Sheffield Resources LIMITED

THUNDERBIRD BFS DELIVERS OUTSTANDING RESULTS

HIGHLIGHTS[1]

- Bankable Feasibility Study confirms Thunderbird as a world class mineral sands project
- Long mine life of 42 years, offering leverage to multiple pricing cycles
- Pre-tax NPV_{10} of A$676 million, IRR of 25%
- Stage 1 capital of A$324 million plus A$24 million contingency (A$348m, US$261m)
- EBITDA of A$5.1 billion over Life of Mine (LOM), averaging A$123 million per annum
- First 10 years of scheduled production comprises 97% Proved Ore Reserves
- Globally significant annual production of zircon and ilmenite
- Premium Zircon is ceramic grade, LTR Ilmenite has market leading qualities
- Offtake negotiations are in progress
- Azure Capital leading discussions with project financiers and strategic investors
- Targeting initial production in 2019
- 100% owned and located in one of the world's best mining jurisdictions

Sheffield Resources Limited ("Sheffield", "the Company") (ASX:SFX) is pleased to report results of the Bankable Feasibility Study (BFS) on its 100% owned Thunderbird Mineral Sands Project (the Project or Thunderbird), near Derby in northern Western Australia.

The BFS has demonstrated a financially robust and technically strong project, forecast to generate EBITDA of A$5.1 billion over a 42 year mine life.

Sheffield's Managing Director Bruce McFadzean described the outcome of BFS as an outstanding result which highlights Thunderbird's status as a world class mineral sands project.

"The study findings show Thunderbird is a technically low risk project and is anticipated to generate significant and consistent financial returns over an exceptionally long mine life of 42 years," he said.

"Thunderbird is located in one of the most attractive mining investment jurisdictions and is well placed to deliver a long term, secure supply of high quality products to a range of potential customers.

"Completion of the BFS clears the way for delivery of the next major milestones; offtake, permitting and project finance ahead of a targeted construction start in the second half of 2017.

"Offtake discussions are progressing with leading global ilmenite and zircon consumers. There has been strong interest in our high quality suite of products.

"In conjunction with our corporate advisors Azure Capital, we are engaging with both project finance providers and potential strategic partners to arrive at an optimal funding solution."

Sheffield's Thunderbird BFS Technical Report will be available in full on the Company's website as of Monday, 27 March 2017.

1. Please refer to the assumptions, sensitivities, risk factors and cautionary statements disclosed respectively on pages 7, 9, 10 and 56 of this announcement, which may adversely impact upon the information and forecasts in this announcement.

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Financial Highlights

The BFS is based on a conventional dozer trap mineral sand mining and processing operation involving an initial 8.5 million tonnes per annum (Mtpa) throughput (single mining unit), doubling to 17Mtpa in Year 5 via the addition of a second mining unit and processing stream.

The BFS has demonstrated a low risk, technically strong project with robust financial metrics as summarised in Table 1-3 and Table 1-4. The financial analysis is based upon capital, cost and revenue assumptions derived from market contract and supply tenders, industry expert product pricing, consensus foreign exchange rates and a real discount rate of 10%.

The forecast EBITDA of A$5.1 billion generated over a 42 year mine life underpins the strategic value of the Thunderbird Project.

The mine schedule has been optimised to provide strong and consistent cash flows over the 42 year mine life. Figure 1 illustrates a consistent cost profile over the mine life with benefits of high grade, near surface ore in early production years, resulting in superior financial metrics.

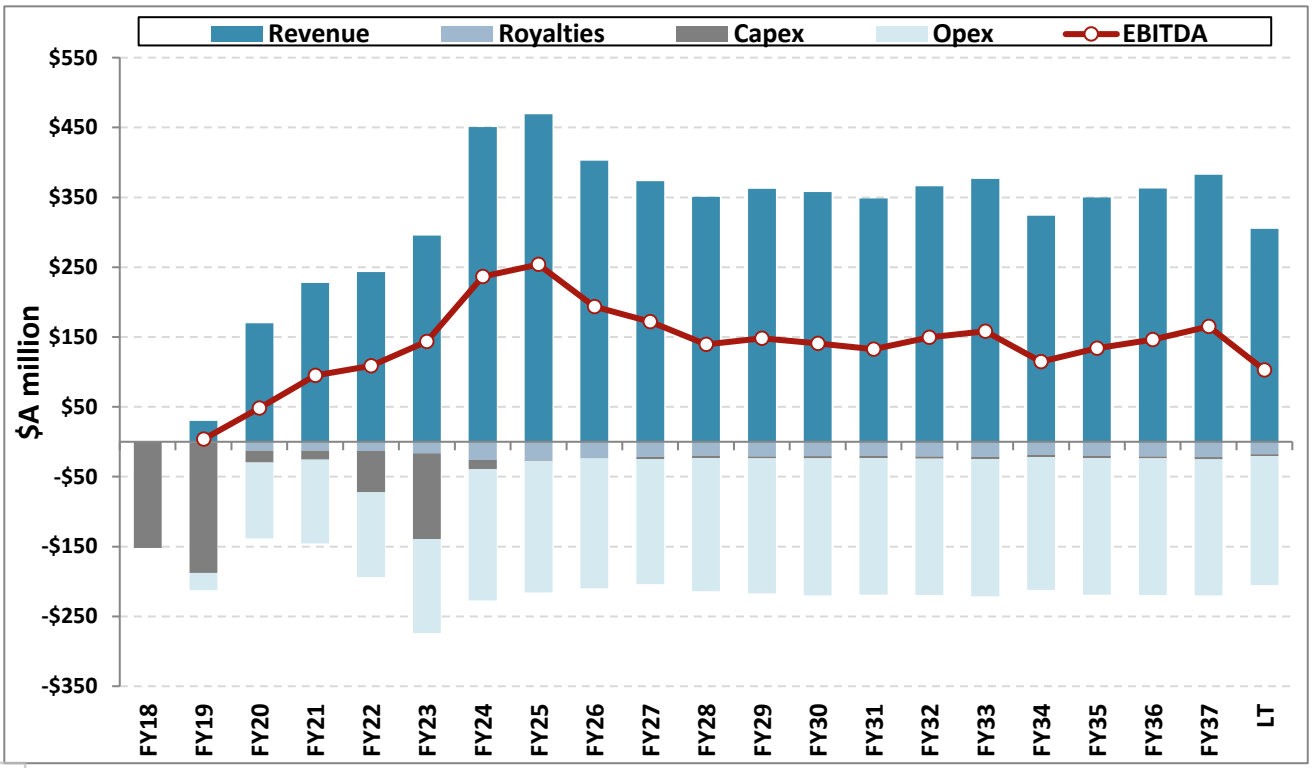

Figure 1: Annual EBITDA (real 2017 prices) and Cash Flows

Table 1-1: Production Assumptions

Production (Average tonnes per annum)	Financial Year 2019 – 2023[5]	Financial Year 2024 – 2033[6]	LOM[8]
Premium Zircon	51,500	88,700	76,100
Zircon Concentrate	49,100	80,100	68,500
LTR Ilmenite	264,500	481,600	387,800
Hi-Ti88	12,800	23,000	20,300
Titano-magnetite	156,600	285,300	229,800

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Table 1-2: Commodity Price Assumptions

Commodity Prices (US$)[4]	Financial Year 2019 – 2023[5]	Financial Year 2024 – 2033[6]	LOM[8]
Premium Zircon	1,282	1,387	1,381
Zircon Concentrate	659	677	676
LTR Ilmenite	183	183	183
Hi-Ti88	500	500	500
Titano-magnetite	48	48	48

Table 1-3: Thunderbird Project Key Financial Metrics

$AM, Real 2017 Prices	Financial Year 2019 – 2023[5]	Financial Year 2024 – 2033[6]	LOM[8]
Revenue	854	3,875	13,560
Royalties	(50)	(223)	(781)
Net Revenue	**803**	**3,652**	**12,779**
Opex: Mining	(104)	(421)	(1,828)
Opex: Processing	(228)	(1,024)	(4,093)
Opex: Logistics	(73)	(288)	(1,005)
Opex: Site G&A	(59)	(172)	(707)
Total Opex[1]	**(464)**	**(1,905)**	**(7,633)**
EBITDA	**339**	**1,746**	**5,146**
A$ Site costs[2] / tonne ore mined	14.65	11.11	11.40
A$ Revenue / tonne ore mined	25.99	22.29	19.92
US$ Site costs[2] / tonne Premium Zircon equivalent[3,4]	721	692	790
US$ Revenue / tonne Premium Zircon equivalent[3,4]	1,278	1,387	1,381

Table 1-4: Capital Expenditure and Financial Metrics

	Stage 1	Stage 2	LOM[8]
Capital Expenditure ($AM)[7]	**348**	**195**	**543**
Pre-Tax Project NPV (10% WACC)[1]			675.6
Pre-Tax IRR %			24.9
Post-Tax Project NPV (8% WACC)[1]			620.4
Post-Tax IRR %			20.6

Notes:
1. Excludes corporate overheads.
2. Includes sustaining capex, excludes corporate overheads and royalties.
3. Premium Zircon equivalent tonnes calculated as total revenues across all products/premium zircon price
4. AUD:USD = 0.75:1.00. USD long term commodity prices are quoted as FOB terms, sourced from TZMI (Premium Zircon, Zircon Concentrate, LTR Ilmenite and Hi-Ti88) and Ruidow (for Titano-magnetite).
5. Stage 1 time period depicted as Q4 FY2019 to Q3 FY2023 inclusive
6. Stage 2 first 10 years depicted as Q4 FY2023 to Q3 FY2033 inclusive
7. Excludes sustaining capex.
8. LOM (Life of Mine) describes the period 2018 to 2061, inclusive of the construction period.

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The pre-tax NPV_{10} of A$676 million and significant pre-tax IRR of 25% support the Project's viability and provide a compelling case for financing and development.

The estimated initial development capital of A$348 million including A$24 million of contingency (7.5%) required over the first two years to facilitate Stage 1 development is based on an Engineering, Procurement and Construction (EPC) approach to the major process plant capital components. Stage 2 construction is expected to commence in 2022. The Stage 2 expansion to approximately 17Mtpa throughput, is estimated at A$195 million (excluding contingency) and Sheffield's current expectation is that this will be predominantly funded from cash flows.

Sensitivity analysis detailed on pages 19 and 20 illustrates the key drivers of the Project's economics are product prices, plant recoveries and ore feed grade. The Thunderbird NPV is less sensitive to capital due to the high cash flows generated over the effective discount period. Thunderbird is also strongly leveraged to the zircon price commanding 62% of forecast revenues.

Globally Competitive

Figure 2 depicts the Calendar Year 2020 TZMI revenue to cost (RC) ratio curve for the mineral sands industry. Thunderbird is represented adjacent to first quartile producers, several of whom are vertically integrated and operate titanium feedstock beneficiation plants.

[1]Note:
- *Period represented for Thunderbird is the 4 year period post-Stage 1 ramp up, equalling Q2 Year 3 to Q1 Year 7 inclusive*
- *RC ratio determined using long-term pricing and forecast exchange rate*
- *TZMI has undertaken a review of the Sheffield BFS financial model. TZMI has relied on operating cost, product pricing and production schedules provided by Sheffield Resources for Thunderbird, all other modelling has been done by TZMI.*

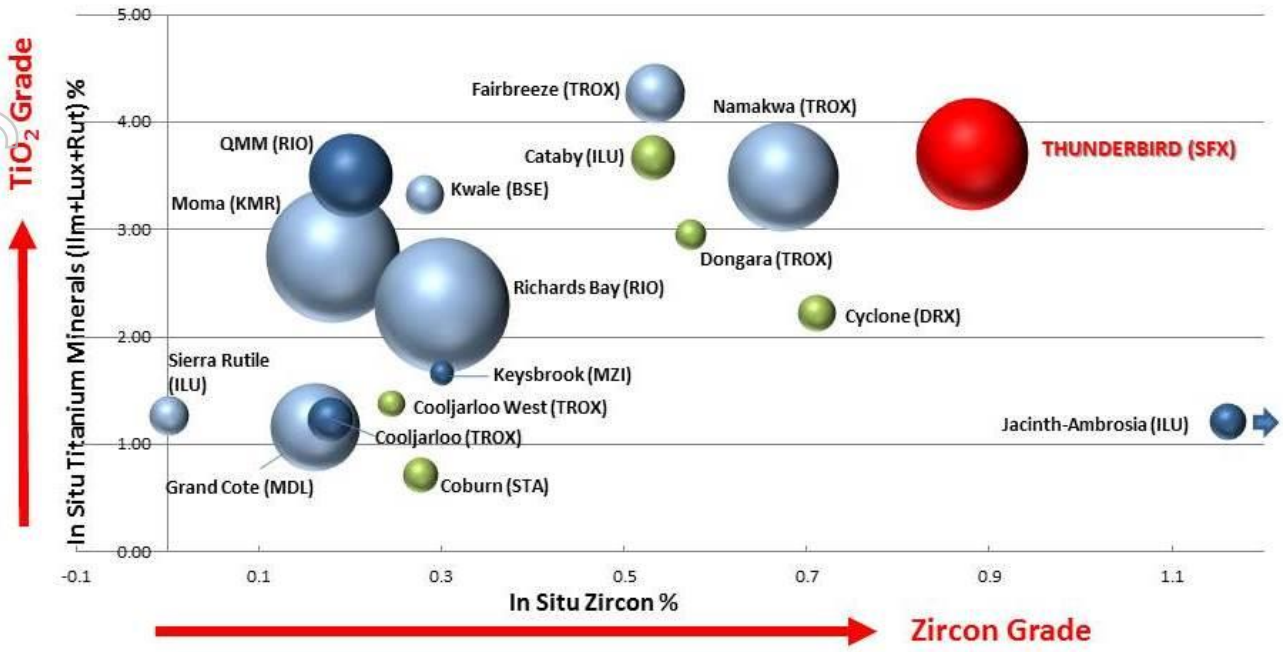
Figure 2: TZMI 2020 Industry Revenue to Cash Cost Curve

Thunderbird's position on an industry RC curve shows the Project is expected to be highly competitive and capable of operating through multiple commodity pricing cycles, underpinning the Project's global strategic value.

