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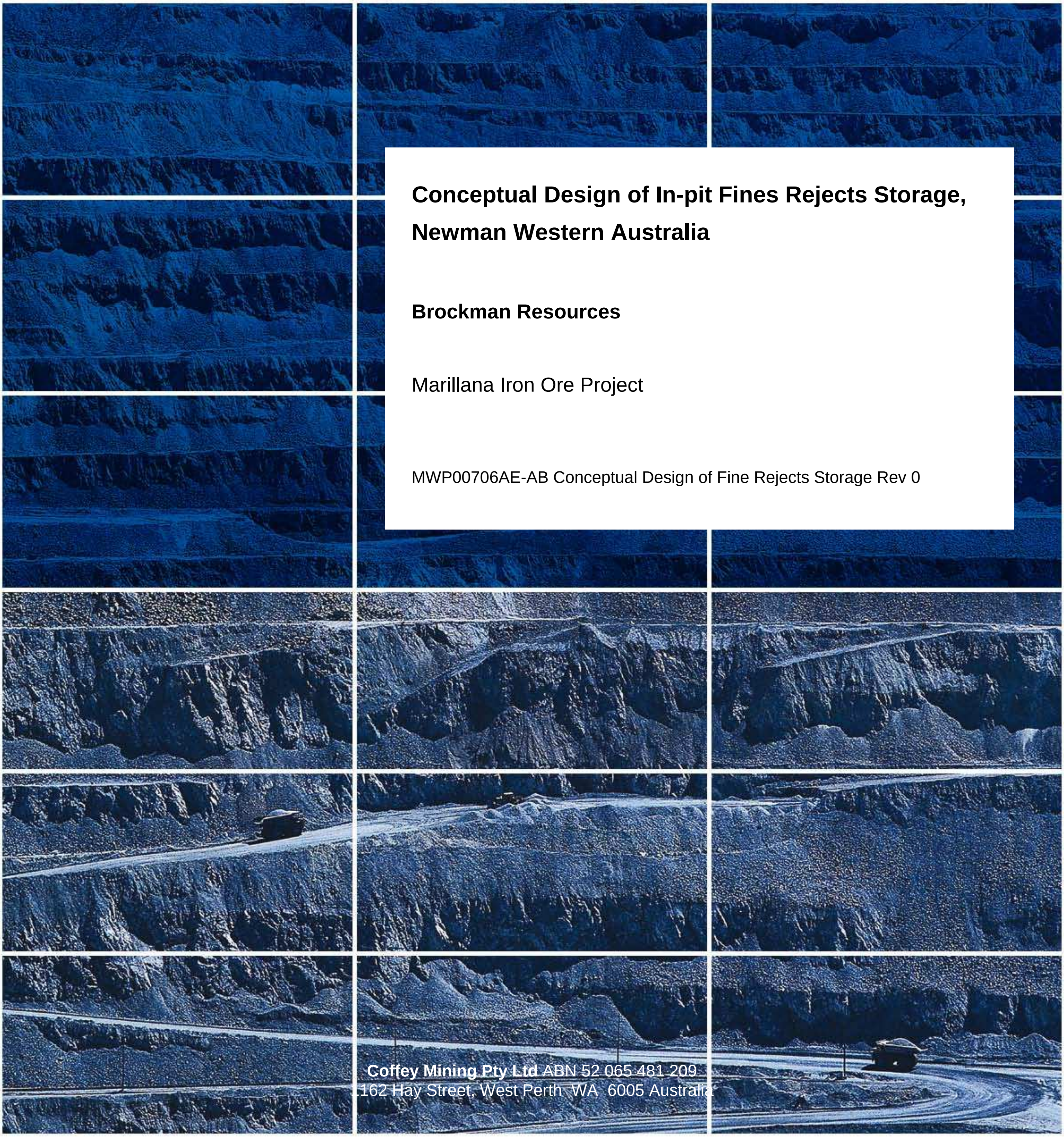

Conceptual Design of In-pit Fines Rejects Storage, Newman Western Australia

Brockman Resources

Marillana Iron Ore Project

MWP00706AE-AB Conceptual Design of Fine Rejects Storage Rev 0

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14 August 2009

Brockman Resources
PO Box 141
NEDLANDS WA 6909

Attention: Mr Jason Greive

Dear Jason

RE: MARILLANA IRON ORE PROJECT, CONCEPTUAL DESIGN OF IN-PIT FINES REJECTS STORAGE, NEWMAN WESTERN AUSTRALIA

Coffey Mining Pty Ltd is pleased to provide (3) bound copies and three (3) electronic copies in PDF format on CD of the final report (Rev 0) for the Conceptual Design of In-pit Fines Rejects Storage for the Marillana Project.

We trust this information meets your immediate requirements. Should you require clarification of any information, please do not hesitate to contact this office.

For and on behalf of Coffey Mining Pty Ltd

Christopher Lane
Senior Principal

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Christopher Hogg
Principal

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Table of Contents

List of Attachments

Executive Summary

A conceptual design has been prepared for Inpit Fines Rejects Storage [Facility] (IP-FRS) for the proposed Marillana Iron Ore Project (MIOP), which is owned by Brockman Resources. The design concepts for the fine rejects storage facilities for the MIOP comprises both above ground storage and in-pit storage. For the first seven years of production fine rejects will be stored at FRS (Fines Rejects Storage [Facility] an integrated waste landform that will be constructed within a mine waste dump, designated FRS1. From year eight and for the remainder of mine life, fine rejects will be stored in a mined out portions of the pits.

The processing plant for the MIOP was designed to produce approximately 9 million tonnes of coarse rejects and 10 to 12 million dry tonnes of fine rejects per annum for a 20 year mine life generated from beneficiation of Detrital and CID ore. FRSF1 is only designed to store fine rejects. The IP-FRSs are designed to store fine and coarse rejects, with storage cells constructed within the mine waste placed within the pit. Coarse rejects will also be incorporated into the mine waste and fine rejects stream and stored within the pit from Years 7 to 20.

The rejects properties were assumed based on the characteristics of typical rejects from beneficiation of iron ore from the Pilbara Region of Western Australia.

The operational design for the FRS and the IP-FRSs has been aimed at:

- Optimising the removal of surface water for return to the processing plant.
- Maximising rejects density and storage capacity by undertaking cyclic deposition for the above ground storages.
- Minimising land disturbance and potential seepage.

Rejects in the form of a slurry will be discharged subaerially and spirally from the full circumference of the perimeter embankments of the above ground FRS. Rejects will be deposited in discrete layers from numerous spigot point discharges. For the in-pit storage, rejects placement will be from a single point spigot discharge location that may be varied throughout the operation to provide optimum rejects deposition and water pond manoeuvring.

Monitoring instrumentation is proposed and a preliminary rehabilitation plan is presented that involves placement of mine waste cover and installation of spillways on the above ground FRS.

Several recommendations are provided to progress the IP-FRS design including rejects testwork, and IP-FRS embankment stability and seepage modelling.

1 INTRODUCTION

This document presents the details of the conceptual design for the Inpit Fine Rejects Storage [Facility] (IP-FRS) for the Marillana Iron Ore Project (MIOP). The IP-FRS comprises nine (9) separate storage cells within the one pit structure. The containment for rejects within each cell is provided through purpose placement of mine waste as part of the mine waste backfilling operation within the pit. .

This conceptual design broadly follows the Guidelines[1] of the Department of Mines and Petroleum (DMP), Western Australia for design of tailings storage facilities and is to be included in the Marillana Iron Ore Project Public Environmental Review (PER) documentation.

This work was commissioned by Jason Greive on behalf of Brockman Resources (BR). This report is prepared and is to be read subject to the terms and conditions contained in our proposal dated 18 June 2009. Our advice is based on the information stated and on the assumptions expressed herein. Should that information or the assumptions be incorrect then Coffey Mining Pty Ltd shall accept no liability in respect of the advice whether under law of contract, tort or otherwise.

2 BACKGROUND INFORMATION

The following information was provided by BR for the preparation of the conceptual design for the IP-FRS:

- Extracts from Section 2, Introduction and Project Background, of the DRAFT Prefeasibility Study.
- DRAFT of the Marillana Groundwater Prefeasibility Report by Aquaterra.
- Marillana Iron Ore Project: Mine-Waste Geochemistry & Implications for Mine-Waste Management by Graeme Campbell & Associates Pty Ltd

It should be noted that this report for the conceptual design of the IP-FRS has been prepared with reference to the above documents, literature on inpit tailings storage and case studies of inpit tailings storage.

This report must be read in conjunction with the reports by Aquaterra, Graeme Campbell & Associates and other reports pertinent to the proposed development.

3 CONCEPT DESIGN CONSIDERATIONS FOR INPIT TAILINGS STORAGE

3.1 General

The concept of filling completed open pits with tailings, or fine rejects as is the case for the MIOP, has been around for many years and is routinely undertaken in the mineral sands industry in Western Australia. However, there is limited published information on its use in the metalliferous mining industry. It has only been since the mid to late 1990s that the concept has been taken seriously and implemented at mines in Western Australia.

