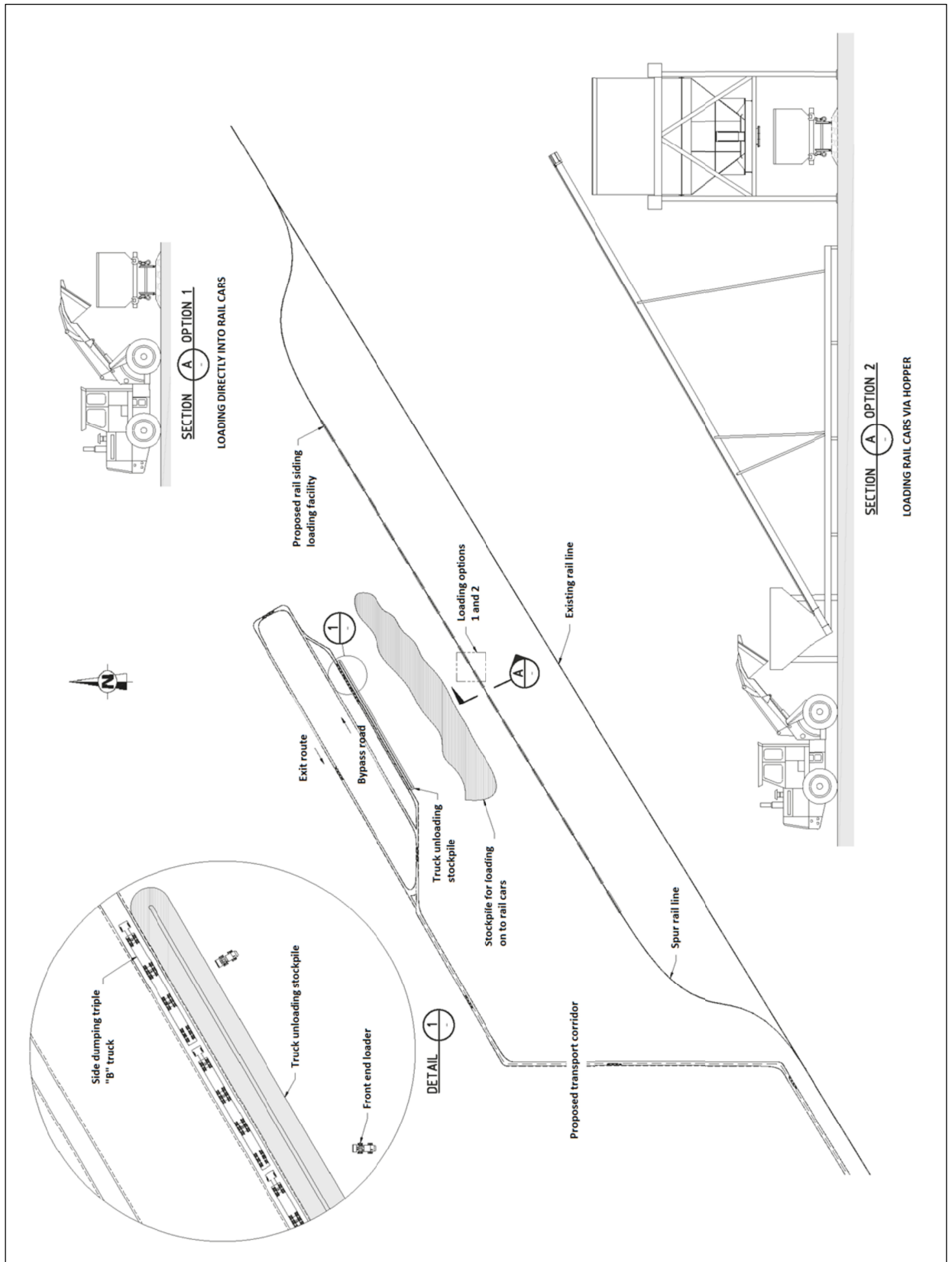


Figure 3-1 Train loading facility

Alternatives considered included locating infrastructure to the north of Bloodwood Creek or to the east of Murray Creek. The disadvantages of these sites include:

- ▶ infrastructure would be located in areas subject to sheet flow;
- ▶ infrastructure would encroach into areas of mulga woodland. Soils in this area are also deeper providing greater value to fauna of conservation significance;
- ▶ infrastructure would be located closer to Mud Hutt Swamp;
- ▶ infrastructure would encroach into areas that are of greater value to Stirling Station due to the presence of stock watering points; and
- ▶ energy costs would increase due to greater haul and pumping distances.

