

6.0 Alternatives

6.1 Introduction

As with any large project, there were a number of alternatives considered for various project components. MRM has conducted a systematic evaluation of those alternatives as part of the scoping and feasibility studies. Project alternatives were assessed on the basis of a number of criteria including economics, technical feasibility, and environmental and social acceptability.

The alternatives presented in the section are those which have had a significant influence on the development of the open cut project.

6.2 Mining Method

The ore deposit at McArthur River consists of seven orebodies stacked above each other, with varying widths, separations and grades. Underground mining of the deposit restricted the amount of these orebodies that could be economically extracted. The thickness and grades of the remaining orebodies, coupled with the requirement to install a past plant and to backfill the existing voids within the underground mine, precluded further economical extraction by underground means. Thus, alternative mining methods were investigated to prevent closure of the operations at McArthur River and to ensure ongoing recovery of the resource.

The mining method with the best overall combination of mining costs, safety, and orebody dilution control and recovery is open cut mining. This is viable and represents the preferred financial outcome when compared closure or continuing with the underground mining operation.

More detailed investigations into open cut mining were commenced in 2001 with a pre-feasibility study. This indicated that an operation based on open cut mining was likely to be physically and economically viable. Based on this favourable study, more detailed investigations were undertaken from 2003 to 2005.

6.3 Open Pit Optimisation

Following the decision to convert to open cut mining, a mine optimisation computer program was used to optimise the pit size. Aspects taken into consideration during this included:

- Site operating costs including mining, processing, marketing and transport costs;
- Geological characteristics of the deposit and surrounding overburden;
- Grade variability within the deposit;
- Expected pit slope angles; and
- Financial assumptions including market demand and prices.

The program undertook a series of iterative runs to identify possible ore and waste volumes in an open pit for a range of revenues. The result was a series of open pit ‘shells’ that were the ‘optimum’ final pit size for the specified inputs at a specific revenue factor. Lower revenue factors resulted in smaller pit shells where the combinations of stripping ratio, grades, and ore quality gave the highest financial return. Higher revenue factors resulted in increasing pit shell size, until the cost of moving ever-increasing amounts of waste per tonne of ore made further ore extraction uneconomic. Based on Xstrata’s long-term outlook and corporate strategy, a pit shell between the two extremes was selected to give a balance between short-term profit and stable long-term investment.

Once the final pit shell had been selected, detailed pit designs, mining schedules, and operating costs were developed. These were then fed into a corporate commercial model to generate more accurate estimates of operating costs and revenues. Project capital costs (such as infrastructure upgrades, watercourse realignment and flood protection bunds) were also added into the model. This enables an assessment of the entire project to be made.

The outcome of this process which was undertaken in the project’s feasibility study conducted from 2003 to 2005 yielded a project that was both technically and financially attractive for investment. This project is the subject of this EIS.

6.4 Pit Size

Open pit mining involves excavating overlying waste earth in horizontal benches to expose the target ore, which can then be removed for processing. To maximise the value of the deposit which dips at 25° to 35° to the east, the excavation needs to be undertaken in stages, progressing from the shallowest parts of the orebody to the deepest parts. As the ore-body deepens, ever increasing amounts of waste must be uncovered for each tonne of ore. The ratio of waste tonnes mined to ore tonnes mined is termed the ‘strip ratio’. Above a certain strip ratio, depending on ore grades, metal prices, and mining and processing costs, it is no longer economic to mine the ore by open cut methods.

The size of the final pit would depend upon the economic conditions present at the time. Using the current economic assumptions for long-term metals prices and operation costs, a final pit containing 43 Mt of ore has been calculated as the optimum size at a mining rate of 1.8 Mtpa.

6.5 Industrial Facilities Location

The existing processing plant and power station are located on Barney Hill which provides flood free ground in close proximity to the mine. The industrial area to service the open cut mine has been located adjacent to the existing facilities. This site has been selected for the following reasons:

- It is adjacent to the existing facilities to enable easy interconnection of services and facilities;
- It is in close proximity to the open cut to minimise haul distances, and;
- It is within the flood protection bund and hence is immune from flooding.