The issues which need to be addressed when investigating use of completed open pits for tailings storage are similar to many of the issues associated with conventional surface tailings storage facilities. The key points to be considered for ***any*** inpit tailings storage are as follows:

- Environmental advantages to the mine which comprise:
    - Potential Storage of hazardous waste, such as asbestiform materials.
    - Reduction in areas of natural vegetation to be cleared to provide alternative, above ground, tailings storage facilities.
    - Backfilling of pits which would otherwise collapse with time.
    - No aesthetic impact, which is normally associated with above ground tailings storage facilities.
- Environmental advantages beyond the mine which comprise:
    - Significant reduction in greenhouse gas production from burning diesel fuel to operate equipment constructing above ground storage facilities.
    - Significant reduction in water resource requirements as water recovery from pits is higher than conventional above ground tailings storage facilities.
    - Where reagents are used in procession there is potential for recovery of some of those reagents, reducing reagent consumption, which in turn reduces the external resource requirements of the project.
- Economic advantages are significant, with savings in capital and operating costs when whole-of-life tailings storage is considered. The only potential disadvantage is an increase in future mining costs if technological development in processing allows for further mineral recovery from the tailings.

3.2 Environmental Requirements

Environmental requirements of tailings disposal into a surface mining void are no different from conventional above ground tailings disposal facilities and should be designed to minimise impacts on:

- Topography

- Surface water, and
- Groundwater

Topographic considerations are important in respect to local aesthetics, particularly where the tailings surface finishes above the natural ground water table and a dry cover is proposed. Consolidation of the tailings is likely to occur with time resulting in a slightly depressed natural surface.

In arid environments the impact on surface waters is generally minimal, except where surface water originates from the open pit such as when a wet cover system is used or where catchment runoff into an open pit is significant. Most open pits are designed such that surface waters are diverted away from the void formed by mining and this regime should be maintained during tailings deposition and post closure.

Groundwater quality issues must be assessed, particularly where water quality is suitable for aquatic ecosystems, consumption by humans, or use in agriculture. The characteristics of the rock mass surrounding the void and the characteristics of the filled void eg groundwater level, tailings level, surface level, water quality, groundwater flows, evaporation rates, rainfall and runoff recharge, permeability, etc must be understood in order to assess the hydrogeological and hydrological regime downstream of the pit. Without such knowledge the impact on downstream users of leachates, if any, produced from the stored tailings cannot be assessed.

The design should also take into consideration potential for acid generation through geochemical characterisation of the tailings material and the surrounding rock mass. In the case of the MIOP the tailings and the surrounding rock are geochemically benign[2].

Dry covers and store and release covers are appropriate in arid environments and use of mine waste, topsoil and vegetation, native to the area, a fairly standard approach will be applied to the MIOP IP-FRS. Aesthetic considerations for the IP-FRS are less critical than for above ground storages as the finished surface will be covered with mine waste and will take the form of a natural land surface.

3.3 Physical Characterisation

Adequate geotechnical laboratory testing of representative samples of the tailings is essential for the design of a surface void tailings disposal facility and the following testing program is suggested as a minimum:

- classification tests, particle size distribution and Atterberg Limits,
- settling and air-drying tests, and
- large scale consolidation testing in a Rowe Cell to provide an indication of the consolidation characteristics of the materials which is linked to particle size distribution and plasticity. It also provides information on the permeability and density of the tailings under various overburden pressures. The results can be used to estimate surface settlement during operation and the final settlement post operation and rehabilitation.

No tailings testing has been done at this stage. Tailings testwork will be done when samples of the tailings are available.

3.4 Water removal/recovery systems

Water recovery is essential to maximise the density of the tailings, necessary for optimising the physical competence of the placed tailings and also to maximise the amount of waste material accommodated within the air space of the surface mining void. In semi-arid and arid environments water recovery is also essential for the operation of the process plant. Water recovery systems generally comprise a supernatant or clear surface water recovery system and in some cases an underdrainage system.

Supernatant water recovery systems are generally selected by the mine to suit particular requirements and usually comprise either a pontoon mounted pump or submersible pump supported by a pontoon. The pumping equipment is raised up the haul road as the tailings and water level rise.

3.5 Surface Settlement

The experience of the writer, for mines in Western Australia, suggests that where the inpit facilities are operated in accordance with the intent of the design, long term settlements of the tailings surface are likely to be less than predicted. This is because the water recoveries and in situ dry densities within the mine void storage facilities are generally higher than those predicted at the design stage. The impact of these settlements is of course minimal if the future use is for pastoral activities or the land is to be returned to native vegetation.

3.6 Geochemical characterisation

Geochemical testing of tailings is an essential part of the mining void tailings disposal design process. Assessing the geochemical characteristics of the void walls and the surrounding rockmass also needs to be considered in the planning process. This work should be done in conjunction with the geochemical testing of tailings. This testing should identify:

- the chemical constituents of the tailings;
- any potential to generate acid from the tailings;
- any implications for the final cover design;
- the proportion of tailings susceptible to acid generation; and
- the presence and toxicity of compounds or elements which may be transported by groundwater flows to downstream users. Geochemical characterisation of the tailings and the pit walls can also influence rehabilitation of the final surface. Chemical constituents of the tailings may be toxic to certain plants or chemicals may be present which can be taken up by plants and accumulate in the food chain as a result of animals grazing on the plants. Clearly, an understanding of the tailings, their chemical constituents, potential reaction(s) with the surrounding environment and the final cover is essential to successful long term tailings storage.

In the case of the MIOP the tailings and the surrounding rock are geochemically benign[2].

3.7 Geotechnical considerations

Safe, on-going void access via the haul road and also wall stability are vital to successful tailings deposition. The impact of tailings deposition on the void walls during operations needs to be recognised. Wetting of the walls is an obvious and unavoidable part of the process. This may have adverse consequences for local rock mass strength and may result in rock falls. In the case of the MIOP the tailings will be entirely encapsulated in mine waste, with conservative slopes of 1:2 (vertical to horizontal) used on the face of the waste dumps to encapsulate the tailings.

Geological, geotechnical and mining history data, collected during the operation of the open pit mine, will generally be available to fine tune the designs as required. Such data must be reviewed in terms of its adequacy and completeness. Visual inspection of the as constructed mine waste walls is essential to ensure compliance with the intent of the design. Potential instability can effect the safe operation of the facility both at the point of tailings discharge and surface water recovery.

Observations at a number of well managed active mining void tailings disposal facilities has shown that where water recovery is maximised the wetted front, caused by capillary rise within the surrounding wall materials, rarely exceeds 300 mm above the free water surface. The rapid rise of the tailings tends to limit saturation of wall materials. Stability of the walls is enhanced as the rising tailings form a buttress to zones of potential instability.

3.8 Rehabilitation

Rehabilitation of the tailings surface is essential where that surface is above the groundwater table. Detailed design is required to determine where the final tailings surface will be, having regard for: future settlement that is likely to take place as the tailings consolidate, potential future use of the landform and its impact on the surrounding environment. When planning rehabilitation all the information derived from the various geological, geotechnical, hydrogeological and geochemical studies are drawn together to optimise the desired outcome.

3.9 Existing Inpit Tailings Sites

In-pit tailings deposition has been used on a number of sites around the world. The list of some of the known sites where these facilities have been commissioned is presented in Table 3.8