Large, High Grade Ore Reserve

The Thunderbird BFS is underpinned by one of the world's largest and highest grade, zircon and ilmenite-rich mineral sands Ore Reserves (Figure 3, Table 2).

Most of the world's minerals sands Ore Reserves are in higher risk jurisdictions. Thunderbird is located in Western Australia, one of the best mining jurisdictions in the world[1].



Blue bubbles are operating mines, green bubbles are Ore Reserves reported but project is not operating. Light blue bubbles represent operating African mines' Ore Reserves
Bubble size proportional to tonnes of contained VHM. Only Ore Reserves > 1Mt contained VHM shown.
Data compiled by Sheffield from public sources
This analysis does not illustrate the variance in product value between rutile, leucoxene and ilmenite products

Figure 3: Thunderbird Ore Reserves ranked against Ore Reserves of current mineral sands operations and projects

Table 2: Thunderbird Ore Reserve March 2017

Ore Reserve			Valuable HM Grade (In-Situ)[2]					
Reserve Category	Material (Mt)	HM (%)	Zircon (%)	HiTi Leuc (%)	Leucoxene (%)	Ilmenite (%)	Oversize (%)	Slimes (%)
Proved	235.8	13.3	1.00	0.29	0.26	3.55	13.7	16.5
Probable	444.8	10.2	0.80	0.26	0.26	2.85	11.0	15.2
Total	**680.5**	**11.3**	**0.87**	**0.27**	**0.26**	**3.10**	**12.0**	**15.7**

[2]The in-situ grade is determined by multiplying the percentage of HM by the percentage of each valuable heavy mineral within the heavy mineral assemblage at the resource block model scale. Tonnes and grades have been rounded to reflect the relative accuracy and confidence level of the estimate, thus the sum of columns may not equal.

Approximately 97% of the first 10 years of production is scheduled from Proved Ore Reserves, the highest confidence classification. Furthermore, Proved Ore Reserves features an exceptionally high in situ zircon grade of 1.00% and 39% of the contained valuable heavy mineral (VHM).

Further details of the Ore Reserve are presented on Page 46 of this announcement and in the Company's ASX announcement dated 16 March 2017.

Financing Opportunities

The BFS has been undertaken to determine anticipated technical and economic outputs based on detailed engineering and geological assessment, and is underpinned by high confidence Ore Reserves.

[1] Fraser Institute Survey of Mining Companies, 2016

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To achieve the forecast outcomes contained in the BFS, Sheffield will require a funding solution that delivers no less than A$355 million (US$266 million)[1] in upfront funding.

Since release of the Pre-Feasibility Study in October 2015, the Company has received interest from international financial and strategic investors, offtake partners and lenders regarding participation in the funding of Thunderbird. This interest has related to a range of structures and instruments, including debt, equity and asset level investments. Sheffield capitalised on this interest during the BFS compilation period by completing a successful A$17.1 million equity raising in August 2016 that was supported by existing and new investors.

Ultimately, Sheffield may also pursue other value realisation strategies such as a partial sale and joint venture that would reduce Sheffield's proportionate ownership of the Project and consequently lessen the funding burden for existing shareholders.

The Company remains confident that an appropriate funding solution will be achievable, based on:

- Thunderbird's expected strong margins and economics, multi-decade mine life underpinned by Ore Reserves, and high quality and consistent mineral sands product mix;
- The Project's Lead Agency status, which will facilitate development;
- The track record of Sheffield's Board and management in raising development capital for several other mining projects;
- Strong support from existing Sheffield shareholders over an extended period;
- Improved market conditions within the mineral sands sector, and the market for financing Australian resources project generally, that the Project's strong economics, Ore Reserves (35% in the highest confidence Proved Ore Reserve category) and the quality of its products, will enable the Company to secure appropriate financing arrangements.

Notwithstanding this, investors should note that there is no certainty that Sheffield will be able to conclude an agreement or raise the necessary funding when required. It is also possible that such funding may only be available on terms that may be dilutive to or otherwise affect the value of Sheffield's existing shares.

High Quality Products

Extensive test work and process design during the BFS and earlier studies has enabled Sheffield to develop a suite of high quality mineral sands products with specifications suited to market requirements.

- *Premium Zircon* – high quality ceramic grade zircon, >66% ZrO_2;
- *LTR Ilmenite* – pre-reduced, high grade TiO_2 with low alkalis and chromium suitable for:
  - Feedstock for sulphate pigment plants - 56.1% TiO_2;
  - Production of chloride grade and sulphate grade slag - 88% TiO_2 with a high purity pig iron co-product;
  - Potential blended feedstock for chloride processing. LTR Ilmenite can be produced at higher grades (57-59% TiO_2) for this potential market;
- *Hi-Ti88* – suited to flux cored wire welding market, production of titanium sponge, or blended material for processing via the chloride process;
- *Zircon concentrate* – zircon rich (44% ZrO_2, 20% TiO_2) suited to zirconium chemicals industry; and
- *Titano-magnetite* – co-product from the LTR process suited to furnace protection in the steel feed industry.

The specifications of each product are detailed in Appendix 1.

1. A$355 million is the modelled quarterly peak cash draw in the BFS financial model, excluding financing costs and corporate overheads.

Test work undertaken by Roundhill Engineering Pty Ltd has subsequently determined the LTR conditions required to reduce the Fe_2O_3 content of the ilmenite to less than 13%. An ilmenite product with these specifications is expected to attract a further pricing premium in the Chinese market (see ASX release dated 13 March 2017).

Production Volumes

A key feature of the Thunderbird Project is its expected ability to deliver consistent, long term, secure supply of high quality products. Figure 4 emphasises the consistency of production over the 42 year mine life.

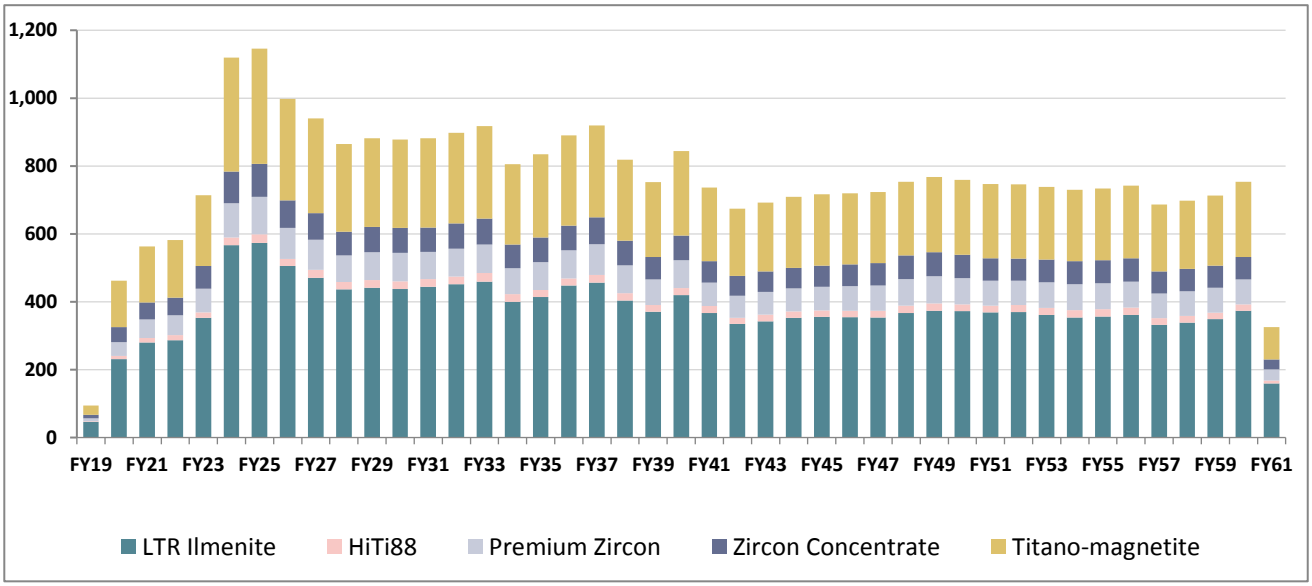

Figure 4: Targeted annualised production of Final Products over Life of Mine (Kt)

Assumptions Underpinning the Production Target and Forecast Financial Information

The material assumptions underpinning the pre-tax NPV of A$676 million and pre-tax IRR of 24.9% are described at Table 1-1 to Table 1-2 above. Other assumptions such as sale prices for mined products, plant recoveries, ore feed grade, mining costs, metallurgical factors, processing factors, infrastructure, and other macro-economic conditions are reported within the body of this document. These assumptions also extend to factors relating to marketing, legal, environmental, social and government factors.

A further material assumption relates to the selection of low cost open pit optimisation shells to guide mine pit design. For the first ten years of production, the Thunderbird Project is underpinned by the selection of an optimisation shell in the range of 50% to 55% of the value weighted 2017 spot prices. In the case of the Life of Mine pit design, it is guided by an optimisation shell in the range of 70 to 75% of the value weighted 2017 spot prices.

The Ore Reserves for the Thunderbird Project are described at Table 2 above. The Ore Reserve has been estimated using the assumptions and variables noted in the preceding paragraph. The estimated Ore Reserves underpinning the BFS (including underpinning the above production target) has been prepared by a competent person in accordance with the requirements of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves, 2012 edition (JORC Code 2012). Only Ore Reserves are included within the production target which underpins the BFS.

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Improved Market Conditions

The delivery of the Thunderbird BFS coincides with recent improvement in market conditions for mineral sands products particularly for sulphate ilmenite, with prices rising significantly over the past twelve months largely in response to an improved pigment market.

Zircon prices are showing signs of recovery as global inventories have declined, with recent price increases implemented and accepted by the market. Additional incremental price increases are predicted during 2017 and beyond based upon TZMI price forecasts and public statements by existing mineral sands producers.

Pathway to Production

The BFS has confirmed the technical viability and robust economics of the Thunderbird project, paving the way for development. The Company has advanced the permitting process, offtake negotiations and funding arrangements in parallel with the BFS and expects these to be finalised during 2017.

During the preparation of the BFS, Sheffield identified an opportunity to expedite the project construction timeline by accelerating the construction tender process with the inclusion of EPC and Build Own Operate (BOO) bids. Whilst subject to final negotiation, this process has expedited the tendering route by several months.

Subject to financing, permitting, offtake and mine construction is scheduled to commence in Q4 2017, followed by commissioning and commencement of production in 2019.

Figure 5: Targeted Timeline to Production

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COMPLIANCE STATEMENTS

Information and documentation which forms the basis of the Thunderbird BFS in relation to Mineral Resources, Ore Reserves and metallurgy and process design has previously been reported as detailed below. The Company confirms that it is not aware of any new information or data that materially affects the information included in the relevant market announcements and, in the case of the July 2016 Thunderbird Mineral Resources and the March 2017 Thunderbird Ore Reserves, that all material assumptions and technical parameters underpinning the estimates in the relevant market announcement continue to apply and have not materially changed. The Company confirms that the form and context in which the Competent Person's findings are presented have not been materially modified from the original market announcements.