There are no other suitable areas that have the same locational advantages as the proposed site.

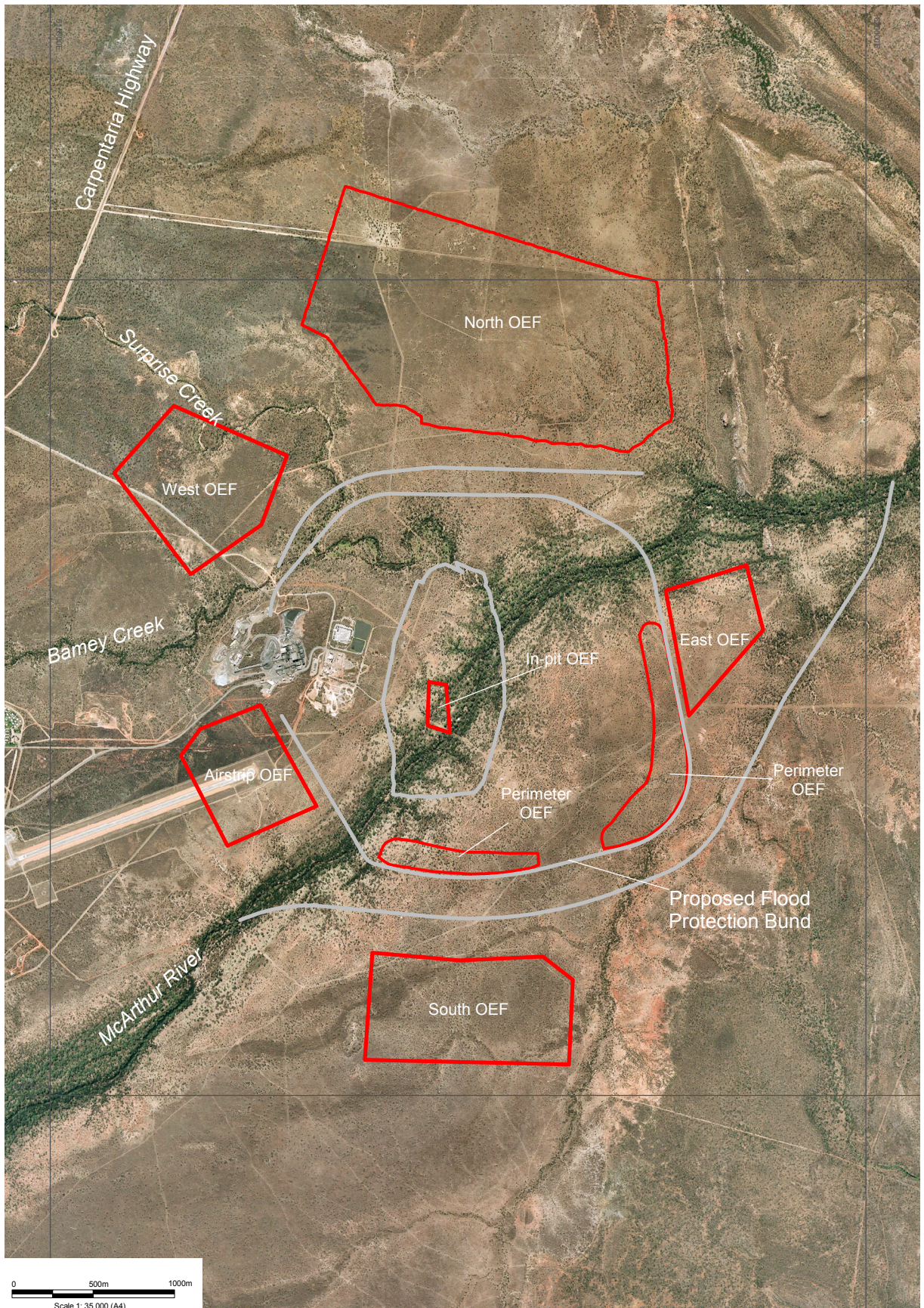
6.6 Overburden Emplacement Facility Location