Table 3.8

In-pit Tailings Storage Facilities

Project Name	Location	Current Owner
Daydream Pit	Cloudbreak	FMG
Hook Pit	Cloudbreak	FMG
Yandi Pit A	Yandi	Pilbara Iron
Mesa J Pit 1	Pannawonica	Pilbara Iron
Samphire Pit	Jubilee Mine	Dioro South Kal Mines
Bassett West Pit	Meekatharra	Mercator Gold Australia Pty Ltd
Rhodes Pit	Woodie Woodie	Consolidated Minerals
Camp East Pit	Woodie Woodie	Consolidated Minerals
Panglo	Kalgoorlie	Norton Goldfields
Baseline	Kalgoorlie	Norton Goldfields
Corlac	Kalgoorlie	Norton Goldfields
Paddington 2	Kalgoorlie	Norton Goldfields
Fisher Pit	Jundee, Wiluna	Newmont
Lawlers East Pit	Lawlers	Barrick - Lawlers Gold Mine
Great Eastern Pit	Lawlers	Barrick - Lawlers Gold Mine
Callop Pit	Meekatharra	Barrick - Plutonic Gold Mine
Catfish Pit	Meekatharra	Barrick - Plutonic Gold Mine
Dogfish Pit	Meekatharra	Barrick - Plutonic Gold Mine
Trout Pit	Meekatharra	Barrick - Plutonic Gold Mine
Redeemer Pit	Agnew Mine	Goldfields - Australia
Bunyip Pit	Cawse	OMG Cawse Nickel Operations
Perch Pit	Meekatharra	Barrick - Plutonic Gold Mine
Perch North Pit	Meekatharra	Barrick - Plutonic Gold Mine
Perch West Pit	Meekatharra	Barrick - Plutonic Gold Mine
Federal Pit	Bulong	Bulong Nickel
Criterion Pit	Bulong	Bulong Nickel
South Bounty Pit	Bounty	Forrestania Gold
East Bounty Pit	Bounty	Forrestania Gold
HP Pit	Lawlers	Barrick - Lawlers Gold Mine
Caroline Pit	Lawlers	Barrick - Lawlers Gold Mine
Manly North Pit	Mt Pleasant	Mt Pleasant Gold Operations
Scarborough Pit	Mt Pleasant	Mt Pleasant Gold Operations
Venture Pit	Norseman	Norseman Mining
Gwendolyn Pit	Diemals	Herbert Mining
Manly South Pit	Mt Pleasant	Mt Pleasant Gold Operations
Black Lady Sands Pit	Mt Pleasant	Mt Pleasant Gold Operations
LBE Pit	Mt Pleasant	Mt Pleasant Gold Operations
K1SE Pit	Marymia	Resolute Resources
K1 Pit	Marymia	Resolute Resources
Back of Beyond Pit	Mt Morgans, Laverton	Mt Morgans Gold Operations
Laterite Pit	Mt Gibson, Wubin	Mt Gibson Gold
Pit 1	Bardoc, Ora Banda	Bardoc Gold Mine
Yuletide Pit	Mt Magnet	Mt Magnet Gold NL
Jaspilite Pit	Mt Magnet	Mt Magnet Gold NL
Fuchsite Pit	Mt Magnet	Mt Magnet Gold NL
Mermaid Pit	Mt Magnet	Mt Magnet Gold NL
Golden Hope North Pit	Jubilee Mine	Harmony South Kal Mines
Bellevue Pit	Jubilee Mine	Harmony South Kal Mines
Mt Goddard Pit	Jubilee Mine	Harmony South Kal Mines
Twin Shafts Pit	Sandstone	Troy Resources
Lewis Pit	Burnakura	Tectonic Resources NL

Table 3.8

In-pit Tailings Storage Facilities

Project Name	Location	Current Owner
Reward Pit	Burnakura	Tectonic Resources NL
NoA 4 Pit	Burnakura	Tectonic Resources NL
NoA 6 Pit	Burnakura	Tectonic Resources NL
Moonlight Pit	Wiluna	Agincourt
Republic Pit	Wiluna	Agincourt
Golden Age Pit	Wiluna	Agincourt
Squib Pit	Wiluna	Agincourt
West Pit	Laverton Gold Project	Crescent Gold
Cock of the North Pit	Laverton Gold Project	Crescent Gold
Nolans Pit	Ravenswood, Queensland	Carpentaria Gold Pty Ltd
Block 1 Pit	Tarkwa, Ghana	Ghanaian Australian Goldfields

3.10 Benefits of Inpit Tailings Storage

The benefits of inpit tailings storage can be summarised as follows:

- Water conservation in arid environments where either water supply is scarce and/or expensive to procure.
- In-pit tailings storages are “essentially immune” to catastrophic failure and can be designed to withstand static and seismic forces.
- The footprint is smaller, when compared to other forms of tailings storage, because of the low moisture content and higher density of the inpit tailings.
- Use of in-pit tailings is seen as good environmental stewardship.

In addition to the benefits outlined above the advantages of combining in-pit tailings with mine waste are:

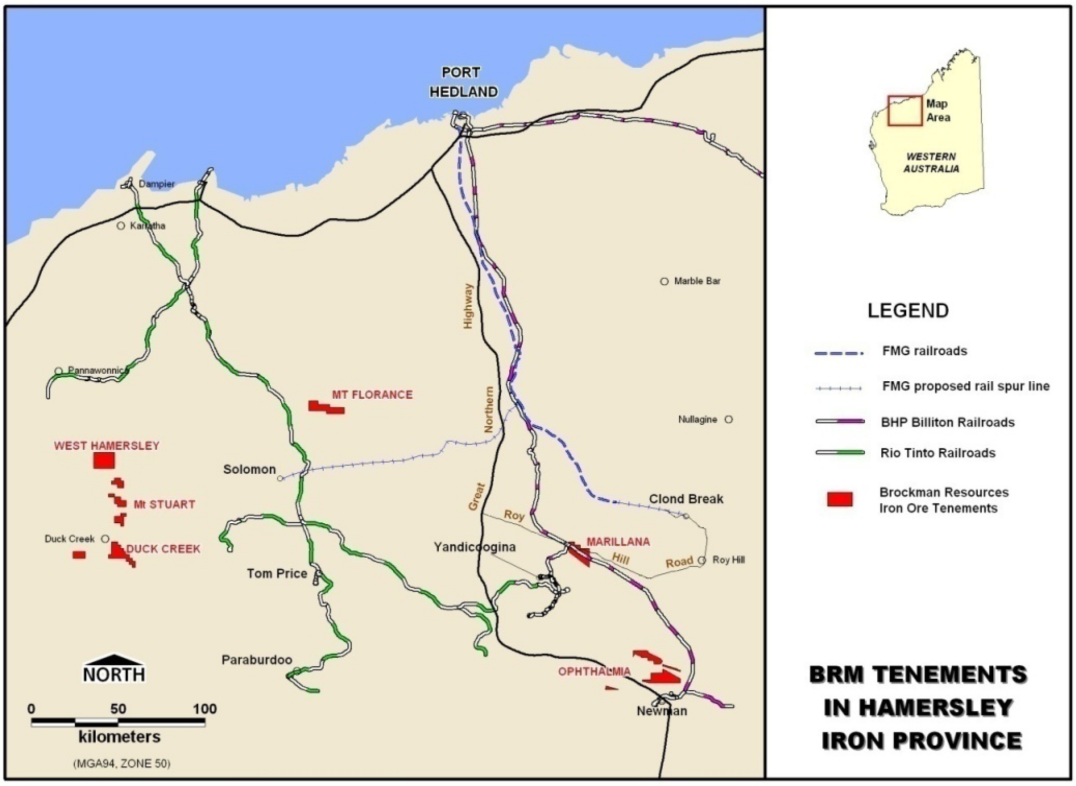
- Encapsulation of potential acid generating materials, both mine waste and tailings, within one structure.
- Lower longer term liability of the inpit tailings storage option compared to conventional above ground TSFs.
- Ability to co-dispose of waste materials within one structure.

4 SITE CHARACTERISTICS

4.1 Location

The Marillana mine site is located within the Pilbara region of Western Australia approximately 100 km north west of the township of Newman, refer to Figure 4.1.

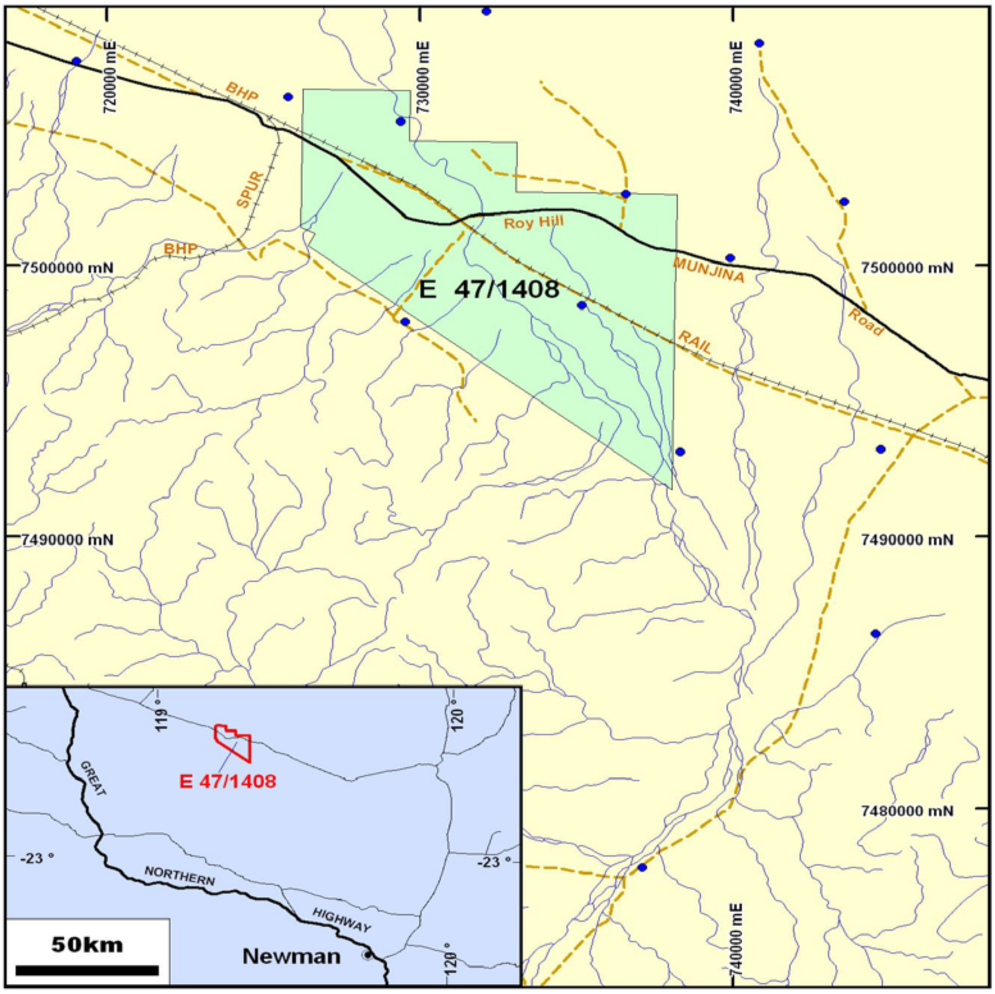
Figure 4.1
Project Location



The main access to the project site is via the Great Northern Highway and the unsealed Munjina – Roy Hill Road. Approximately 58 kilometres along the Munjina – Roy Hill Road.