PREVIOUSLY REPORTED INFORMATION

Reference has been made in this announcement to Exploration Results, Mineral Resources and Ore Reserves which were prepared and first publicly disclosed under the JORC Code (2012). The information was extracted from Sheffield's previous ASX announcements which are available on Sheffield's web site www.sheffieldresources.com.au as follows:

- Derby Port: "SHEFFIELD GRANTED PREFERRED PROPONENT STATUS FOR DERBY WHARF BULK HANDLING FACILITY" 2 March, 2015
- Lead Agency Status: "THUNDERBIRD TO RECEIVE APPROVALS SUPPORT" 6 March, 2015
- Geotechnical Investigations: "THUNDERBIRD MINERAL SANDS PROJECT UPDATE" 17 March, 2015
- Scoping Study: "SCOPING STUDY HIGHLIGHTS THUNDERBIRD'S EXCEPTIONAL FINANCIAL RETURNS" 14 April, 2014
- Thunderbird High Grade Resource Update: "THUNDERBIRD HIGH GRADE RESOURCE UPDATE" 31 July 2015
- Bulk Sample Collection: "CONVENTIONAL DOZER TRAP MINING ASSESSED AS PREFERRED MINING METHOD AT THUNDERBIRD" 17 September, 2015
- Pre-feasibility Study Update: "PRE-FEASIBILITY STUDY UPDATE CONFIRMS THUNDERBIRD AS THE WORLD'S BEST UNDEVELOPED MINERAL SANDS PROJECT" 14 October, 2015
- Access Agreement Derby Wharf: "SHEFFIELD SECURES ACCESS AGREEMENT OVER DERBY WHARF" 19 October, 2015
- Maiden Ore Reserve: "MAIDEN ORE RESERVE – THUNDERBIRD PROJECT" 22 January, 2016
- Study Manager Appointed: "SHEFFIELD APPOINTS HATCH TO DELIVER BFS FOR THUNDERBIRD PROJECT" 2 March, 2016
- Night Train discovery: "PREMIUM ZIRCON AT NIGHT TRAIN" 14 April, 2016
- Resource Update: "SHEFFIELD DOUBLES MEASURED MINERAL RESOURCE AT THUNDERBIRD" 5 July, 2016
- LTR Ilmenite Test Results "THUNDERBIRD ILMENITE EXCEEDS PREMIUM SPECIFICATION", 13 March, 2017
- Ore Reserve Update "THUNDERBIRD ORE RESERVE UPDATE"16 March, 2017

The Company confirms that it is not aware of any new information or data that materially affects the information included in the relevant market announcements and, in the case of estimates of Mineral Resources and Ore Reserves, that all material assumptions and technical parameters underpinning the estimates in the relevant market announcement continue to apply and have not materially changed. The Company confirms that the form and context in which the Competent Person's findings are presented have not been materially modified from the original market announcements.

CAUTIONARY STATEMENTS AND RISK FACTORS

The contents of this announcement reflect various technical and economic conditions at the time of writing. Given the nature of the resources industry, these conditions can change significantly over relatively short periods of time. Consequently, actual results may vary from those detailed in this announcement.

Some statements in this announcement regarding estimates or future events are forward-looking statements. They include indications of, and guidance on, future earnings, cash flow, costs and financial performance. Forward-looking statements include, but are not limited to, statements preceded by words such as “planned”, “expected”, “projected”, “estimated”, “may”, “scheduled”, “intends”, “anticipates”, “believes”, “potential”, "predict", "foresee", "proposed", "aim", "target", "opportunity". “could”, “nominal”, “conceptual” and similar expressions. Forward-looking statements, opinions and estimates included in this announcement are based on assumptions and contingencies which are subject to change without notice, as are statements about market and industry trends, which are based on interpretations of current market conditions. Please also refer to the additional risk factors described below on Page 56.

Forward-looking statements are provided as a general guide only and should not be relied on as a guarantee of future performance. Forward-looking statements may be affected by a range of variables that could cause actual results to differ from estimated results, and may cause the Company’s actual performance and financial results in future periods to materially differ from any projections of future performance or results expressed or implied by such forward-looking statements. So there can be no assurance that actual outcomes will not materially differ from these forward-looking statements.

These statements are subject to significant risks and uncertainties that include but are not limited those inherent in mine development and production, geological, mining, metallurgical and processing technical problems, the inability to obtain and maintain mine licenses, permits and other regulatory approvals required in connection with mining and processing operations, competition for among other things, capital, acquisitions of reserves, undeveloped lands and skilled personnel, incorrect assessments of the value of projects and acquisitions, changes in commodity prices and exchange rate, currency and interest rate fluctuations and other adverse economic conditions, the potential inability to market and sell products, various events which could disrupt operations and/or the transportation of mineral products, including labour stoppages and severe weather conditions, the demand for and availability of transportation services, environmental, native title, heritage, taxation and other legal problems, the potential inability to secure adequate financing and management's potential inability to anticipate and manage the foregoing factors and risks. There can be no assurance that forward-looking statements will prove to be correct.

Where the Company expresses or implies an expectation or belief as to future events or results, such expectation or belief is expressed in good faith and on a reasonable basis. No representation or warranty, express or implied, is made by the Company that the matters stated in this announcement will in fact be achieved or prove to be correct.

Except for statutory liability which cannot be excluded, the Company, its officers, employees and advisers expressly disclaim any responsibility for the accuracy or completeness of the material contained in this announcement and exclude all liability whatsoever (including in negligence) for any loss or damage which may be suffered by any person as a consequence of any information in this announcement or any error or omission there from.

This announcement does not take into account the individual investment objectives, financial or tax situation or particular needs of any person. It does not contain financial advice. You should consider seeking independent legal, financial and taxation advice in relation to the contents of this announcement.

Except as required by applicable law, the Company does not undertake any obligation to release publicly any revisions to any forward-looking statement to reflect events or circumstances after the date of this announcement, or to reflect the occurrence of unanticipated events, except as may be required under applicable securities laws.

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Sheffield Resources LIMITED

THUNDERBIRD PROJECT
BANKABLE FEASIBILITY STUDY

Sheffield Resources Limited ASX : SFX

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Introduction

Thunderbird is located in the Kimberley region in northern Western Australia on the Dampier Peninsula about 70 km west of Derby, and 25 km north of the sealed Great Northern Highway joining Derby and Broome.

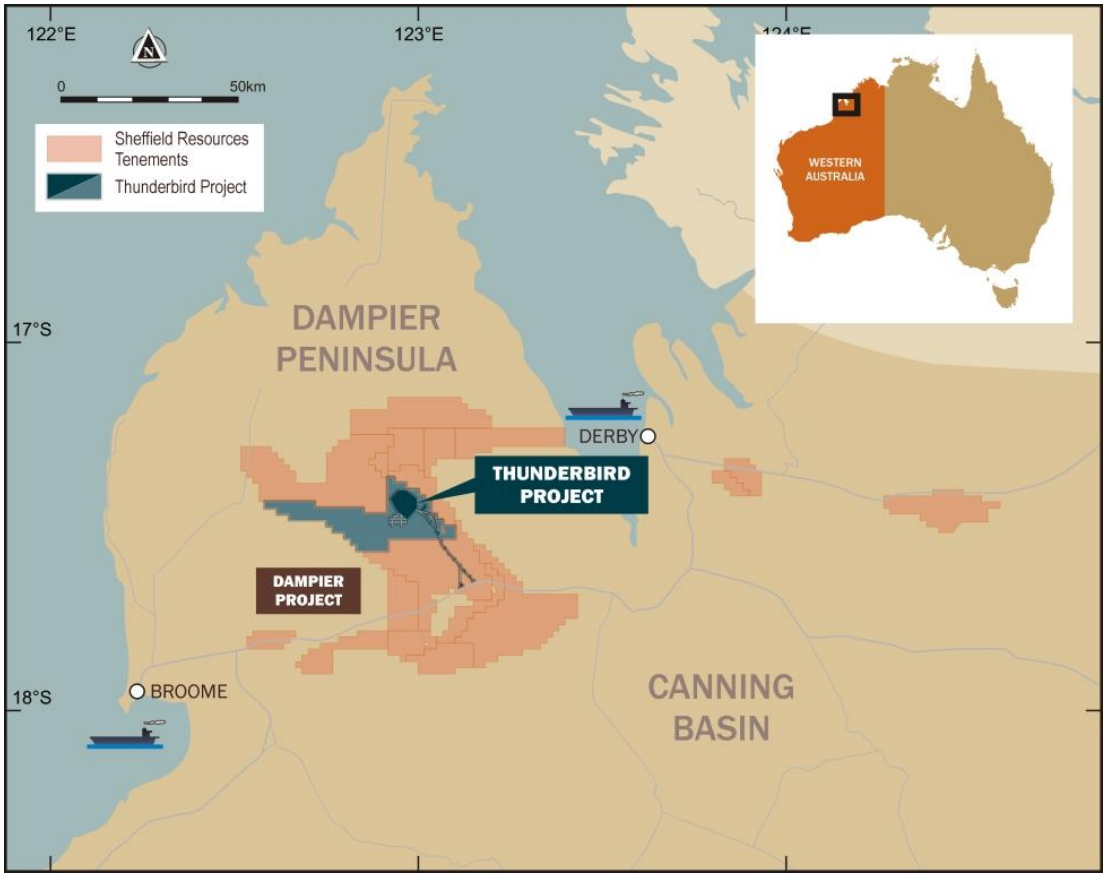

Figure 6: Project location

Thunderbird has progressed from an exploration project, the Dampier Project, to a substantial development project with significance to the local region and the State of Western Australia. After applying for an exploration licence in December 2010 over what is now known as Thunderbird, Sheffield announced the granting of exploration licence E04/2083 on 7 September 2011. A subsequent drilling campaign resulted in Sheffield declaring a large, high grade maiden resource for Thunderbird on 18 December 2012. This Mineral Resource which has since increased significantly in both size and confidence to the level estimated at Page 39 was a globally significant discovery defining a new mineral sands province.

Following further resource updates and studies, on 14 October 2015, Sheffield publicly disclosed the results of the Thunderbird Pre-Feasibility Study Update (PFS Update). The PFS Update characterised Thunderbird as an anticipated low risk, high margin, long life mining project. The PFS Update described a two phase implementation (12Mtpa and 18Mtpa of ore feed respectively) of a large scale zircon and ilmenite mineral separation plant. Of note, the PFS Update also described the addition of an ultra-low temperature roast process to the ilmenite production process to enable removal of iron impurities in order to obtain a higher quality final ilmenite product.

The State of Western Australia assessed the potential of Thunderbird as significant to the State and designated it as a Level 2 Lead Agency Project Proposal under the auspices of the State's Department of Mines and Petroleum.

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In March 2016, Sheffield announced the appointment of Hatch to provide consulting services to deliver a Feasibility Study for Thunderbird. In defining the basis of design for the BFS, Sheffield took the opportunity to capture the benefit of higher head-grade in the Project's early years by further refining its two-stage production strategy. The new strategy, defined throughput to commence at 8.5Mtpa and ramp up to 17Mtpa from year four. This throughput design provides for similar total production from Thunderbird over the first seven years of operation, however reduces the initial size of the plant.

Reliance on Other Experts

In March 2016, Sheffield sought competitive proposals to manage and deliver the BFS from a number of recognised engineering groups.

The BFS incorporates input from a variety of specialist consultants, consulting companies and engineering companies, as well as appropriately qualified and experienced Sheffield employees. A list of groups used in delivery of the BFS is shown in Table 3.

The basis for execution of the BFS was the process design provided by Robbins Metallurgy (now IHC-Robbins Pty Ltd), as selected at successful completion of the PFS. During the course of the BFS, IHC-Robbins carried out full scale or scalable test work for all mineral separation processes in Brisbane, Australia, whilst Hazen Research Inc. carried out pilot test work of the ilmenite roast process in Denver, USA.

Table 3: List of BFS Areas and Expertise Groups Utilised

Topic	Expertise Group
Mineral Resources	
QAQC and Database Integrity	Sheffield Resources Ltd
Geological Interpretation	Sheffield Resources Ltd
Mineral Resource Estimation	Optiro Pty Ltd
Ore Reserves	
Mine Planning and Optimisation	Entech Pty Ltd
Ore Reserve Statement	Entech Pty Ltd
Geotechnical Engineering	ATC Williams Pty Ltd Entech Mining Pty Ltd
Mining Study	Entech Pty Ltd
Process Design and Process Engineering	
Metallurgical Test Work	IHC-Robbins Pty Ltd Hazen Research Inc.
Materials Handling Test Work	IHC-Robbins Pty Ltd TUNRA Bulk Solids Handling Research Associates
Process Design (Mineral Separation)	IHC-Robbins Pty Ltd
Process Design (Roasting)	Hatch Pty Ltd Roundhill Engineering Pty Ltd
Process Engineering (BFS Ref. Case)	Hatch Pty Ltd
Tailings Characterisation and Treatment	Golder Associates Pty Ltd BASF Australia Ltd
Product Specification	IHC-Robbins Pty Ltd
Environmental Impact and Approvals	
Preparation of Environmental Approval Documents	MBS Environmental
Hydrogeology	Rockwater Pty Ltd

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Topic	Expertise Group
Project Scope Definition	
Process Plant and Associated Infrastructure (BFS Reference Case)[1]	Hatch Pty Ltd
Operating Parameters	Hatch Pty Ltd Sheffield Resources Ltd
Capital Cost Estimate Assembly	Sheffield Resources Ltd
Project Risk	Hatch Pty Ltd Sheffield Resources Ltd
Implementation	Vendor
Assistance with Operational Readiness	Hatch Pty Ltd Sheffield Resources Ltd
Project Financial Assessment	
Capital Cost Estimate Inputs	Sheffield Resources Ltd
Operating Expenditure Inputs	Hatch Pty Ltd Sheffield Resources Ltd Entech Pty Ltd
Product Appraisal and Pricing	TZ Minerals International Pty Ltd Beijing Ruidow Information Technology Co. Ltd
Financial Modelling Sensitivity Analysis	Azure Capital Limited Azure Capital Limited

1. The operating cost, capital cost and financial analysis presented in the BFS are based on vendor specific design attributes, market based proposals and Sheffield specified operating factors.