At a national, territory, regional and local level there are no significant differences between the locations considered.

The short, medium and long term advantages of the preferred location is that it is adjacent to a boundary of Stirling Station in an area with less grazing value due to the absence of permanent water.

The preferred location also has less potential value for species of National Environmental Significance.

3.4.2 Power Supply

The two options considered for the supply of power to the mine site were diesel and gas. At full production the power draw for the mine and process plant is estimated at 24 MW.

Due to the volume of diesel needed to generate this amount of power, the option of using diesel was quickly discounted. Use of diesel would treble the cost of fuel. Diesel would also need to be delivered by tanker and diesel has significantly more greenhouse gas emissions than gas.

The Amadeus Gas Pipeline runs approximately 40 km to the east of the mine and a sufficient supply of gas for the Project is available. Gas is more cost effective than diesel and has environmental benefits associated with reduced emissions.

3.4.3 Water Supply

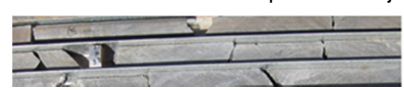
Three options were considered for the supply of water to the Project:

- ▶ use of dewatering water from the pit;
- ▶ groundwater extraction from the alluvials of Murray Creek adjacent to the mine site; and
- ▶ groundwater extraction from the Hanson River palaeovalley, 25 km to the north of the mine site.

From a cost perspective, the closer the supply is to the mine site, the lower the cost.

Test pumping of bores on the orebody and bores constructed in Murray Creek provided very low to zero groundwater yield. The low yield would be insufficient to supply Project water needs of 2,625 MLpa.

Drilling was then undertaken in the Hanson River palaeovalley with results suggesting that sufficient water is sustainably available to supply the Project. A concept design for the borefield was developed with 10 active and two standby bores spaced 1.8 km apart pumping at 8.5 L/s. The borefield was located so that it did not impact groundwater outfall from the Ti Tree Basin but was still close to the mine site.



3.4.4 Access Road Crossing of Stuart Highway

An access road between the mine site and Adnera Loadout Facility will serve the dual purpose of providing general vehicle access from Stuart Highway to both the mine site and loadout facility, and as the haulage route for concentrate product. At the location of the preferred crossing, Stuart Highway is flat, straight and has no speed restriction on public traffic.

During construction and operation the Project is expected to generate 66 and 30 one-way (132 and 60 return) vehicle movements per day that will require access from / to Stuart Highway. In addition, up to 50 loads of concentrate will be delivered to Adnera from the mine site per day (up to 100 return truck movements or four per hour).

Whilst recognising that an at grade intersection of Stuart Highway will be required to facilitate vehicle access to the Project, consideration was given as to how concentrate trucks were to cross the highway in a way that ensured the safety of all road users.

Community consultation identified safety concerns around haul trucks crossing Stuart Highway at-grade. In addition, discussions with the NT Transport Infrastructure Planning Division and the Department of Mine and Energy indicated that any proposal for an at-grade intersection would be rejected.

Concepts were prepared for more expensive grade-separated crossings with three options considered:

- ▶ Option 1 – mine access road over Stuart Highway (Figure 3-2).

A diversion road with the appropriate speed restrictions and traffic management will be required while the Super-Cor™ arch (Figure 2-6) is assembled over the existing Stuart Highway. Once assembly is completed, traffic on the Stuart Highway would recommence, as backfill forming the access road and approach ramps is placed and compacted.

While this option reduces the time required for traffic to bypass the Stuart Highway, it has the ongoing drawback of dust and debris from the access road potentially falling onto Stuart Highway.

This method will not require any rework to be performed on the existing Stuart Highway, with its current alignment maintained.