The project is located on Exploration Licence (E47/1408). In December 2007, Yilgarn Mining (WA) Pty Ltd applied for Mining Leases (M47/1414 and M47/1419) over an area of approximately 82.5 square kilometres, covering the mineralised areas and infrastructure requirements. The mining leases are still yet to be granted as of July 2009. The approximate centre of the IP-FRS is Australian Map Grid (AMG84) co-ordinates 7500000 m North and 73000 m East. Tenements are shown on Figure 4.2

Figure 4.2
Tenements



4.2 Climate

The project is located in the Pilbara region of Western Australia and experiences an arid-tropical climate with two distinct seasons; a hot summer from October to April and a mild winter from May to September. Within the Pilbara, the temperature range is large and maxima are high. Summer temperatures may reach as high as 46C at Newman, which is a mean maximum of 31.3C. Light frosts occasionally occur during July and August. The climate experienced throughout the year is usually very dry since high temperature and humidity seldom occur simultaneously. Rainfall in the Pilbara is highly unpredictable and recordings are highest at stations around the Hamersley Ranges, which lie at altitudes of up to 900 m. From January to March, rain results from moist tropical storms penetrating from the north, producing sporadic and drenching thunderstorms. Tropical cyclones moving south from northern Australia waters also bring sporadic heavy rains. The average annual rainfall in the project area is in the order of 310mm and the annual evaporation in the order of 3000mm. The 1 in 100 year average recurrence interval 72 hour precipitation event in the project region has been estimated by Aquaterra to be 370 mm.

4.3 Landform

The project area lies on the Fortescue valley floor to the northeast of the Hamersley Range. The area is flat lying and consists of mainly transported colluvium and alluvium deposits, with minor outcrops of canga and Archaean Wittenoom Dolomite. The combined thickness of the transported cover is up to 80 m, and it hosts the targeted detrital deposits.

4.4 Geology and Soils

Transported cover can be divided into four subdivisions, including: colluvium (and alluvium), hematite detritals, pisoliths and cemented pisoliths. The colluvium and alluvium are interbedded and varies in thickness from 10 m to 57 m in the areas drilled. Below the colluvium/alluvium are hematite detrital accumulations, interbedded with lenses of pisolite rich material. In places, the base of the profile is a cemented goethitic pisolite, interpreted to represent a buried and partially re-cemented channel iron deposit (CID). The rocks within the deposit are part of the Brockman, Mt. McRae Shale, and Mt Sylvia Formations. Mineralisation is hosted within Detrital and Channel Iron Deposits (CID). Overburden material will include variable cemented silts, clays, and gravely clays.

4.5 Hydrogeology

In general, the water table throughout the region is a subdued reflection of the topography, so that groundwater elevations are generally highest along topographic high points and lowest in valley locations. The main aquifer sequence within the Project area is the orebody itself. This represents a palaeo-channel of the ancestral Weeli Wolli Creek and comprises Channel Iron Deposit (cemented pisolite) overlain by an uncemented pisolite gravel and Tertiary Hematite Detritals. These three units have varying hydraulic parameters (although all are relatively permeable).

Underlying the orebody are basement units from the Hamersley Group, which comprises BIF, shale and dolomite predominantly from the Mt Sylvia and Wittenoom Formations. The aquifer potential of these units within the Project is low, the basement is of generally low permeability. The alluvial sequence and the basement do not appear to have a hydraulic connection. The orebody is bounded to the north by distal clayey-alluvial deposits that form the flood plain of the Fortescue Valley. These alluvial deposits are generally clay-rich and of low permeability.

Aquifers are recharged directly from rainfall events. Direct recharge of rainfall in arid environments is minimal. However, indirect recharge may be locally significant with infiltration of runoff (streamflow) along drainage courses and the marsh. Recharge occurs preferentially along creeks and from the Fortescue Marsh (where the evapotranspiration of groundwater from the Marsh is periodically supplanted by recharge when the Marsh is inundated with surface water).

4.6 Hydrological Characteristics

The IP-FRS will only be subjected to incident rainfall directly onto the surface of the facility.

5 IP-FRS DESIGN CONCEPT

5.1 Parameters

The design parameters for the IP-FRS for the MIOP, as advised in the Scope of Work and relevant comments, for the conceptual design of the IP-FRS are presented in Table 5.1. The construction and operation program is presented in Section 5.2.

Table 5.1

Process Parameters

Parameter	Criteria	Comment
Project Life (years)	20	Years 1 to 7 are based on using an above ground storage whilst mining is undertaken to create the volumes for mine waste and rejects from years 8 to 25.
Pit strip ratio	1:2.5	First years of operation
Pit strip ratio	1:1.4	Average for life of Mine (LOM)
Plant feed (Mtpa)	37.5	
Concentrate production (Mtpa)	16.88	45% of plant feed
Coarse rejects (Mtpa)	9.0	P_{100} of -8.0 mm with bottom size of +1 mm, and is 24% of plant feed
Fine rejects (Mtpa)	11.63	Comprises sand with a P_{100} of -1.0 mm, and is approximately 10% of plant feed, 3.75 Mtpa and fine rejects (slimes) P_{100} of -0.063 mm, and is approximately 21% of plant feed,
Process water salinity (TDS mg/L)	<1,000	
Rejects slurry pH	7	
Fine rejects slurry density (% solids)	55	
% moisture at discharge (Engineering Terms)	82	
Solids SG	3.2	

At this stage, for the conceptual study, the fine rejects will be assumed to be a combined stream. Studies for keeping the sand and slimes streams separate may be undertaken at a later date.

It should be noted that the pit will accommodate approximately 90% of the total waste mined from the pit and when the coarse and fine rejects are added to the mine waste 64% of all materials mined will be returned to the pit.

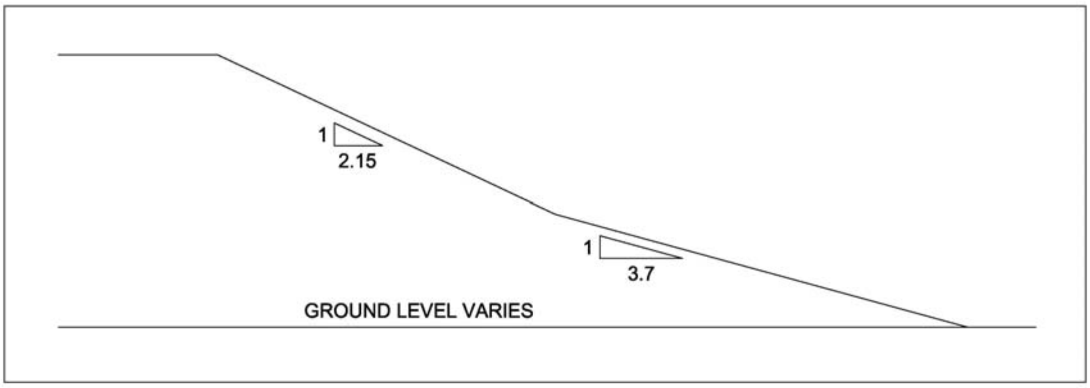
The processing of ore is primarily a mechanical process, involving minimal use of process reagents. The reagents employed in mineral processing and dewatering are non-hazardous biodegradable liquid and solid flocculants to assist settling in the thickeners. As the flocculant(s) exhibit a very low order of toxicity they are not classed as dangerous goods.

5.2 Design Concept

The design concept for the IPTSF involves scheduling placement of mine waste to create a series of 9 rectangular cells, shaped like inverted pyramids, for rejects storage within the mined open pit, with the storages protruding above ground level.