The objective of selecting the OEF location is to achieve the minimum costs over the extended project life (which extends beyond the cessation of mining activities) whilst achieving a physically and chemically stable stockpile. The choice of OEF location depends on many factors, including:

- Orebody and open pit excavation geometry;
- Extraction sequence;
- Physical limitations on the surface:
 - geographical features (topography, watercourses)
 - geological features (underlying rock and soil types)
 - environmental features (flora and/or fauna habitats)
 - heritage and cultural values
 - presence of other infrastructure
- Possible ore deposits under the surface; and
- Method of transporting overburden.

A number of alternative sites were considered for the location of the OEF. These are shown on Figure 6.1. Comments on the various alternative sites are given below:

- North OEF
 - Must allow room for Barney and Surprise Creek floodwaters;
 - Must avoid the Carpentaria Highway to the west, and the Mount Stubbs to the east;
 - Topography is relatively flat, enabling drainage (both seepage and surface runoff) to be managed effectively; and
 - Haul distances are long due to the Barney Creek floodplain.
- East OEF
 - This could be located between the Barney Creek and McArthur River realignments; and
 - Likely to be prone to flooding, with risks of physical erosion and instability making the site unsuitable.
- South OEF
 - Shorter haul for material in the southern end of the pit;
 - Has to cross the McArthur River realignment; and
 - Unknown environmental or heritage impacts.



Horizontal Datum: AGD84, Zone 53
 Date of Aerial Photography, 2001

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McARTHUR RIVER MINE
 OPEN CUT PROJECT
 ENVIRONMENTAL IMPACT STATEMENT

ALTERNATIVE
 OVERBURDEN EMPLACEMENT
 FACILITY SITES

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Figure: 6.1

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- West OEF
 - Area is interrupted by a line-of-site cultural heritage restriction that limits the volume of overburden contained for a given surface area; and
 - May possibly restrict floodwaters in Barney and Surprise Creeks.
- Airstrip OEF
 - This location would provide a reasonable short haul for overburden in the southern end of the pit; and
 - Use of this OEF location would require re-location of the airstrip which would be a significant cost.
- Perimeter OEF
 - This location is between the limit of the open cut and the inside of the flood protection bund;
 - Short-haul;
 - Immune from flooding;
 - Must be located outside any possible future pit expansion; and
 - Limited capacity available.
- In-pit OEF
 - The use of available areas within the open cut would minimise hauling costs and the site disturbance area;
 - Large-scale use of in-pit dumping was evaluated in the open pit mining studies, however, the geometry of the deposit rendered this option unworkable;
 - Portions of the footwall where the dip of the pit floor is flat enough to enable safe operations to continue below the dumped piles were identified as possible sites for small in-pit OEFs; and
 - Areas would not become available until towards the end of the mine life.

After assessing all of the above considerations, it was determined that a combination of the above alternatives would be suitable. While the Perimeter OEF option has some advantages and hence will be used, it has a relative small capacity and so the vast majority of the overburden will be placed in the North OEF as this provides the greatest capacity and has suitable topography.

6.7 Processing Technologies

Two alternative processing technologies to produce a bulk concentrate were considered as well as the existing technology used at McArthur River.

Differential flotation test work, aimed at producing separate zinc and lead concentrates, was undertaken in a laboratory test-work program. This program was unsuccessful as the process did not achieve the benchmarks set with the concentration of lead in the zinc concentrate being too high.

A laboratory test work program was also undertaken to ascertain how individual and composite samples of MRM ore would perform with heavy medium separation. Whilst technically feasible, the required flowsheet and subsequent high capital cost resulted in this option not being pursued.