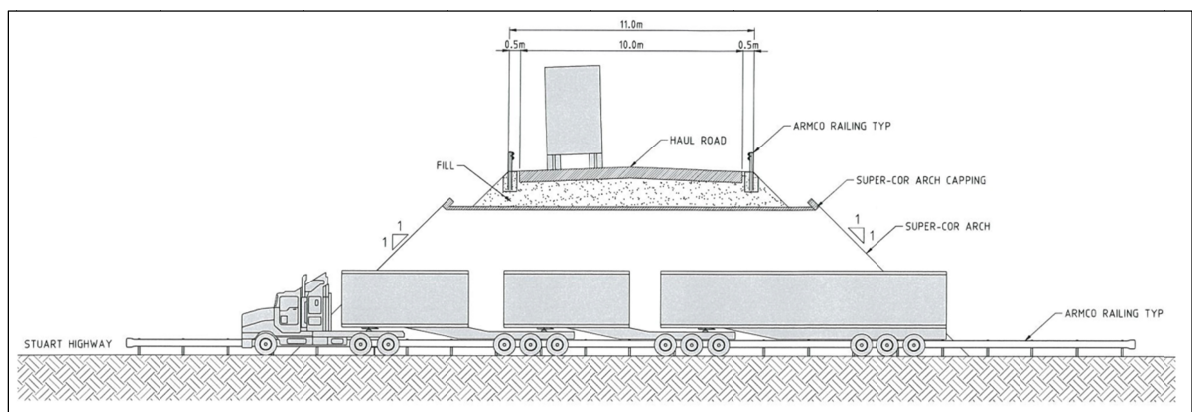


Figure 3-2 Option 1 – Mine access road over Stuart Highway

- ▶ Option 2 – mine access road under the Stuart Highway (Figure 3-3).

A diversion road will be required while the existing road is demolished and excavation is completed for the construction of the Super-Cor™ arch (Figure 2-6).

This option will require traffic to be diverted for longer than Option 1.

This option eliminates issues associated with product dust and debris from the haulage trucks impacting on the Stuart Highway. This option also has considerably less earthworks since approach ramps will not be required.

This is the least expensive option.

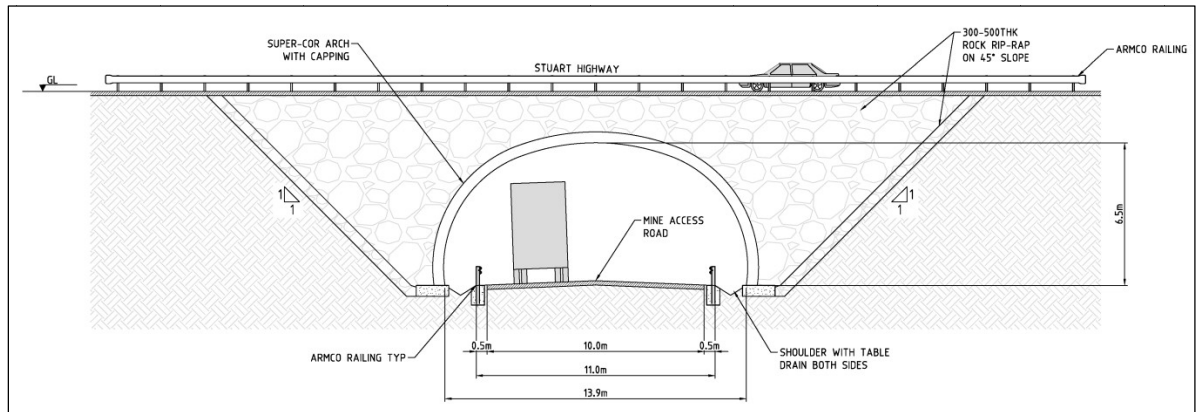


Figure 3-3 Option 2 – Mine access road beneath Stuart Highway

- ▶ Option 3 – Stuart Highway passing over the mine access road.

This option is similar to Option1 but with Stuart Highway passing over the access road.

This option will require the diversion of Stuart Highway to be in place for the longest period of time. The option will also require significant earthworks to provide long and shallow approach ramps to maintain appropriate levels of safety for highway users.

This is the highest cost option.

Option 2 was selected as the preferred option for the following reasons:

- ▶ the current grade of Stuart Highway is maintained;
- ▶ less earthworks are required;
- ▶ minimal disruption to the Stuart Highway throughout construction works;
- ▶ more control related to safety in design and construction;
- ▶ it has the shortest overall construction period;
- ▶ it has the smallest disturbance footprint;
- ▶ there is no visual intrusion in the landscape; and
- ▶ it has the lowest cost.

3.4.5 Waste Rock Dump

Approximately 70 Mt of waste will be generated over the life of the Project. Some of this waste will be used for construction purposes (building pads, ROM pad, road construction etc) during the two years of construction. The waste rock dump will reach an ultimate height of 40 m with a footprint of around 90 ha.

The location of the waste rock dump was selected to minimise the distance needed to haul waste rock from the pit. The location avoids any vegetation of conservation significance and does not encroach into any significant drainage lines.

The height of the dump was kept low to minimise visual impact and reduce costs associated with haulage of waste up a higher landform.

A single dump was selected as it has a smaller surface area to volume ratio than several smaller dumps, resulting in lower rehabilitation costs.