Process waste, rejects, and mine waste will be combined and located into one facility, with separate rejects cells crested by specific placement of mine waste to allow for the encapsulation of rejects. The objective of the IP-FRS is to create cells for rejects deposition which can be safely operated whilst mining is being undertaken in other parts of the pit. At this stage of the conceptual design the cells have internal side slopes of 1:2 (vertical to horizontal) and will be constructed with a geotextile filter on each side, and across the base where mine waste is present in the floor of each cell, to separate the rejects from the mine waste. The filter will allow clear water to pass from the rejects into the mine waste during consolidation of the rejects. The conceptual design of the above ground section of each facility has a 40 m wide crest, 5 m above the final surface of the rejects. Downstream slopes are concave as shown in Figure 5.2.

Figure 5.2
Typical Downstream Slope for 1P-FRS/FRS and Outer Batter Slope for Waste Dumps



The minimum distance between the active cell(s) and the working mine area is 100 m. Stability modelling has not been undertaken at this stage as it is likely that the configuration of the containment waste around each cell will change as fine tuning of the mine scheduling is undertaken with downstream slopes being flatter than the current conceptual design.

Figure A1 shows the overall concept of all the cells within the pit, with a plan, elevation and view of the underside of the cells provided. Drawing MWP00706AE-01 shows a more detailed plan and section with the final 'post closure' ground water level. It should be noted that the groundwater table, post closure is no closer than 2 m from the minimum final surface level. Drawing MWP00706AE-02 shows a plan of the pre-mining surface at the edges of the pit and pit contours and a section showing the pre-mining surface, pit section and existing ground water table.

Backfilling of the open pit with mine waste commences in Year 3 of the proposed project and Inpit Cell 1 will be available for rejects deposition in Year 7. Details of the concept design are summarised in Table 5.2.1.

Table 5.2.1

In-pit Cell Details

Inpit Cell No.	**Base RL**	**Top RL**	**Volume Contained (x 10^6 m^3)**
Inpit Cell 1	380	465	10.3
Inpit Cell 2	388	465	10.6
Inpit Cell 3	380	465	17.2
Inpit Cell 4	380	465	17.3
Inpit Cell 5	388	465	17.2
Inpit Cell 6	390	465	12.1
Inpit Cell 7	410	465	7.3
Inpit Cell 8	410	455	3.4
Inpit Cell 9	380	445	12.0

At this stage all inpit cells are filled such that the final surface is a minimum of 2 m above the projected post closure water table.

The construction and operation program for rejects facilities for the is presented in Table 5.2.2

Table 5.2.2

Construction and Operation Program

RSF No.	**Operating Years**																			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
FRSF1	🟥	🟥	🟥	🟥	🟥	🟥														
FRSF2 (if required)																				
Mine waste backfill in pit			🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨
Inpit Cell 1							🟥	🟥	🟥											
Inpit Cell 2								🟥	🟥											
Inpit Cell 3										🟥	🟥	🟥	🟥							
Inpit Cell 4											🟥	🟥	🟥	🟥	🟥					
Inpit Cell 5													🟥	🟥	🟥	🟥	🟥			
Inpit Cell 6														🟥	🟥	🟥	🟥	🟥		
Inpit Cell 7																	🟥	🟥	🟥	🟥
Inpit Cell 8																		🟥	🟥	🟥
Inpit Cell 9																			🟥	🟥

5.3 Geotechnical Considerations

5.3.1 General

No geotechnical investigations have been conducted for the IP-FRS as the facilities will essential be encapsulated within mine waste with conservative slopes of 1:2 (vertical to horizontal) used on the internal face of the waste dumps to contain the rejects.

Geological, geotechnical and mining history data, collected during the operation of the open pit mine, will generally be available to fine tune the designs as required. Such data must be reviewed in terms of its adequacy and completeness. Visual inspection of the as constructed mine waste walls is essential to ensure compliance with the intent of the design. Potential instability can effect the safe operation of the facility both at the point of rejects discharge and surface water recovery.

The conceptual design of the above ground section of each facility has a 40 m wide crest, 5 m above the final surface of the rejects. Downstream slopes are concave as shown in Figure 5.2. The minimum distance between the active cell(s) and the working mine area is 100 m.

Stability modelling has not been undertaken at this stage as it is likely that the configuration of the containment waste around each cell will change as fine tuning of the mine scheduling is undertaken with downstream slopes being flatter than the current conceptual design.

5.3.2 Concentrator Plant Rejects

Rejects from the concentrator comprise two streams; coarse rejects (P_{100} of -8.0 mm with bottom size of +1 mm) and fine rejects (P_{100} of -1.0 mm with a bottom size of 0.002 mm).

5.3.3 Rejects Characteristics

The rejects properties were assumed based on the characteristics of typical beneficiated iron ore rejects from the Pilbara region. It was assumed the average rejects slurry density ex-plant would be approximately 55% solids by mass. The rejects are assessed by Graeme Campbell[2] as geochemically inert, non acid forming (NAF).

The particle sizes were expected to be predominantly in the medium sand (<1 mm) to silt size range, with some clay sized materials (<0.002 mm). The settled dry density of the rejects was estimated to be 1.50 t/m^3 and the rejects beach slope was assumed to be 0.5%. Some segregation of rejects by particle size may be anticipated at the time of discharge to the IP-FRS. The actual segregation being a function of the particle size distribution and the rejects slurry density (% solids) at the time of discharge.

5.3.4 Mineralogy

The mineralogy of the rejects is not available at this stage and given the ores are Detrital and Channel Iron Deposits (CID) it can reasonably be expected that the mineralogy will comprise quartz, iron oxides and carbonates. No sulphide material is anticipated given the colluvial origin of the ores, confirmed by routine sulphur assays.

5.4 Engineering Parameters

The assumed engineering parameters for the design of the IP-FRS are based on other similar iron ore projects and these parameters and relevant comments in respect to the expected behaviour of the rejects materials are presented in Table 5.4.

Table 5.4

Engineering Parameters

Parameter	Value	Comment
Coarse Rejects		
P_{100} Coarse rejects (mm)	8	
Plasticity		Expected to be non plastic.
Permeability (m/sec)	1.0×10^{-3} – 1.0×10^{-5}	Medium permeability[3].
Loose dry density (t/m^3) @ 5% moisture content	1.75	1.75 (t/m^3) adopted for design purposes in the absence of testwork.
Loose angle of internal friction (ϕ - degrees)	30^o	
Cohesion (c – kPa)	0	
Fine Rejects		
P_{100} Fine rejects – fine rejects (mm)	1	
P_{70} Total rejects (microns)	63	
Rejects plasticity		Expected to be low.
Rejects permeability (m/sec)	1.0×10^{-8} – 1.0×10^{-9}	Very low permeability to practically impermeable[3].
Rejects loose dry density (t/m^3) @ 35% moisture content	1.50	1.50 (t/m^3) adopted for design purposes in the absence of testwork.
Rejects angle of internal friction (ϕ - degrees)	25^o	
Rejects cohesion (c – kPa)	5	
Mine Waste		
Maximum particle size	300 mm	Advice from Jason Grieve
Size range % > 100 mm	5	Advice from Jason Grieve
% < 100 mm > 1 mm	70	
%< 25 mm	50 - 55	
% < 1 mm	25	
Mine waste dry density (t/m^3)	2.40	
Mine waste angle of internal friction (ϕ - degrees)	40	
Mine waste cohesion (c – kPa)	0 - 5	
Mine waste permeability (m/sec)	1.0×10^{-1} – 1.0×10^{-5}	High to medium permeability[3]

5.5 Implications for Handling Rejects Materials

From experience of performance of other similar materials and inpit rejects facilities, the following comments are made:

(i) The coarse rejects -8mm to +1mm material are essentially a gravel, with some sand and are likely to be non plastic. These materials will readily drain or release free water once wet and consolidation under load will occur relatively quickly. These materials should be easy to handle and may be lost in the voids within the mine waste.

(ii) The fine rejects are sandy silt and may have low plasticity. The high percentages of fines, materials finer than 75 microns (silt and clay) approximately 70%, means that these rejects materials may not readily drain or release free water once wet. This will occur during deposition and infrequently during heavy rainfall events following deposition. This will impact on the methods used to place mine waste and place the rejects materials when they are partially saturated, ensuring that alternate facilities are available for cycling of rejects as required. It is however likely that consolidation of the materials, under load, will occur relatively quickly. If these materials are non dispersive and have low plasticity, then there will be potential for these materials to generate dust when dry and exposed to wind. If this is the case then covering these materials with other erosion resistant materials, or maintaining a moist surface will help to minimise dust generation.

(iii) Mine waste materials are essentially gravel, with cobbles and sand and are likely to be non plastic. These materials will readily drain or release free water once wet and settlement under load will occur relatively quickly. These materials should be easy to handle and given the predominance of the smaller particle size, less than 50 mm will facilitate placement of filters between the rejects and waste.

(iv) Blending the coarse rejects with the mine waste at the face of the IP-FRS may result in reduction of the grade of geotextile filter. Use of the various materials to generate filters has not been assessed at this stage.