The technology currently used for the existing operation is known and understood to the point where future prediction of ore performance can be made to an accurate level. Based upon the unsatisfactory results obtained for the alternative technologies and the low risk of non-performance with the existing technology, it is proposed to continue to use the current processing plant for the open cut project using the existing technology.

6.8 Environmental Management Technologies

6.8.1 Overburden Emplacement

Overburden produced from the open cut will consist of a mixture of potentially acid forming materials (PAF) and non-acid forming materials (NAF). It is important that the PAF be protected from oxidation to minimise the potential for acid leachate to be generated which could be deleterious to the downstream environment.

Conventional disposal of the PAF material would be to dispose of it in a large overburden dump and to cover the dump with a low permeability cover to minimise oxygen and rainfall entering the dump and contacting the NAF. However, at McArthur River this disposal method was seen to pose a significant risk in the event that there was a failure in the integrity of the dump cover in the long term.

The technique proposed to be used at McArthur River is to encapsulate the PAF in a series of clay-lined cells deep inside the OEF. This will result in improved environmental performance of the OEF as it minimises the time that PAF materials are exposed to the atmosphere and therefore reduces the risk of environmental harm from the generation of acidic runoff. Constructing a clay lined PAF cell within the OEF will also reduce the costs of final rehabilitation works, given that a low permeability cover will not be required across the surface of the OEF. It will also limit long-term cover failure risks associated with more traditional OEF design (cover erosion, surface runoff ingress, localised cover failure through deep rooted trees, burrowing animals, uprooting of trees in storm events, *etc*).

6.8.2 Tailings Management

Alternative tailings disposal technologies can be broadly considered as follows:

- The use of earth or rock fill to create embankments behind which “wet” or “low density” tailings can be stored;
- Separation of the coarse fraction of the tailings from the fines and using the coarse fraction for embankment construction to store the fines; and
- Thickened “high density” tailings impoundment.

The first alternative relies on a conventional dam to store tailings that are not thickened. Such a dam would need to be located in a valley with moderately graded slopes and a limited upstream catchment. There are no suitable natural valley areas within close proximity of the mine site. Furthermore, this arrangement would require the diversion of upstream water. It would also involve disturbing a significant area of presently undisturbed land.

The second alternative of separating coarse and fine fractions would have limited benefit at McArthur River mine because the ore grind is extremely fine and there would be only a relatively small amount of coarse tailings generated.

The third alternative is the technology currently employed at McArthur River mine. Thickened tailings form a beach slope by sub-aerial discharge from a central discharge point. Thickening the tailings avoids the segregation of the coarse and fine fractions.

The preferred alternative is to continue to use the existing thickened slurry tailings impoundment method in the area of the TSF adjacent to the current disposal cell. This approach has the following significant advantages:

- The thickened slurry process is already used on site and no operational or equipment changes would be required;
- The area currently used to store runoff water from the existing TSF is already disturbed and is large enough to accommodate the tailings from the open cut operations;
- Using the existing TSF footprint avoids the need to disturb additional undisturbed land; and
- Pipelines to take the tailings to the TSF and return water to the processing plant are already in place.

6.8.3 Drainage Realignment

The location of the orebody is such that, to enable it to be mined by open cut methods, the McArthur River and Barney Creek need to be realigned around the open cut.

The simplest design option of the realigned channels was to construct them with a trapezoidal cross section with a uniform slope and using engineered methods for erosion protection as dictated by the varying geotechnical conditions. This approach would be a lower cost option and would be easier to construct and maintain. However, it would not provide an ecologically sustainable solution.

An alternative design for the realigned channels is to mimic the shape and character of the existing channels. This includes incorporation of numerous characteristics of the existing river system including:

- Variable cross section widths and bed slopes to match existing conditions;
- Provision of intermediate berms for deeper sections of the channel banks;
- Avoiding hydraulic impediments to fish passage;
- Revegetating and stabilising the channel banks with endemic trees and shrubs;

- Providing micro habitats along the channel bed; and
- Providing intermediate resting pools for fish at intervals along the channel.