Competent Persons for the Thunderbird Mineral Resource, as previously announced to the ASX on 5 July 2016, are Mrs. Christine Standing who is an employee of Optiro Pty Ltd and Mr. Mark Teakle who is an employee of Sheffield. The Competent Person for the Thunderbird Ore Reserve, as previously announced to the ASX on 16 March 2017, is Mr Per Scrimshaw who is an employee of Entech Pty Ltd. The Company confirms that the form and context in which the Competent Person's findings are presented in this announcement have not been materially modified from the relevant original market announcements.

Financial Analysis

The BFS has demonstrated a technically sound and financially robust project over a 42-year mine life.

The key highlights and assumptions are:

- EBITDA of A$5.1 billion over Life of Mine
- Pre-tax Net Present Value of A$676 million at a 10% discount rate
- Internal Rate of Return of 25%
- Revenue to Cost ratio of 2:1 for first ten years of operation (post ramp up)
- Stage 1 development capital, including contingency, of A$348 million (US$261 million)
- An A$/US$ exchange rate of US$0.75
- Conservative ramp applied to recommended TZMI zircon pricing assumptions
- Two year ramp up applied to Stage 1 production and recovery
- Long initial mine life of 42 years

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The summary financial metrics and assumptions for Thunderbird are shown in the following tables below:

Table 4-1: Production Assumptions

Production (Average tonnes per annum)	Financial Year 2019 – 2023[5]	Financial Year 2024 – 2033[6]	LOM[8]
Premium Zircon	51,500	88,700	76,100
Zircon Concentrate	49,100	80,100	68,500
LTR Ilmenite	264,500	481,600	387,800
HiTi88	12,800	23,000	20,300
Titano-magnetite	156,600	285,300	229,800

Table 4-2: Commodity Price Assumptions

Commodity Prices (US$)[4]	Financial Year 2019 – 2023[5]	Financial Year 2024 – 2033[6]	LOM[8]
Premium Zircon	1,282	1,387	1,381
Zircon Concentrate	659	677	676
LTR Ilmenite	183	183	183
HiTi88	500	500	500
Titano-magnetite	48	48	48

Table 4-3: Thunderbird Project Key Financial Metrics

$AM, Real 2017 Prices	Financial Year 2019 – 2023[5]	Financial Year 2024 – 2033[6]	LOM[8]
Revenue	854	3,875	13,560
Royalties	(50)	(223)	(781)
Net Revenue	**803**	**3,652**	**12,779**
Opex: Mining	(104)	(421)	(1,828)
Opex: Processing	(228)	(1,024)	(4,093)
Opex: Logistics	(73)	(288)	(1,005)
Opex: Site G&A	(59)	(172)	(707)
Total Opex[1]	**(464)**	**(1,905)**	**(7,633)**
EBITDA	**339**	**1,746**	**5,146**
A$ Site costs[2] / tonne ore mined	14.65	11.11	11.40
A$ Revenue / tonne ore mined	25.99	22.29	19.92
US$ Site costs[2] / tonne Premium Zircon equivalent[3,4]	721	692	790
US$ Revenue / tonne Premium Zircon equivalent[3,4]	1,278	1,387	1,381

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Table 4-4: Capital Expenditure and Financial Metrics

	Stage 1	Stage 2	LOM[8]
Capital Expenditure ($AM)[7]	**348**	**195**	**543**
Pre-Tax Project NPV (10% WACC)[1]			675.6
Pre-Tax IRR %			24.9
Post-Tax Project NPV (8% WACC)[1]			620.4
Post-Tax IRR %			20.6

Notes:
1. Excludes corporate overheads.
2. Includes sustaining capex, excludes corporate overheads and royalties.
3. Premium Zircon equivalent tonnes calculated as total revenues across all products/premium zircon price
4. AUD:USD = 0.75:1.00. USD long term commodity prices are quoted as FOB terms, sourced from TZMI (Premium Zircon, Zircon Concentrate, LTR Ilmenite and Hi-Ti88) and Ruidow (for Titano-magnetite).
5. Stage 1 time period depicted as Q4 FY2019 to Q3 FY2023 inclusive
6. Stage 2 first 10 years depicted as Q4 FY2023 to Q3 FY2033 inclusive
7. Excludes sustaining capex.
8. LOM (Life of Mine) describes the period 2018 to 2061, inclusive of the construction period.

Macroeconomic Assumptions

The key macroeconomic assumptions are summarised as follows:

- A fixed exchange rate of 0.75 AUD:USD has been assumed.
- No inflation has been applied to either costs or revenues.
- A real pre-tax discount rate of 10%.
- No terminal value is assumed for the project.

Product Prices

The USD product prices assumed in this study are shown at Table 4-2 above and Figure 7 below. Prices are based upon forecasts provided to Sheffield by mineral sands industry expert TZMI for Thunderbird Premium Zircon, Zircon Concentrate, LTR Ilmenite and Hi-Ti88. Sheffield has elected to conservatively apply a further discount to the TZMI price forecast for Premium Zircon and Zircon Concentrate for the 2019 to 2022 period, increasing from current 2017 spot prices to long term pricing over that period. Sheffield has applied Ruidow's long term pricing assumption for the Thunderbird Titano-magnetite.

All prices are shown in real 2017 terms and free-on-board ("FOB") at the port of Derby or Broome, as appropriate.

Product volumes

The first stage, anticipated to commence in 2019 and end in 2023, produces over 500,000 tonnes of saleable product per annum; the second stage, anticipated to commence in 2024, produces over 1,000,000 tonnes of saleable product per annum; with a Life of Mine average of approximately 800,000 tonnes per annum (Table 5, Figure 7).

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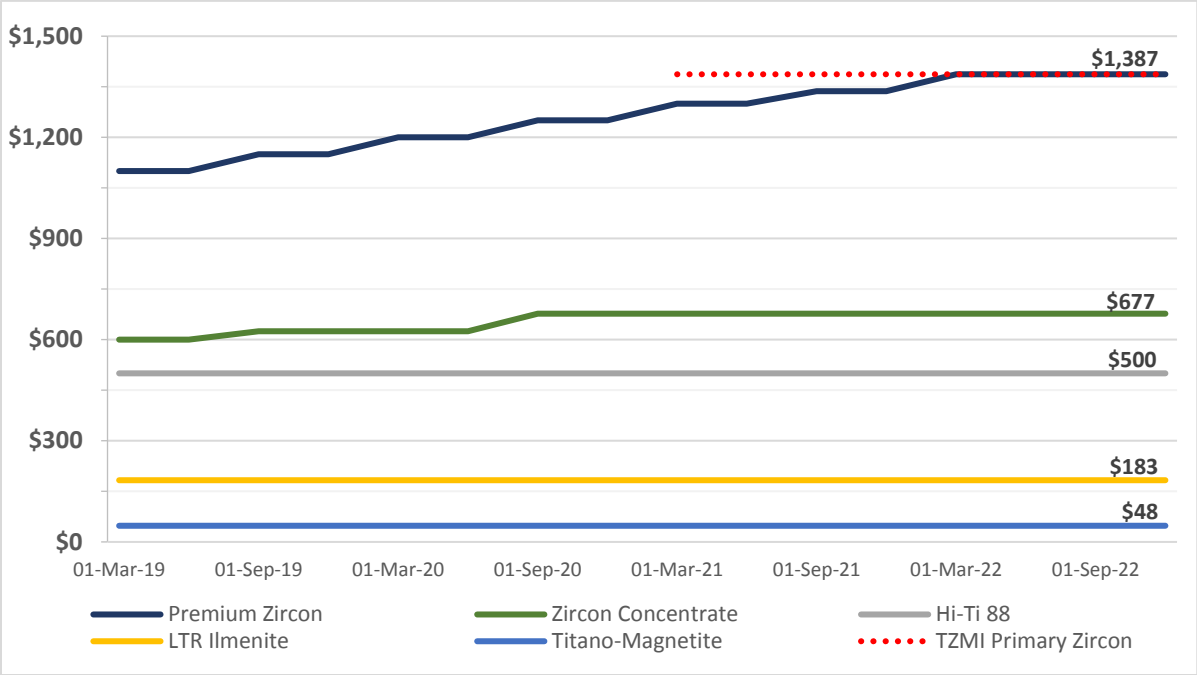

Figure 7: Product Price Assumptions during Stage 1 Ramp-Up Period.
(Long term pricing assumptions apply from 2022)[1]

Table 5: Targeted Thunderbird Production Rates

Product	Years 1 – 4 (Average tpa)	Years 5 – 10 (Average tpa)	Years 11 – 42 (Average tpa)	Life of Mine (Average tpa)
LTR Ilmenite	264,500	515,800	371,800	387,800
Hi-Ti88	12,800	23,000	20,300	20,300
Premium Zircon	51,500	95,000	75,100	76,100
Zircon Concentrate	49,100	86,200	67,200	68,500
Titano-magnetite	156,600	305,400	220,400	229,800
Total Products	534,500	1,025,400	754,800	782,500

*All values rounded to nearest 100

1. USD long term commodity prices are quoted as FOB terms, sourced from TZMI (Premium Zircon, Zircon Concentrate, LTR Ilmenite and Hi-Ti88) and Ruidow (for Titano-magnetite).

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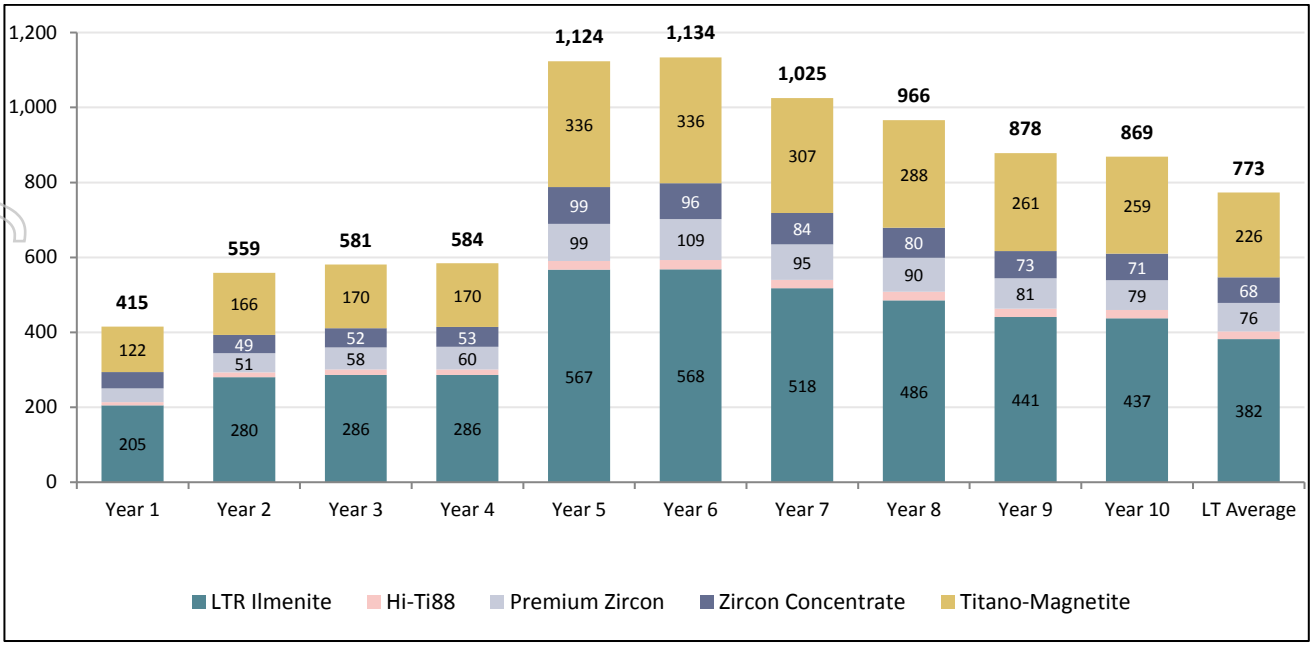

Figure 8: Final Products – First Ten Years & Long Term Average (Kt)

Over the life of mine, forecast production remains strong and consistent, reflecting the size and consistency of grade the ore body offers (Figure 8). The current Thunderbird Ore Reserve supports production volumes at levels that will elevate Sheffield into the ranks of Australia's top-tier mineral sand producers.

Revenue

Life of mine revenue and EBITDA peak after Stage 2, remaining strong and consistent over the life of the Project. As a function of the feed grade and low strip ratios, costs and revenues remain generally consistent over the mine life. The consistency of these strong cash flows allows the Project to operate through commodity price cycles.