Stability analyses will be essential in the detailed design phase given the degree of saturation of the rejects and characteristics of the mine waste, to ensure that there is no impact on tip head stability if the mine waste materials are to be end dumped over an open tip face whilst the rejects deposition is operating.

5.6 Construction

Figure A1 shows the conceptual design layout of the various cells within the mine pit, with Drawing MWP00706AE-01 providing a more detailed plan and section for the concept. Clearly the implementation of the IP-FRS requires the logistics of placement of mine waste to provide storage capacity to be in advance of rejects deposition. The construction and operation program for rejects facilities for the is presented in Table 5.2.2

The design concepts for the IP-FRS have the following construction features:

- Mine waste placement is progressive over the life of the Project.
- The waste containment embankments are constructed to full height using competent gravelly mine waste. These materials are removed as part of the routine mining operation.
- The minimum distance from an active cell to active the face of any mine waste dump is 100 m.
- Filter construction for each cell can be undertaken in stages as each cell is filled, particularly where deposition can be cycled between cells.

- At this stage deposition can be undertaken between 2 and sometimes 3 cells. Further refinement of the construction logistics during detailed design may allow additional cells to be brought on stream to optimize the flexibility of rejects deposition. With One cell in Operation, as in the case of Year 10 the maximum rate of rise is 25 m per year. With 2 cells operating the rate of rise is 12.5 m per cell per year and with 3 cells the rate of rise is approximately 8 m per cell per year. These rates of rise are consistent with other below ground storage facilities. The storage facilities must be operated and managed such that multiple cells, at least 4, are available for fine rejects storage to ensure the rate of rise is maintained at manageable level.
- Supernatant water must be continuously be removed from the facilities.
- Once there are a number of cells operating and the slurry density and moisture content of the thickened rejects is optimised, the rejects can be progressively placed in layers with layer thickness optimised to allow period of drying. Because there is no construction over the rejects the rate of rise will be a function of stability of the mine waste, water recovery at the surface and consolidation within the rejects stack.
- A final cover layer, 0.3 m to 0.5 m of mine waste is recommended, to prevent dust formation. A thicker cover will be required to provide a suitable surface safe for heavy equipment to traffic.
- The final surface can be rehabilitated as soon as possible after the mine waste is placed.

5.7 Water Recovery System

The primary method of water recovery is via the thickeners and filtration processes within the plant.

Surface water can be recovered via the use of pontoon mounted pumps located within each cell of the IP-FRS. Water liberated from the rejects can be collected in the mine dewatering system. Water recovered by this system can be returned to the process plant.

5.8 Seepage Management

No liners have been incorporated into the design of the IP-FRS.

Water recovery is expected from the pontoon mounted pumps and through the mine dewatering as seepage from the IP-FRS will be into the low points of the pit. Filters are incorporated into the design so as to retain the fine rejects solids and it is expected seepage from the tailing through the mine waste will occur as the rejects consolidate. Once the rejects have dried and consolidated it is expected that the rejects will have a permeability in the range of 1.0×10^{-8} m/sec to 3.8×10^{-9} m/sec, and thus would by classified, according to Terzaghi and Peck (1967)[5] as being very low to practically impermeable. It is reasonable to expect that seepage may well occur during the commissioning and post commission stage until such time as the operation of the thickeners and pumping processes are optimised.

5.9 Stability analyses

No stability analyses have been undertaken at this stage. Detailed stability analyses will be undertaken as part of the work for the preparation of the MP as it is likely that the configuration of the containment waste around each cell will change as fine tuning of the mine scheduling is undertaken with downstream slopes being flatter than the current conceptual design. Factors of safety for these analyses will be in accordance with ANCOLD (1999)[4].

5.10 Design Floods

The IP-FRS will be designed such that a 1 in 100 year average recurrence interval 72 hour storm event of 370 mm can be temporarily stored on the top of the facility. The design however assumes that the correct operational controls are adhered to and in particular that water is continually removed from the rejects during the thickening and filtration process, such that maximum freeboard allowances are easily maintained with dry materials.

A minimum operational freeboard (vertical height between the rejects beach and embankment crest) of 300 mm, together with a minimum beach freeboard of 200 mm, as per the DMP[1] requirements, is recommended to be retained at all times.

5.11 Drainage Diversion

Drainage diversions will be established (constructed) around the various section of the pit during mining, in a phased approach, prior to each panel within the pit being mined. These diversions will be maintained until such time as drainage is reinstated at specific locations across the backfilled pit. Two diversion channels are proposed at Mine Grid Eastings of 10850mE and 15950mE. Both channels are to be 2m deep with a 5m wide channel base (assumed minimum width) and 1:2.5 side batters. This channel design provides for a capacity of at least a 10 year ARI event. Due to the relatively high slopes, the channel is able to carry a relatively large flow within a relatively small cross sectional area. Full details of the drainage diversions are presented in the Aquaterra reports.

5.12 Hydrogeological Considerations

From a hydrogeological perspective, the deposition of waste-fines into the mine void will not impact on the restoration of continuity along the aquifer system. However, the aquifer parameters will be significantly different to those of the pre-mining system. The waste fines will have a very low permeability (~0.001 m/d) and will occur as a series of discrete inverted cones from the surface to the base of the pit.

This will be surrounded by waste rock which may be of a slightly lower permeability than the original orebody material (~1 m/d) but sufficiently large so as to allow some groundwater flow. The existing numerical groundwater model has been used to simulate water table recovery and subsequent flow through this reconstructed system. The results show that the long-term recovery of the reconstructed aquifer results in increased water levels at the upstream end of the mine void and decreased water levels at the downstream end.

Overall water level changes are generally less than 2.5 m, and are focused on the areas directly upstream and downstream of the backfill zone. Figure 5.12.1 shows the minimal effect that the low permeability backfill material has on the overall groundwater contours on a regional scale.

Figure 5.12.1
Predicted Water Levels: Calibration and Infill Cases.