This alternative design has been selected because of it provides a better long term ecologically sustainable solution. Further details are provided in Section 12.

6.9 On-site Zinc Metal Production

The costs of production of zinc from the McArthur River mine are strongly dominated by smelter, transport, handling and shipping costs which currently account for approximately 51% of total costs. They present limited opportunities for cost reductions. The option of producing zinc metal on-site at McArthur River would improve the downstream operations costs and present an opportunity to value add to the resource, thus improving the economic benefit to the local community and the Northern Territory.

The three key drivers on the viability of the McArthur River mine site as a location to produce zinc metal are:

- **Transport Cost:** Basing a zinc refinery at the mine site would eliminate the need to transport the bulk concentrate to a separate zinc refinery.
- **Disposal of Residue:** On-site disposal of the iron residue would be required.
- **Power Cost:** Zinc refining is a highly electricity intensive industry. At the present time, no suitably priced power source can be confirmed to meet the consumption needs of a zinc refinery at the McArthur River mine.

The first key driver is a positive reason for siting the refinery on-site; the second will require careful environmental management; and the third is a significant cost impediment. After assessing these and other relevant issues, the option of downstream processing to zinc metal at the mine site was not considered further.

6.10 Transport and Port

Given the existing infrastructure in place for the transport and shipping of concentrate from the mine, there are no viable alternatives for transport and port operations.

6.11 Water Supply

In order to secure a reliable water supply for the open cut operations, preliminary investigations were undertaken to investigate feasible alternatives.

A number of surface storage options were considered including either dams or weirs on the McArthur River, Glyde River, Barney Creek and Surprise Creek. All of these options were dismissed because of their significant cost and environmental impacts.

The preferred water supply alternative is continuation of the existing groundwater supply system augmented by the proposed mine pit dewatering system. Combining these two systems will provide adequate water supplies for the expanded operations with less environmental impact.

6.12 Final Void

The following closure scenarios were considered for the open cut void:

- Do nothing and let the pit fill naturally from groundwater inflows and direct rainfall. No inflow will occur to the pit from the McArthur River.
- Breach the flood protection bund temporarily and allow the McArthur River to flow along its original alignment and through the pit until the pit is full. Then re-establish the bund permanently and re-divert the river to the realigned channel.
- Breach the flood protection bund permanently and allow the McArthur River to flow along its original alignment and through the pit.
- Remove part of the flood protection bund but maintain the McArthur River in the realigned river channel. River flows that overtop the McArthur River channel will be allowed to enter the pit and overflow downstream.

Detailed water balance and water quality modelling that was undertaken for each of the above options (Section 20.3.7) indicated that the last option is preferred because it has least impacts on river ecosystems as well as on void water depth and water quality.

6.13 Workforce Accommodation

The following workforce accommodation alternatives were considered for the open cut operation:

- Location of a permanent workforce and their families at the McArthur River mine, accommodated in a new town, or in Borroloola; or
- Flying the workforce in and out from Darwin, as is the current practice.

The preferred alternative is a continuation of the existing fly-in/fly-out arrangement. This has the following advantages:

- Avoids the need to construct a new town and new infrastructure.
- Avoids a significant change to the social fabric of Borroloola.
- Avoids additional pressures on the limited social and community facilities at Borroloola.
- Avoids additional pressures on regional recreational facilities.
- Avoids social pressure likely from moving families accustomed to an urban environment to a remote rural location with limited facilities.
- Avoids a significant change to the accommodation arrangements of the existing workforce.

6.14 No Project

Should the open cut project not proceed, mining at McArthur River will cease. This will result in a loss of economic production for the Northern Territory, the loss of employment for the existing workforce, and detrimental socio-economic impacts in the region. Furthermore, the project benefits described in Section 2.3 will not be realised.