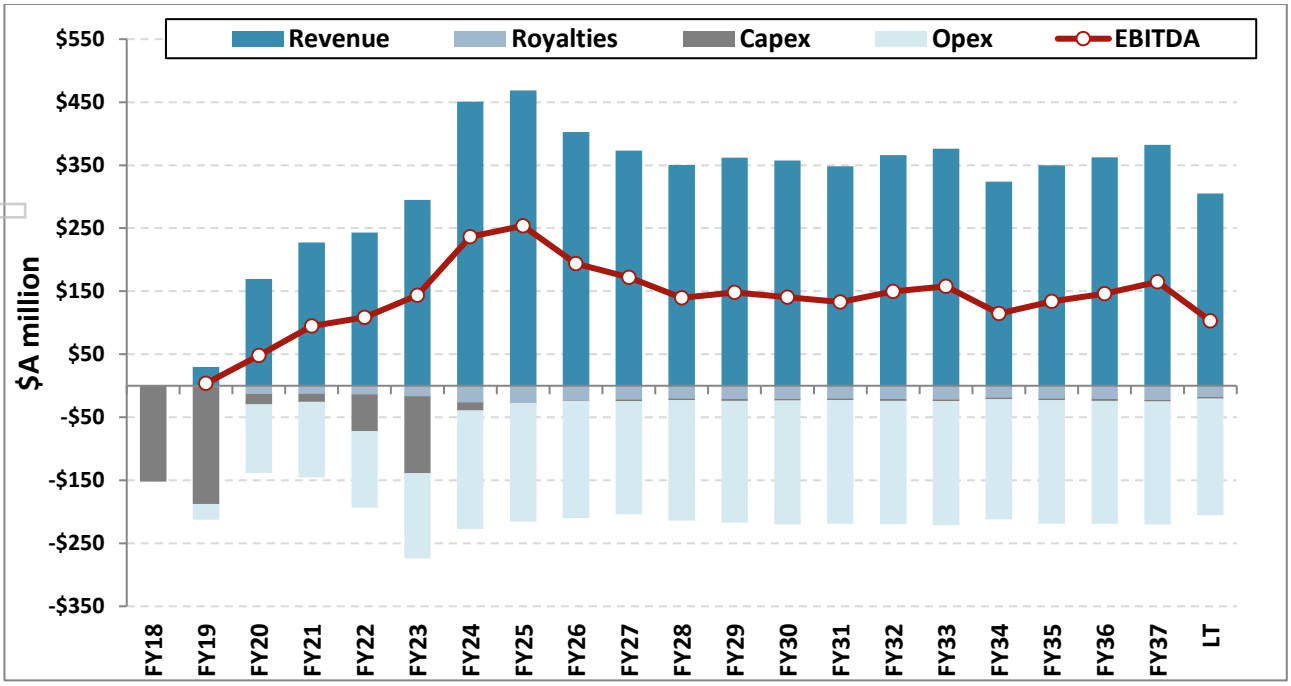

Figure 9: Annual EBITDA (real 2017 prices) and Cash Flows

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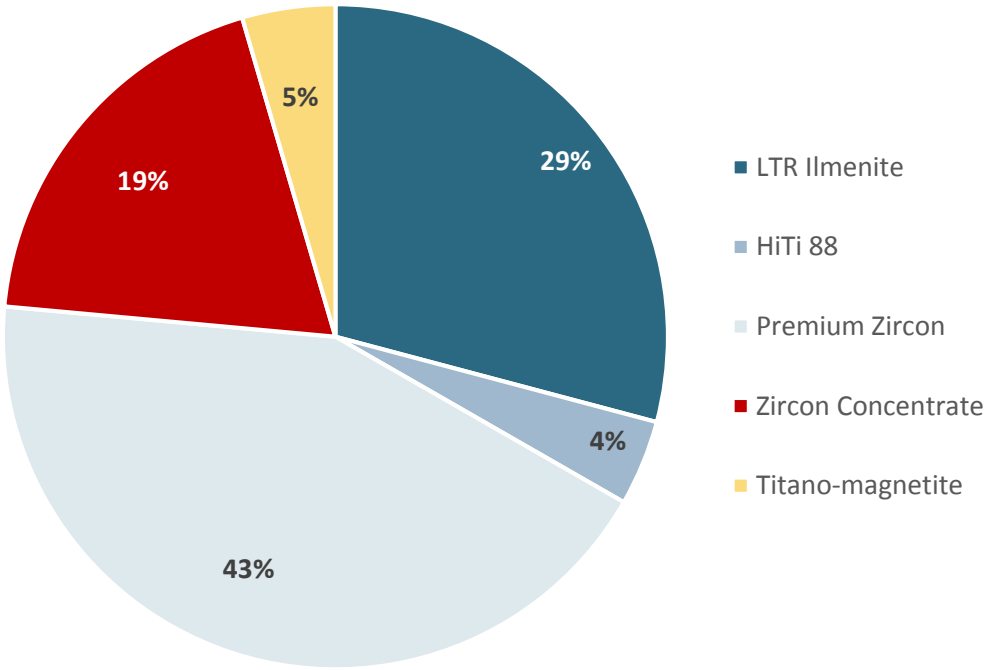

Figure 10: Life of Mine Revenue by Product

Project Sensitivity Analysis

Key Project sensitivities to NPV (+/- 10%) are as follows:

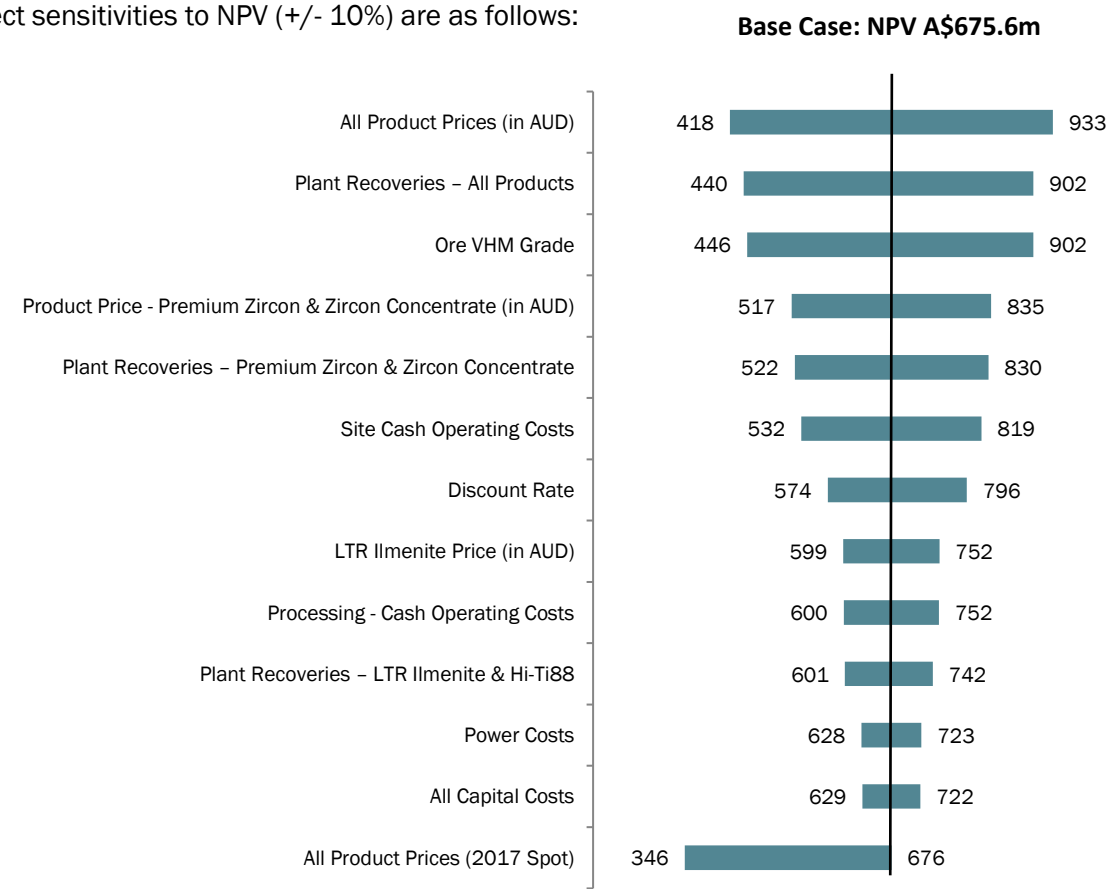

Figure 11: Key Project Sensitivities to NPV (+/- 10%)

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Based on the above sensitivity analysis, the key drivers of the Project's economics are product prices, plant recoveries and ore feed grade.

Sheffield considers the potential for variance in ore feed grade to be low. The mine schedule has been optimised over the first ten years to include high grade near surface Ore Reserves with 97% of these tonnes within the highest confidence Proved Ore Reserve category.

With regards to the potential for variance in recovery, Sheffield considers the metallurgical process flow sheet to have been thoroughly assessed with large representative bulk samples using full-scale or scalable continuous test work equipment. The recoveries obtained from this test work have been used in the financial model. Conservative throughput and recovery factors have been applied to the first two years of operation on a quarterly basis for ramp-up in Stage 1.

The Thunderbird NPV estimate is not particularly sensitive to capital due to the high cash flows expected to be generated over the effective discount period comprising the first ten years.

Key Project sensitivities to IRR (+/- 10%) are as follows:

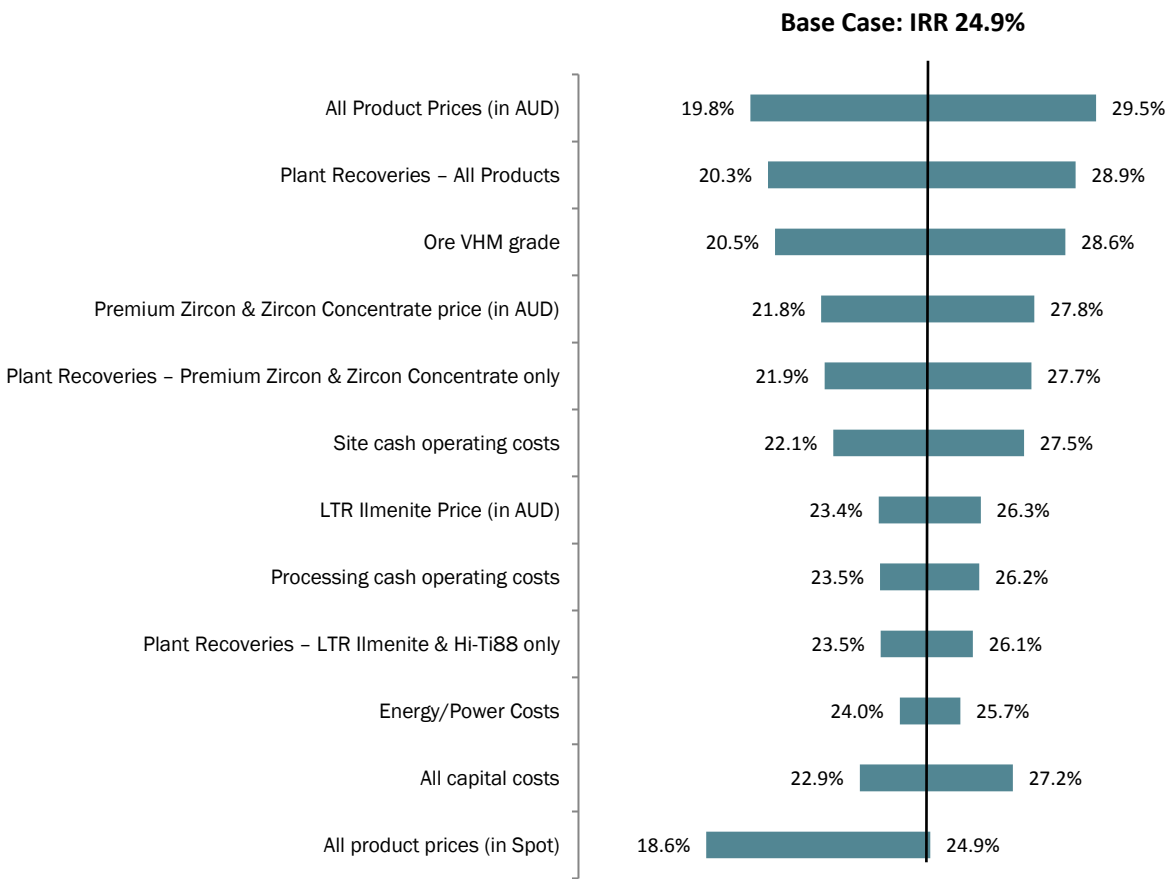

Figure 12: Key Project Sensitivities to IRR (+/- 10%)

The sensitivity analysis above illustrates the IRR to be robust, rarely falling below 20% on the majority of the measures.