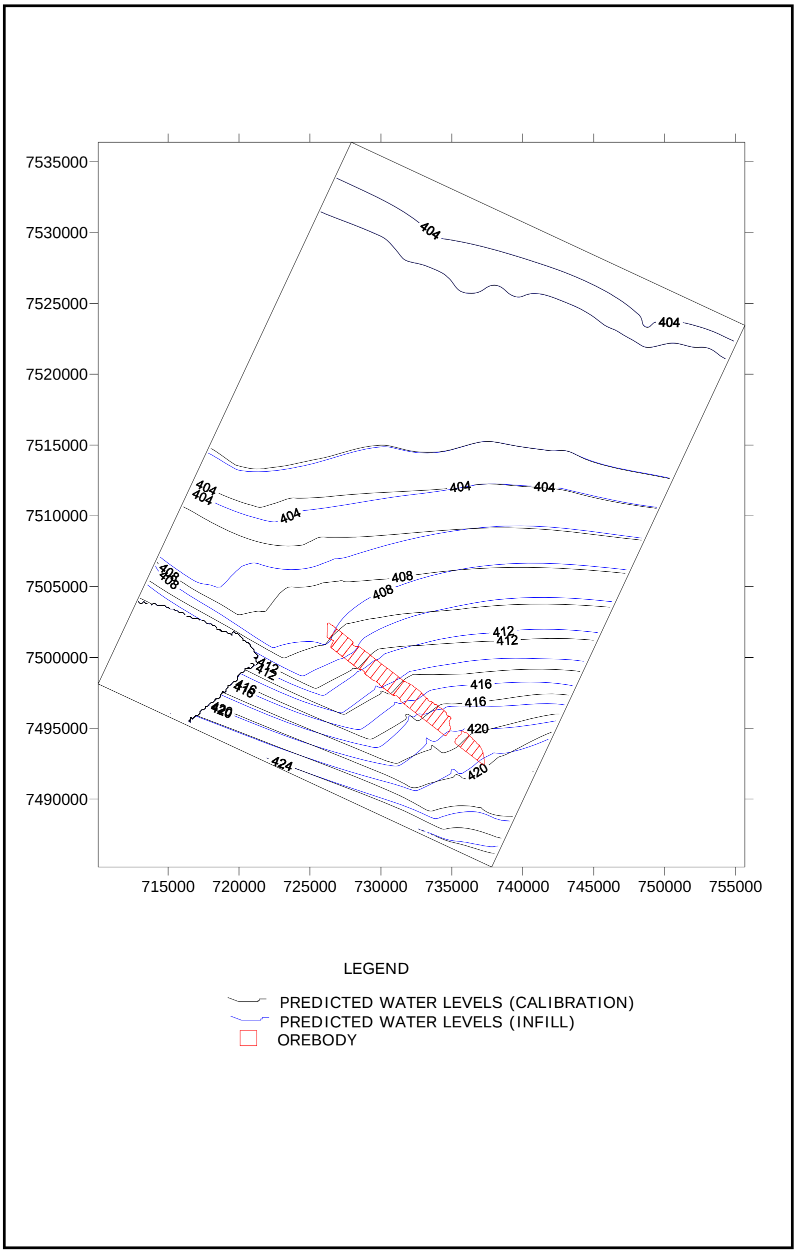
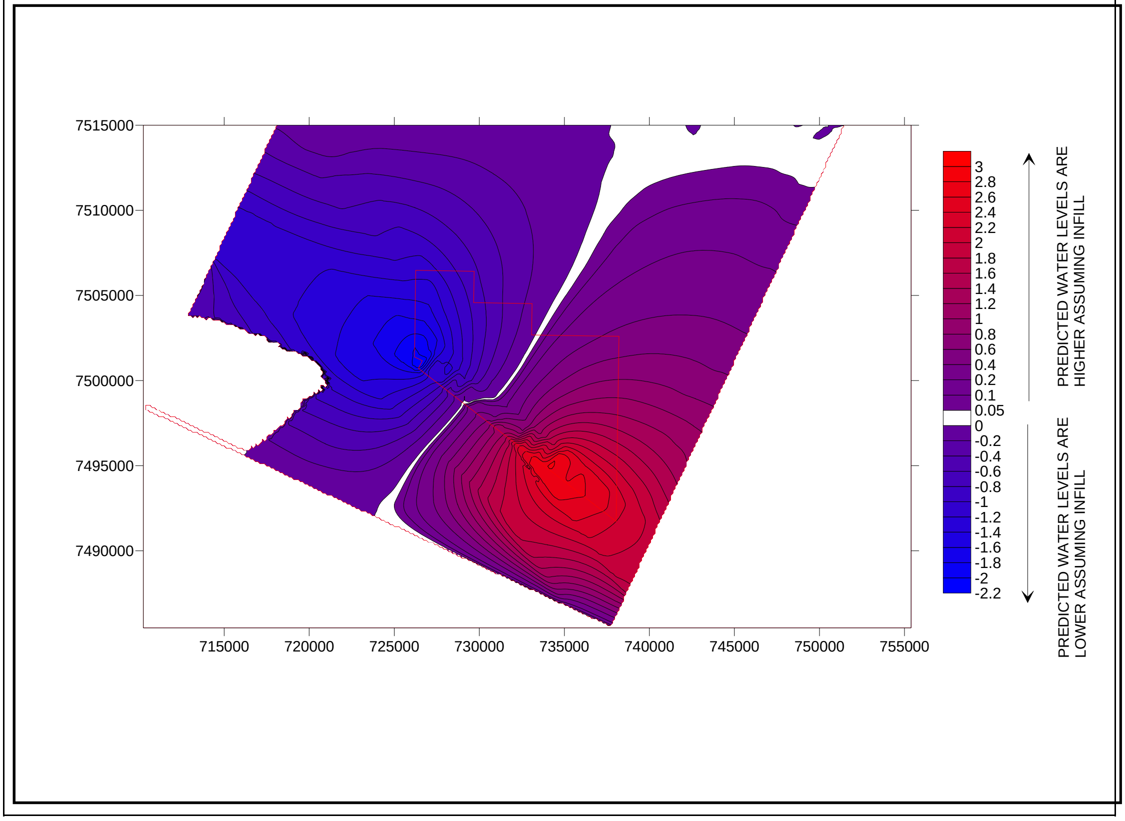


Figure 5.12.2 shows the modelled change in groundwater levels in the vicinity of the backfill operations.

Figure 5.12.2
Predicted Water Level Change



6 OPERATION

The IP-FRS will have an operations manual prepared as part of the preparation of the Mining Proposal (MP). The operational design of the IP-FRS is aimed at:

- Optimising the removal of surface water from the facility,
- Maximising the rejects density and storage capacity by rotating the deposition, and;
- Reducing environmental impacts.

The following design considerations have been incorporated into the conceptual design of the IP-FRS:

- Rejects in the form of a slurry will be discharged sub-aerially, in discrete layers across the deposition surface by moving the deposition points. Movement of the discharge point will to ensure an even development of the rejects surface within the cells. The length of time between successive depositions (i.e. drying time) on any one area will be maximised.

- The storage facilities must be operated and managed such that multiple cells, at least 4, are available for fine rejects storage to ensure the rate of rise is maintained at manageable level.
- Supernatant water must be continuously be removed from the facilities.
- At closure the rejects will be covered with mine waste to prevent dusting and optimise consolidation and the insitu dry density of the rejects.
- The facility could contain a considerable body of water during a rainstorm. The minimum total freeboard volume is estimated at 0.8 m maximum per cell in order to provide temporary storage of a 1 in 100 year average recurrence interval (ARI) 72 hour storm event (0.4 m) plus a margin for emergency.
- With the surface sealed, at closure of the IP-FRS, there will be no freeboard volume requirement.
- On decommissioning the IP-FRS will remain as a permanent feature of the landscape and will consolidate and drain to an increasingly stable mass within the mine waste dump. The top surface and the batters will be stabilised and will be rehabilitated as described in Section 8. Rejects stored within the IP-FRS will be part of the overall waste dump facility.
- Based on the performance of other inpit rejects storage facilities, settlement post closure is expected to be minimal.

7 INSTRUMENTATION AND MONITORING

Monitoring will comprise recoding of water recovered by the supernatant pump and mine water recovery with particular attention to total suspended solids (TSS) from the toe of the waste dumps adjacent to the operating cells of the IP-FRS. The data collected will be used to assess the IP-FRS performance from a geotechnical and environmental perspective.

It is recommended that water records are updated monthly. Water sampling and laboratory testing of recovered water samples should be conducted on a quarterly basis. Collected information will be reviewed regularly and reported in an annual audit and management review of the IP-FRS.

8 CLOSURE AND REHABILITATION

At this stage, all perimeter embankments cells of the IP-FRS will be covered with mine waste and a minimum 0.3 m to 0.5 m thickness of mine waste is recommended. A specific closure plan will have to be developed for the whole mine pit. The main objectives of the IP-FRS cover will be to:

- Provide a robust long-term cover that will stabilise the surface of the IP-FRS;
- Retain/store all rainfall from most precipitation events within the cover system for subsequent release by a combination of evaporation and evapotranspiration; and

- Control the flow of any excess surface water across the IP-FRS such that significant erosion does not occur.

It should be noted that pit backfilling operations will be such that the entire mine void will be backfilled to a minimum of 2 m above the water table, with some areas having fill 20 m above the water table.

9 EMERGENCY ACTION PLAN

The Operations Manual for the IP-FRS, to be developed as part of the detailed design, will provide a detailed description of the operating procedures for the rejects storage and include an 'Emergency Action Plan'. However, the likelihood of a failure of the IP-FRS leading to an out rush of rejects and/or water with the potential to cause serious injury or death is considered to be a very low possibility, based on the following factors:

- The rejects will have moisture when placed in a hot dry climate, with filters in each of the cells.
- The retention embankments will be engineered, mass structures.
- The hot dry climate will promote rapid drying following extreme rainfall conditions.
- The IP-FRS is below ground level in very flat terrain, with no potential for significantly concentrating any outflow from a dam break incident.

10 RISK ASSESSMENT

Given that the coarse and fine rejects are NAF and the groundwater system will not be adversely impacted from the deposition of rejects within cells within the mine waste dump, there is low risk to the environment from the proposed inpit rejects deposition.

The main area of risk is effectively a project risk, in that the operational logistics for movement of mine waste must be such that cells are available for rejects deposition in a timely manner. Table 5.2.2 shows the current sequencing of IP-FRS construction. It is expected that this sequence will be refined as the project progresses through the detailed design phase.

11 REFERENCES

The following standards and references were used in the preparation of this report.

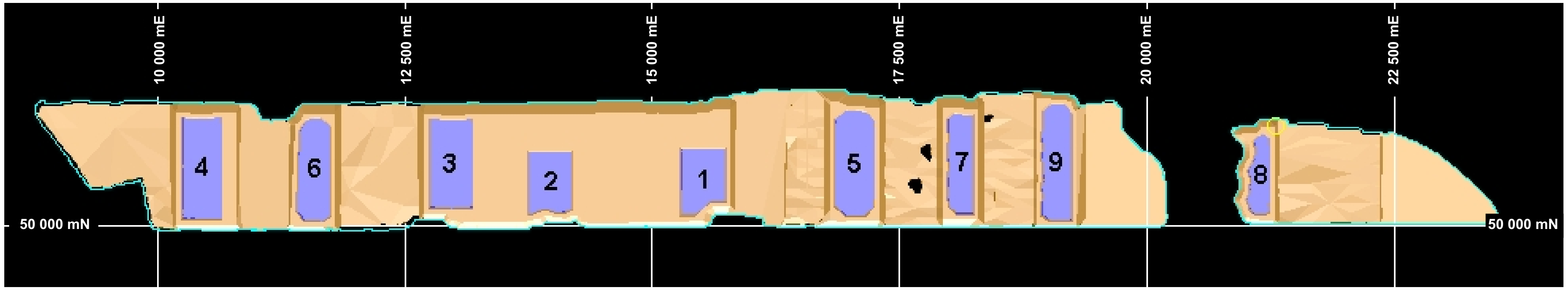
1. DMP (1999), *'Guidelines on Safe Design and Operating Standards for Tailings Storage'*.
2. Campbell, G., (2009) *'Marillana Iron Ore Project: Mine-Waste Geochemistry & Implications for Mine-Waste Management'*.
3. Lambe, W. T., and Whitman, R. V., (1979) *'Soil Mechanics, SI Version'*, page 287.
4. ANCOLD (1999) *'Guidelines on Tailings Dam Design, Construction and Operation'*.