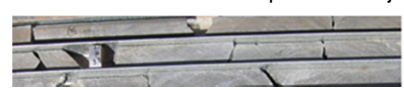
Due to the benign nature of the waste material it is not expected that specific handling of waste will be required. Geochemical testing identified that the waste does not contain significant quantities of AMD material. Two samples (out of 6000) were identified as having low acid forming potential. The Acid Neutralising Capacity of the orebody was found to be high and it is expected that any minor quantities of potentially acid forming material will be co-disposed with non-acid forming material to take advantage of this neutralising capacity.

3.4.6 Tailings Storage Facility

The processing plant will produce around 63 Mt of tailings over its 15 year life. An options study considered three options for tailings disposal:

- ▶ Option 1 – dry stacking of tailings. Dry stacking would involve tailings filtration by either vacuum belt filter or pressure filter to produce a filtrate with a solids content of around 90%. Filtrate would be trucked from the filter plant to the dry staking area, where it would be deposited and spread;
- ▶ Option 2 – wet deposition in a convention tailings dam. Wet deposition is a conventional tailings deposition method in which the tailings are thickened to 40% – 55% solids and then discharged into a TSF. Given that the natural ground at the TSF site is generally flat, the TSF would be constructed as a paddock style facility. The tailings would be discharged from the TSF perimeter walls forming a concave beach with the lowest point in the centre of the TSF. The excess water would be collected in the central decant pond and then returned to the process plant. The final height of the TSF would be 24 m and it would be constructed and operated as two adjacent cells (950 m x 950 m); and
- ▶ Option 3 – slurry deposition to a tailings dam. Slurry deposition would involve tailings thickening at the process plant to produce a slurry with a solids content of 65%, with the slurry then pumped into the TSF (paste disposal, with paste having a solids content of 75%, was also considered, however the absence of clayey fines does not allow the tailings to bind and achieve this higher solids content). As the TSF area is generally flat, a Central Thickened Discharge (CTD) was considered to be the most suitable. CTD would result in the tailings being discharged from the centre of the TSF to form a cone shape of the tailings beach. A drainage system would be installed in the floor of the TSF to recover around 30% of the water entrained in the slurry and return it for use in the process plant. The area of the TSF is typically delineated by a perimeter bund to collect drainage and rainwater, and to prevent uncontrolled spreading of the tailings. The maximum final height of the TSF would be 32 m at its centre and 2 m at the perimeter bund, and it would have a deposition area of around 357 ha.

The options study concluded that dry stacking of tailings was the most effective disposal system in terms of water recovery, which was estimated to exceed 90%. However, the filter performance is very sensitive to variations in the ore feed and the beneficiation process. Dry stacking was found to be the most capital intensive tailings disposal option by a considerable margin (45% and 100% more expensive than slurry and wet deposition respectively). Dry stacking poses very low residual risk.



The benefits of wet tailings deposition are that it has the lowest capital cost, is technologically simple and thus poses low design risk, and has low sensitivity to the performance of the tailings deposition system. However, this option would result in much lower water recovery, estimated to be less than 50%. The major disadvantages of this option are that it has comparatively higher operational risks, along with potential difficulties and risks for closure. It also has the highest operating costs (45% more expensive than dry stacking and slurry deposition respectively).

Slurry deposition was estimated to return approximately 74% of tailings water (through thickening and drainage capture) to the process. Capital expenditure for this option was found to be considerably lower than for dry stacking. When compared with dry stacking, tailings thickening and slurry deposition was considered less sensitive to potential changes in feed properties and ore beneficiation. Rehabilitation of a CTD tailings facility would be easier than a conventional wet TSF.

On balance slurry deposition was selected as the preferred tailings disposal method. Slurry deposition has a high rate of water recovery, poses no technology challenges, is not susceptible to changes in ore feed properties or beneficiation, has a low operational and residual (closure) risk and is cost effective.

For the three options considered, lining of the tailings facility will not be necessary given the nature of the material to be deposited – non-magnetic silts and sands.

There are no significant differences between the options on Matters of National Environmental Significance.

3.5 Pit Void

At the completion of mining the pit will cover approximately 77 ha and be approximately 2,000 m long, 600 m wide and 125 m deep. The pit will remain as a void at the end of mining.

The option of partially filling the pit with waste rock was considered but rejected for the following reasons:

- ▶ the cost of double handling the waste is cost prohibitive;
- ▶ the placement of waste material back into the pit would sterilise any remaining ore; and
- ▶ direct in-pit dumping is not feasible due to the operation of a single pit (although there may be an opportunity to dispose of small volumes of waste towards the end of mining once an area of the pit has been mined out).