In addition to the above, a sensitivity has been run on a scenario where Titano-magnetite is not sold as a product. The impact on Project NPV is to reduce it to A$614m and IRR to 23.7%.

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Revenue to Cost Ratio Analysis

Figure 13 depicts the Calendar Year 2020 TZMI revenue to cost (RC) ratio curve for the global mineral sands industry. Thunderbird is represented adjacent to first quartile producers, several of whom operate beneficiation plants within the industry.

For the purposes of the Figure 13, the following should be noted:

- Thunderbird is represented by the 4 year production period immediately following Stage 1 ramp up, equalling cumulative TiO_2 units produced from Q2 Year 3 to Q1 Year 7 inclusive;
- The RC ratio curve is determined by TZMI using long-term pricing and forecast exchange rate. Pricing and rates may differ from Sheffield forecasts.
- In preparing the RC ratio curve, TZMI has undertaken a review of the Sheffield financial model. TZMI has relied on operating costs and production schedules provided by Sheffield, all other modelling has been performed by TZMI.

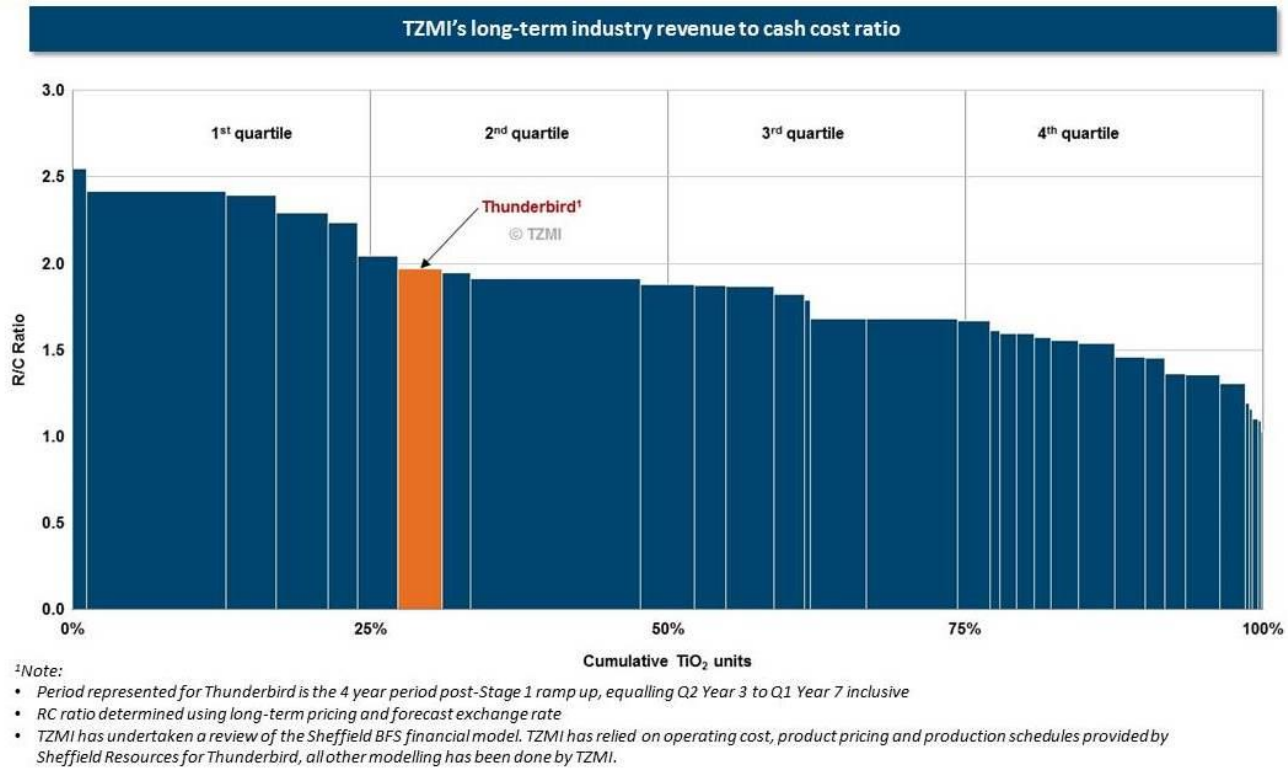

Figure 13: TZMI Mineral Sands Industry Revenue to Cost Ratio Curve (cumulative TiO_2 units)

The Revenue to Cost competitiveness of Thunderbird is further described in Figure 13 above, demonstrating the strong cash margins generated over time.

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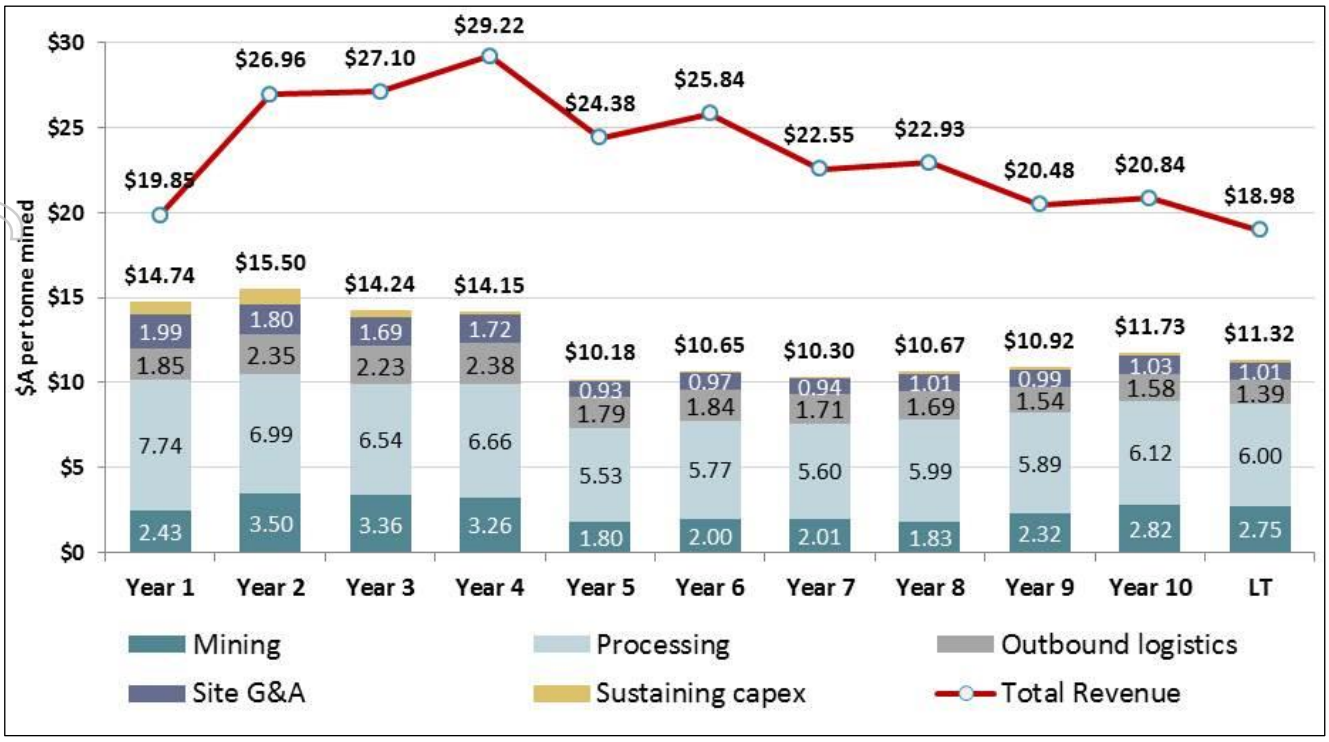

Figure 14: Revenue and Site Cash Costs per tonne of Ore Mined (Production Years)

Capital Cost Estimate

The total estimated cost to design, procure, construct and commission Stage 1 of the project scope, inclusive of process plant (EPC) and supporting infrastructure, owners team costs, operational readiness costs, pre-production costs and contingency has been estimated by Sheffield at A$347.9M (US$260.9M) in Q1 2017 (estimate Base Date) terms. This includes A$24M (US$18.0M) of contingency.

The capital cost estimate includes:

- Direct costs of Project development for Stage 1, including costs associated with the design, construction, procurement and commissioning of the process plant on an EPC basis and associated Infrastructure.
- Owners Team costs associated with the management of non-processing plant infrastructure requirements associated with the Project, through to Project completion and handover to operations.
- Operational readiness, pre-production costs, Project insurances and operating spares.
- Contingency on Project scope definition and risk elements.

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Table 6: Capital Cost Summary

Description	US$M	A$M
Direct Costs		
Plant Area Concrete, Civils & Buildings, Process Water Systems	19.0	25.3
Wet Concentrator Plant (WCP)	43.5	58.0
Concentrate Upgrade Plant (CUP)	25.7	34.3
Zircon Processing Plant	59.2	78.9
Ilmenite Processing Plant	22.7	30.2
Low Temperature Roast (LTR)	32.6	43.4
Sub-Total	**202.6**	**270.1**
Non-Processing Infrastructure (NPI) Costs		
Site Preparation & Materials, Roads & Access	5.0	6.7
Tailings Dams, HV Distribution, Bore field Infrastructure	12.0	16.0
Derby Port Facilities	5.0	6.6
Sub-Total	**22.0**	**29.3**
Owners Costs		
Labour & Operational Readiness	6.7	8.9
Trial Pit, Mining Services, Mobilisation and Infrastructure	4.6	6.1
Accommodation Village Services and Infrastructure	3.9	5.2
Systems, Insurances, Administration & Services	3.2	4.2
Sub-Total	**18.3**	**24.4**
Contingency	**18.1**	**24.2**
TOTAL CAPITAL COST	**260.9**	**347.9**

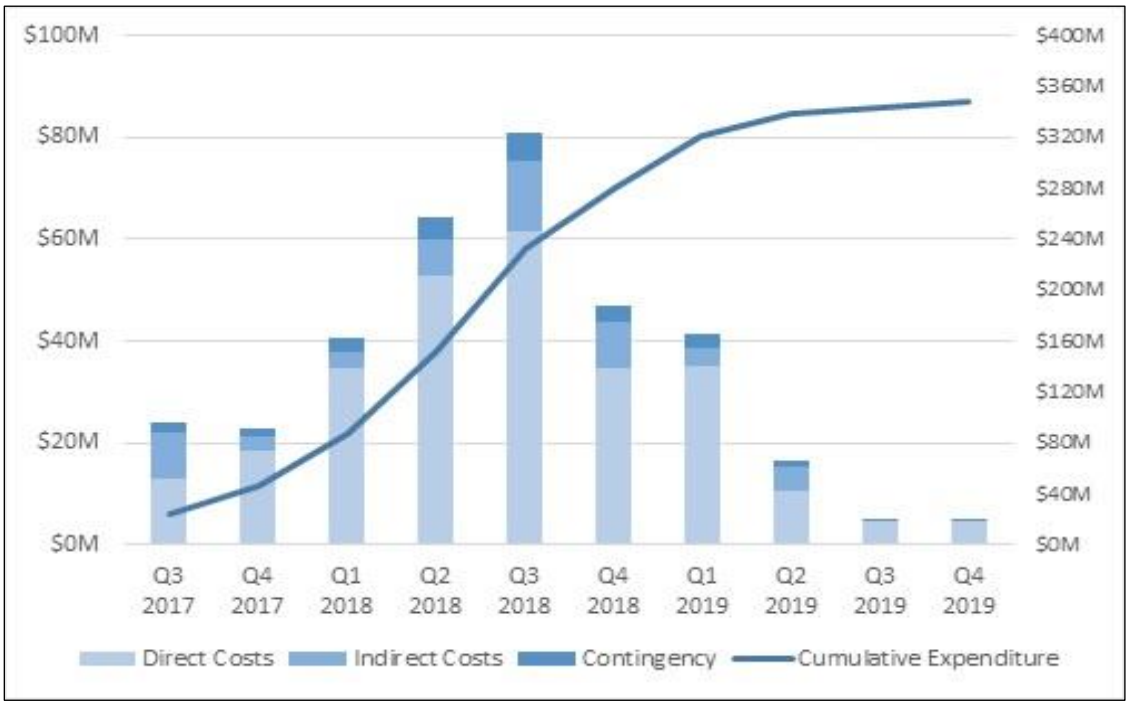

Figure 15: Stage 1 Capital Cost Expenditure (A$M)

Sustaining capital includes expansion of the surface tailings storage facility (TSF) and final upgrade of the Thunderbird access road, minor and incidental capital requirements to sustain operations. The long term sustaining capital expenditure reflects benefits gained as a consequence of a large single 42 year mine life ore body with no requirement for relocation of the Wet Concentrator Plant.

The table below details the sustaining capital by department.