Attachments

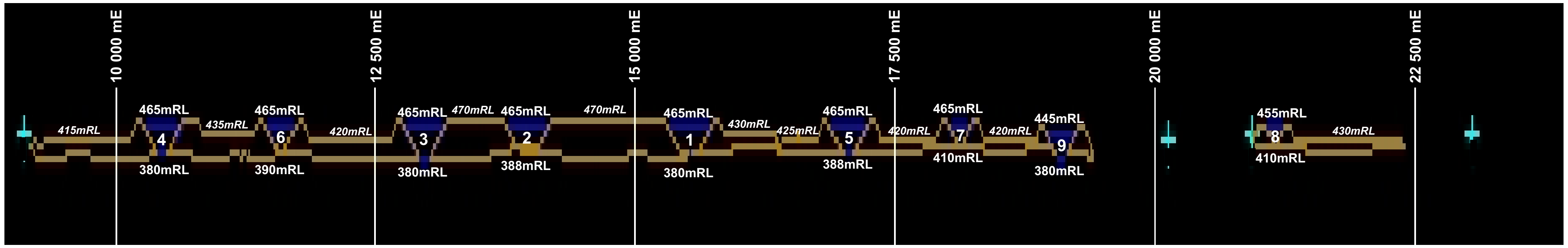
Appendix A - Design Concept Figure A1

Drawing MWP00706AE-01 Plan and Section – Post Mining

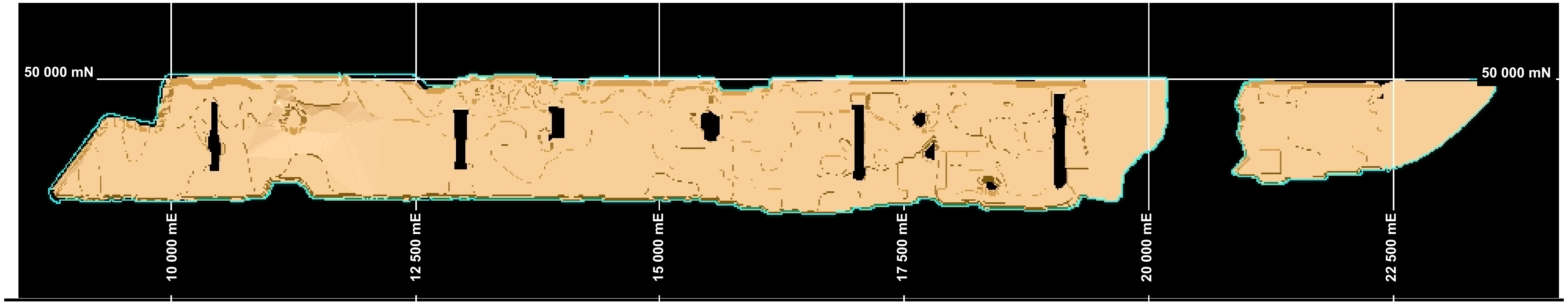
Drawing MWP00706AE-02 Plan and Section – Pre-Mining



PLAN



SECTION @ 50650 mN (Vertical scale exaggerated)



UNDERNEATH VIEW

coffey mining
SPECIALISTS FROM
BOARDROOM TO MINE FACE

Drawn	FAC	**Original Size**	A3
Approved	CL	**Project no:**	MWP00706AE
Date	13/07/2009	**Figure**	**A1**
Scale	1:50000		

BROCKMAN RESOURCES
MARILLANA IRON ORE PROJECT

CONCEPT DESIGN FOR INPIT FINE REJECT STORAGE

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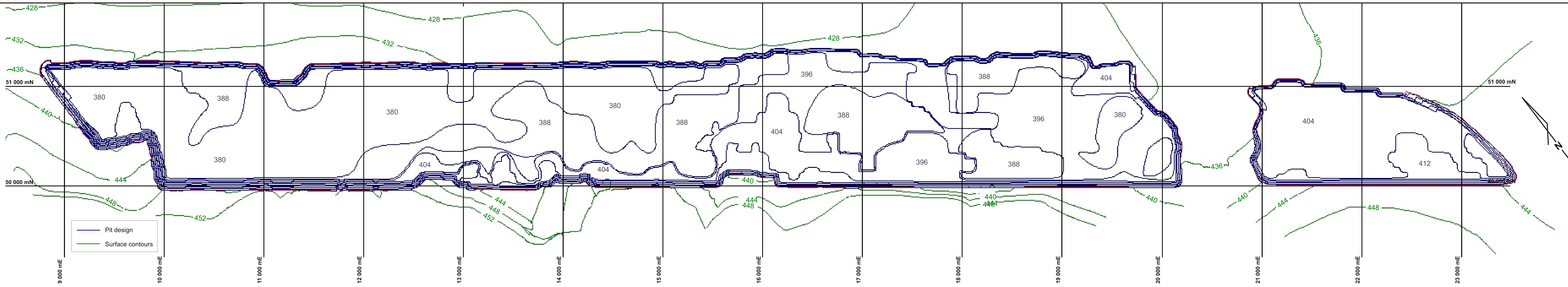
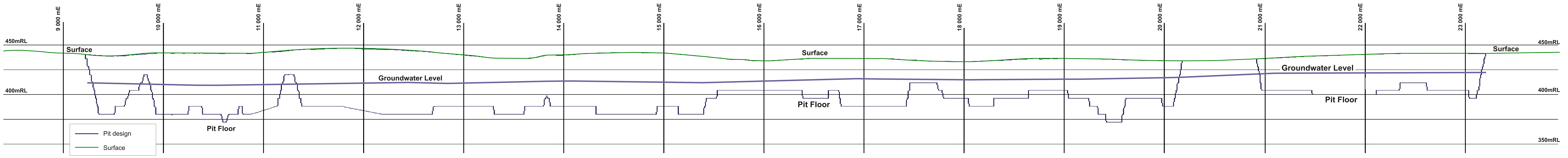


PLAN - PIT FLOOR CONTOURS



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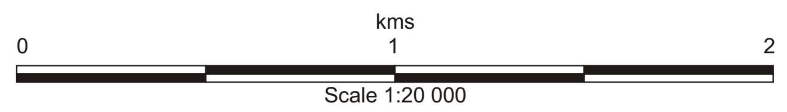

coffey mining SPECIALISTS FROM BOARDROOM TO MINE FACE	Drawn	FAC	BROCKMAN RESOURCES MARILLANA IRON ORE PROJECT CONCEPT DESIGN FOR PIT	Original Size	A1
	Approved	CL		Project no:	MWP00706AE
	Date	23/07/2009		Drawing	MWP00706AE-02
	Scale	1:20000			

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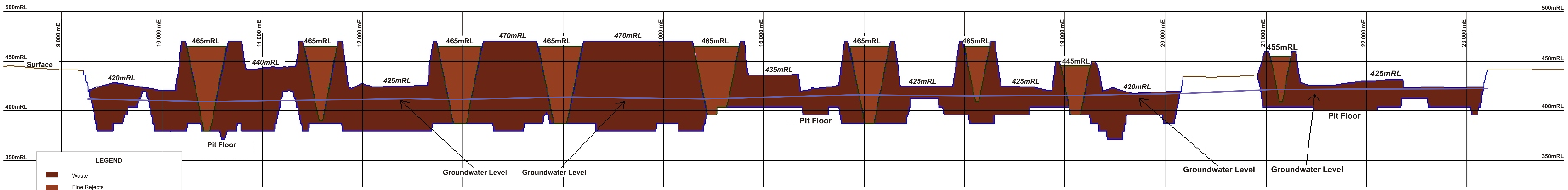
PLAN - MINE BACKFILL



SECTION @ 50650 mN (Vertical scale exaggerated)

LEGEND

▇	Waste
▇	Fine Rejects

Areas with fill below pit rim have volumes as shown

Co-ordinates shown are mine grid

kms
0 1 2
Scale 1:20 000

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Drawn	FAC
Approved	CL
Date	22/07/2009
Scale	1:20000

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CONCEPT DESIGN FOR BACKFILL

Original Size	A1
Project no:	MWP00706AE
Drawing	MWP00706AE-01