Table 7: Sustaining Capital Expenditure (A$M)

	2019	2020	2021	2022	2023	2024	2025	2026+
Mining	4.2	3.6	0.9	0.1	0.2	0.2	0.1	0.6
Plant Mobile Fleet	2.3	2.2	0.6	0.2	2.0	0.3	0.2	1.8
Maintenance	0.3	0.4	0.2	0.2	0.4	0.2	0.2	0.2
Admin, Port & Other	0.3	0.9	0.8	0.1	0.1	0.1	0.1	0.6
Total (A$M)	**7.1**	**7.0**	**2.5**	**0.7**	**2.7**	**0.8**	**0.7**	**3.1**

Operating Cost Estimate

The operating cost estimate summary is presented in Table 8 based upon an average full production year for Stage 1 (Year 1 to 4) and Stage 2 (Year 5 – 10) respectively. The figures and values described in the table are reflected in the BFS financial model.

Table 8: Operating Cost Estimate Summary

Cost Elements	Stage 1 (Year 1-4) Average Annual Operating Cost	Stage 2 (Year 5- 10) Average Annual Operating Cost	Life of Mine Total Operating Cost
Mining	22.8	32.1	1601.9
Labour	16.8	21.3	875.9
Reagents & Consumables	9.0	16.6	657.5
Natural Gas	16.3	32.5	1,293.1
Electricity	17.1	33.2	1,321.4
Maintenance	5.8	9.6	393.3
General and Administration	11.1	13.4	549.1
Product Logistics	17.1	28.1	940.5
Total A$M	**116.0**	**186.8**	**7,632.8**

Site cash operating unit costs of production which include sustaining capital are set out in Table 9 below. Table 10 below illustrates the same unit costs in dollars per Premium Zircon units.

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Table 9: Site Cash Operating Costs per Tonne of Ore Mined[1]

	$US Years 1-10	$US LOM	$A Years 1-10	$A LOM
Mining	1.78	2.01	2.37	2.69
Processing	4.56	4.51	6.08	6.01
Product Logistics	1.36	1.11	1.82	1.48
Site G&A	0.88	0.78	1.17	1.04
Sustaining Capital	0.16	0.14	0.22	0.18
Total	**8.74**	**8.55**	**11.65**	**11.40**

[1] Assumes an exchange rate of AUD:USD = 0.75:1.00

Table 10: Site Cash Operating Costs and Revenue per tonne Premium Zircon equivalent[1]

	$US Years 1-10	$US LOM
Mining	136	186
Processing	349	417
Product Logistics	104	102
Site G&A	67	72
Sustaining Capex	12	13
Total	**669**	**790**

[1] Tonnes of Premium Zircon equivalent are calculated by dividing total Project revenues from all products by assumed Premium Zircon prices.

Production of high-quality products requires commensurate processing stages and energy inputs consistent with a strategy of supplying premium finished products to the world market. The processing costs represent 53% and outbound logistics represent another 13% of operating costs.

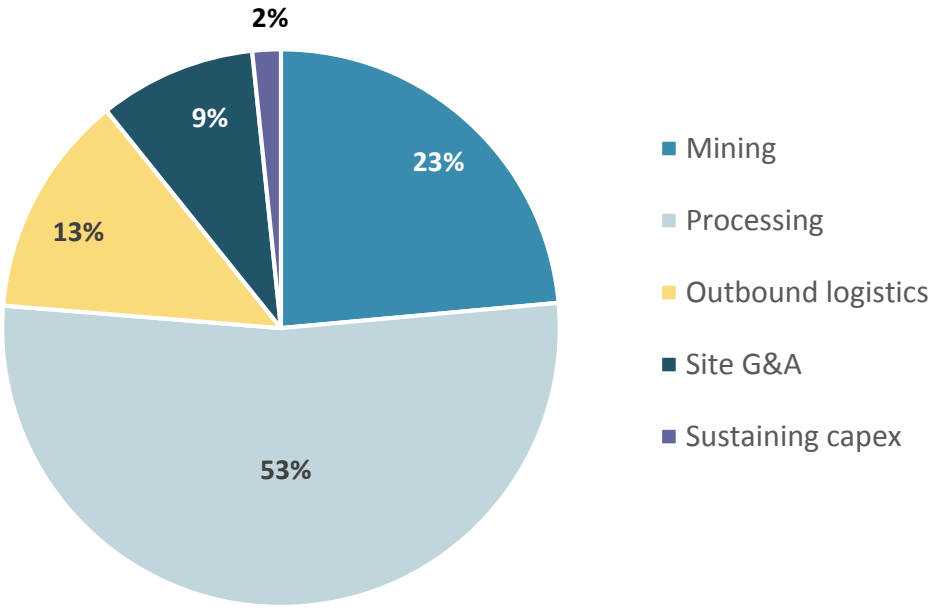

Figure 16: LOM Site Costs by Function

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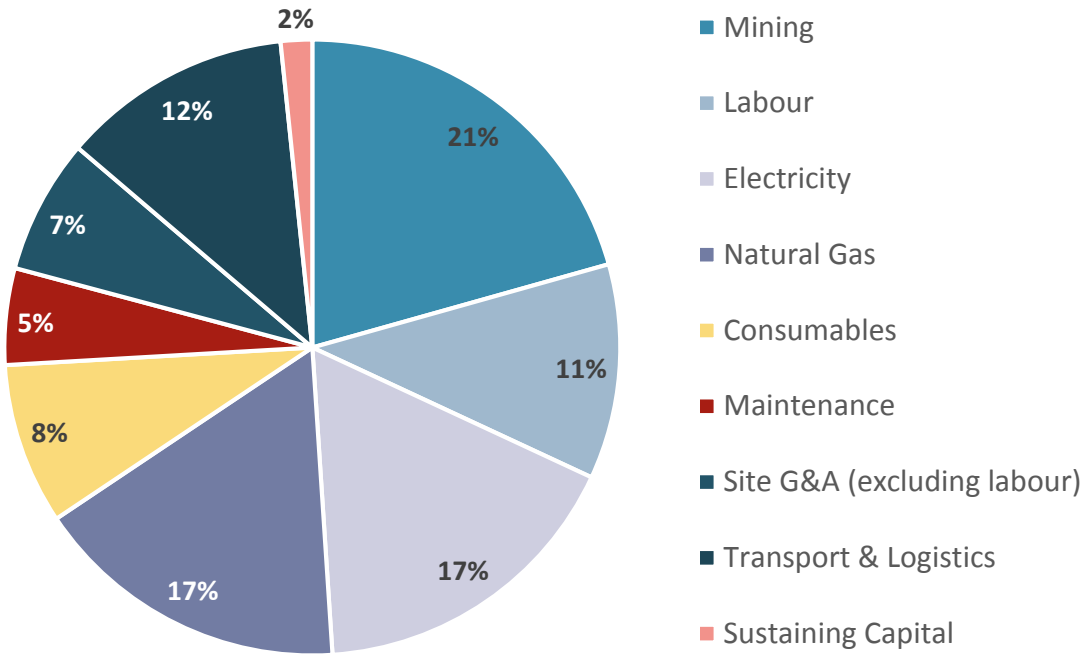

Figure 17: Life of Mine Costs – by Major Area

Energy costs represent approximately a third of operating costs based upon a Life of Mine Build-Own-Operate (BOO) project configuration. There may be opportunity to reduce these costs which are discussed in the relevant section below at Page 56.

Mine Operating Costs

Direct mine operating costs have been determined from first principles based on the mine designed and scheduled by Entech. Equipment ownership and operating costs were provided by equipment suppliers for the mining equipment proposed.

The operating cost estimate is based on working 365 days per year, 7 days per week, with two 12 hour shifts per day and includes allowances for the following items:

- Personnel and equipment mobilisation
- Site office and workshop establishment
- Fixed and operating equipment costs
- Diesel
- Manpower
- Limited flights for high skilled employees
- In-pit production dewatering
- Overheads.

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Excluded from the mining cost estimate, but included as part of the Sheffield costs are the following:

- Management and technical staff
- Drive in drive out cost (DIDO) from Broome, Derby and surrounding areas
- Accommodation and messing
- General costs including management, safety and environmental services.

The total estimated mining cost is summarised in Table 11 below.

Table 11: Total Estimated Mining Cost

Mining Activity	Quantity	Total Cost (A$M)
Establishment, Mobilisation and Demobilisation		
Establishment, mobilisation and demobilisation	-	5.2
Clearing and grubbing	1,658Ha	0.9
Total Establishment, Mobilisation and Demobilisation		**6.1**
Load and Haul Topsoil and Overburden		
Remove and stockpile topsoil	2.1Mt	4.1
Remove and place topsoil for rehabilitation	4.6Mt	6.9
Remove and place stockpiled topsoil to rehabilitation	2.1Mt	7.5
Load and haul overburden to pit void or stockpile	42.1Mt	50.6
Load and haul overburden for in-pit TSF construction	481.2Mt	591.6
Load and haul overburden from stockpile to pit void	18.8Mt	20.4
Load and haul post mined overburden to backfill pit void	6.2Mt	11.3
Place, spread, condition and compact material for TSF wall construction	481.2Mt	107.0
Total Load and Haul Topsoil and Overburden		**799.4**
Ore Production		
Dozer push, pre-mined ore to stockpile	0.2Mt	0.3
Dozer push ore to feed hopper	680.7Mt	415.3
Oversize rehandle in pit	81.4Mt	93.2
Total Ore Production		**508.8**
Rehabilitation		
Rehabilitate mining panels	1,658Ha	3,8
Total Rehabilitation		**3.8**
Indirect Costs		
Mine overheads		157.1
Support equipment		99.7
Total Indirect Costs		**256.8**
Total Mining Cost		**1,574.9**

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Labour

An organisational structure and labour cost estimate was developed by Sheffield. Labour costs were developed on the basis of a drive-in, drive-out (DIDO) workforce ex-Broome and ex-Derby and salary rates include a provision of 35% for salary related on costs. Corporate office labour is not included in the operating cost estimate.

Annual salary and wages for Sheffield operational personnel have been sourced from the 2016 Hays Salary Guide and the 2016 Michael Page Salary Guide, in addition to Sheffield budget estimates. Salaries have been selected from the mid-point range and include the provision of salary related on costs such as superannuation guarantee, annual and sick leave provisions, state payroll taxes and employee insurance premium costs.

Direct Labour estimates by area for Stage 1 and Stage 2 are shown in the tables below:

Table 12: Annual Labour Estimate - Stage 1

Area	No. of Personnel	Total Cost A($M p.a.)
Site Management, Warehousing & Administration	14	2.1
Health, Safety & Environment	12	1.7
Mine Engineering & Geology	6	1.0
Processing	60	7.5
Plant Maintenance	27	3.6
TOTAL	**119**	**16.8**

Table 13: Annual Labour Estimate - Stage 2

Area	No. of Personnel	Total Cost (A$M p.a.)
Site Management, Warehousing & Administration	15	2.2
Health, Safety & Environment	13	1.8
Mine Engineering & Geology	6	1.0
Processing	81	10.0
Plant Maintenance	34	4.5
TOTAL	**149**	**19.5**

Reagents & Consumables

Reagent pricing was sourced from third party suppliers. The reagent quantities are based on a number of sources including the mass balance, test work and calculations based on typical addition rates for similar applications. Allowances are made for minor reagents based on similar reference plants.

Electric Power and Natural Gas

The process plant electric power load was estimated by third party EPC contractors, following a review of the BFS reference case electrical load design. Average annual kWh are estimated at 88.4 million for Stage 1 and 171.7 million for Stage 2.

Power supply is based upon the provision of electricity from an on-site build own operate (BOO) power generation facility, utilising natural gas as fuel source. The cost of power was estimated at a rate of A$0.19/kWh delivered to site. Pricing was obtained via an expression of interest process issued and evaluated by Sheffield and third party consultants.

Sheffield has assumed some ancillary equipment to be powered by diesel generation units where appropriate. The cost of diesel, estimated at A$0.70 per litre (after rebate of A$0.39 per litre) has been included within the cost of electricity. The estimated quantity of diesel usage was completed by third party consultants.

The cost of natural gas was based on a supply rate of natural gas for the process plant as part of the power station BOO contract. Supply cost of natural gas was estimated at approximately A$15/GJ delivered to site. Pricing was obtained from various independent sources, including an expression of interest process issued and evaluated by Sheffield and third party consultants. Average annual quantities of gas to be supplied are estimated at approximately 1,070 Tera joules for Stage 1 and 2,140 Tera joules for Stage 2.

Maintenance Costs

Maintenance costs for the process plant are estimated on a fixed percentage of the total direct equipment capital cost for each area location of equipment. The maintenance percentage (varying between 2% and 4%) for each area is specific to the type of equipment and processing conditions and have been developed based on experience with similar operations and equipment. The values represent averaged maintenance costs over several years of operation and account for both planned and major maintenance activity.

Maintenance costs associated with the BOO plant such as power generation facilities and camp accommodation facilities are included within the BOO estimate and not included within the maintenance cost section.

General and Administration

General and Administration expenses are estimated to total A$11.1 million per annum for Stage 1 and A$13.4 million per annum for Stage 2. The major components comprise, administration, accommodation and on-site laboratory costs.

Stage 1 administration expenses have been estimated at an annual cost of A$4.1 million and include (but are not limited to) IT and communications service infrastructure, insurance charges, shutdown personnel and consultants, employee transportation, recruitment costs, community relations expenditure and other costs directed related to supporting site personnel. Stage 2 costs have been escalated to A$5.3 million per annum.

Sheffield has sourced firm pricing for the provision of a 200 person camp over the life of mine. For Stage 1, the Company has estimated 129 man-days per day at a rate of approximately A$91 per man-day, totalling A$4.3 million p.a. For Stage 2, 168 man-days per day are assumed, and given the fixed nature associated with the capital component of the camp, the annual rate of A$75 per man-day has been applied, totalling A$4.6 million p.a.

Operation of an on-site laboratory has been estimated on a build own operate (BOO) estimate basis. Laboratory consumables are included as part of the BOO services agreement. The annual estimate for this service has been sourced from third party service providers by Sheffield and estimated at A$2.7 million per annum for both an analytical and metallurgical laboratory. This cost is estimated to increase to A$3.5 million per annum for Stage 2.

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Outbound Logistics

The costs associated with transportation of product to the ports of Derby and Broome are based on firm pricing estimates supplied by third party service providers. Costs associated with transhipment of product from Derby to an ocean going vessel (OGV) has also been included within the cost estimate.

Table 14: Product shipment basis

Item	Basis
Hi-Ti88	2 T bags, trucked to Broome Port storage facility
Premium Zircon	2 T bags, trucked to Broome Port storage facility
Zircon Concentrate	Bulk product to Derby Port storage facility
LTR Ilmenite	Bulk product to Derby Port storage facility
Titano-magnetite	Bulk product to Derby Port storage facility

Table 15: Outbound Logistics charges

Item	Description	Stage 1 Cost	Stage 2 Cost
All Ports	Pilotage/Loadmaster Services	A$90,000 p.a.	A$180,000 p.a.
Broome	• Mine to Port - Road Freight • Warehousing & Transfer to OGV • Broome Port Changes	A$46.50/t	A$36.04/t
Derby	• Mine to Port - Road Freight • Warehousing & Transfer to OGV • Derby Port Charges	A$30.05/t	A$27.16/t
Site	Handling of Titano-magnetite	A$1.00/t	A$1.00/t

Market Analysis

Respected marketing consultant TZ Minerals International Pty Ltd (TZMI) is forecasting long term deficits in both zircon and ilmenite markets if new projects fail to be brought on line in a timely manner. TZMI states this is a result of a progressive decrease in supply from existing producers, the closure of mature operations, coupled with a lack of new projects, and ongoing growth in consumption. TZMI prepared a confidential market study update including quality assessment and long term price forecasts of Sheffield's planned Thunderbird mineral sands products in November 2016.

Chinese group Beijing Ruidow Information Technology co. Ltd (Ruidow) completed an additional market appraisal study of the products, with specific reference to the Chinese market in December 2016. The Ruidow report is also most relevant to the Titano-magnetite product which is targeted for the large Asian steel industry.

Thunderbird ilmenite has been upgraded by a low temperature reduction roast process to produce a high grade (56.1% TiO_2) feedstock LTR Ilmenite which is suited to the production of:

- Sulphate TiO_2 pigment.
- Chloride-grade titanium slag (88% TiO_2).
- Chloride pigment manufacture as a potential blended feedstock

Thunderbird Premium Zircon product with high ZrO_2 content and very low contaminant trace elements which is suitable for varied applications. Major applications for premium grade zircon sand include:

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- Ceramics industry: opacifier in glazes, frits and flour.
- Investment castings: foundry applications.
- Specialty markets: chemical zirconia, high-end applications such as zirconium metal, fused zirconia, electronics.

Sheffield's marketing strategy is to produce high quality products, from a low risk, politically stable location and deliver these products consistently over a 42 year period into select regions, supplying key primary and secondary markets.

Product Logistics

Thunderbird is conveniently located within 140km of two existing ports, Broome and Derby. Together these ports are capable of meeting the varied shipping requirements of customers (either packaged or bulk form dependant on product type).

The location of these ports in the northern Western Australia, ideally places Thunderbird to supply the bulk of its exports to major markets in South-East Asia, China and India with good connections to European markets.

Key regional markets for Premium Zircon include China, India, and Europe and consumers typically take small lots in packaged form (in bags or containers). The Company has assumed that all shipments will be on a FOB basis and therefore delivery to the customer's nominated port will be the responsibility of the customer. The relatively small tonnage of Hi-Ti88 is expected to be exported on a similar basis to Premium Zircon.

The primary markets for LTR Ilmenite include China, Southeast Asia and Europe. Consumers of ilmenite receive product as bulk shipments and usually purchase on an FOB rate and are responsible for shipping from the vessel loading point to their nominated port. Sheffield expects to be responsible for delivering product to the customer's nominated vessel, which would anchor at an anchorage point in King Sound, near the port of Derby.

Chinese customers are expected to be the major consumer of zircon concentrate and take material as bulk shipments, usually purchased on an FOB rate, utilising the same supply methods as that of LTR Ilmenite. Zircon concentrate is expected to be shipped in 2-3 bulk shipments throughout the year in volumes as required by the customer.

China is also the major market for the other significant tonnage product of Titano-magnetite which is accepted in bulk form and is expected to be shipped in a similar manner to LTR Ilmenite.

Zircon products are planned to be packaged on site in bulka bags and transported to Broome on flat-bed trucks or taut-liners where by the material will be stored in warehouses near the port facilities. Packaging will be maximized in bulk bags, i.e. 2.5t bulka bags, to reduce transport costs.

The Port of Broome is well equipped with existing infrastructure and stevedoring services to load packaged products directly to ships' holds, whilst Derby has been used successfully in the past to export substantial quantities of bulk product via transhipment. Both ports are currently under-utilised, with Derby having essentially no other substantial trade. The use of Derby will require construction of a storage shed and restoration of an existing shiploader and existing jetty conveyor.

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Figure 18: Port of Derby, Western Australia

Accessibility, Climate, Physiography and Infrastructure

Modern transport and communication infrastructure in the region provides Thunderbird with relatively easy and secure access. The Project site is positioned mid-way between the regional coastal towns of Derby and Broome. The Great Northern Highway provides all-weather sealed road access from Broome and Derby to the Thunderbird access road. Great Northern Highway forms part of National Highway 1, connecting to Darwin in the north and Perth to the south. Access to the Thunderbird project site from Great Northern Highway is via a 30km long access road (currently called Mt Jowlaenga Homestead Road providing access to the Mt Jowlaenga Station homestead). The Project will upgrade 19km of the Mt Jowlaenga Homestead Road and add a dedicated 11km branch road to provide a heavy-haul unsealed mine site access road.

The regional towns of Broome and Derby augmented by smaller regional settlements will provide sufficient population and infrastructure resources to support ongoing operation of Thunderbird. Both Broome and Derby have seaports, airports, industrial and residential real estate plus commercial and civil services that regional centres typically offer, sufficient to enable the operational workforce to be residential in the region.

High quality road, aviation and marine transport infrastructure currently supports significant primary industries including offshore gas production, mining and agriculture. The Thunderbird Project requirements fit easily within the demonstrated performance of existing infrastructure as evidenced by current and past projects.

Reflecting a widespread decline in mineral commodity prices over the past few years, both towns have seen a reduction in economic activity resulting in surplus skill and services capacity across mining and construction support industries and high unemployment. This has given rise to a strong interest from local service providers, business operators and private individuals to be involved in development and operation of the Thunderbird Project.

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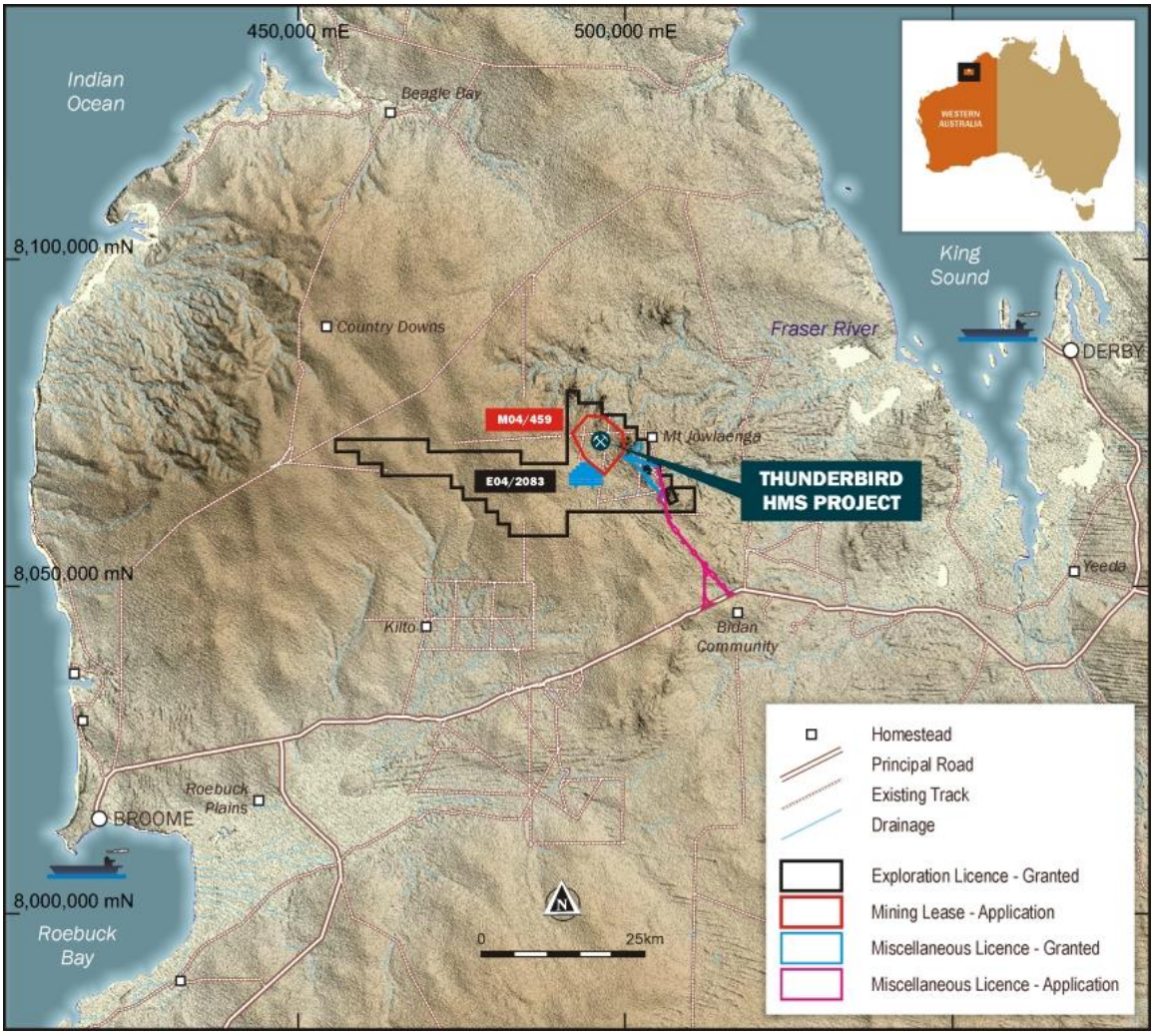

Figure 19: Location of Thunderbird Project on the Dampier Peninsula (Shuttle Radar Topography Mission Image)

The climate exhibits some high temperatures and is generally dry with an annual average rainfall of 840mm, falling predominantly in a limited 'wet season', for an average of approximately 50 days per year. Most rain falls in modest daily amounts, with just 2-3 days per year experiencing heavy falls. Year-to-year variation can be significant, with individual storm and cyclone activity being the key driver.

Legal, Regulatory and Commercial

Sheffield is the registered holder of the Thunderbird tenements and will transfer Thunderbird to be owned and operated exclusively by a wholly-owned subsidiary, Thunderbird Operations Pty Ltd. Sheffield is listed on the Australian Stock Exchange (ASX:SFX).

There is no State Agreement applicable to the development of Thunderbird, therefore Thunderbird is not dependent on the State of Western Australia for the performance of contractual obligations or reliant on any guarantee or security against failure to perform those obligations.

Thunderbird Operations Pty Ltd will ultimately have ownership of mineral rights and access to the lands necessary to develop the Thunderbird Project, including to build and operate the mine and connected infrastructure, and to produce and sell the product. There are no overlapping mining tenements to Thunderbird.

The principal mineral rights ownership and land access rights will be conferred by the relevant licences issued under the Mining Act 1978 (Mining Act). Sheffield is obligated to liaise and negotiate with other interested parties, including Native Title parties and Traditional Owners, pastoral lessees and the holders of other mining tenements (should they arise).

The construction and operation of Thunderbird will be subject to approvals required under Commonwealth and State Laws as well as local government (Shire of Broome and Shire of Derby - West Kimberley).

Tenure and Approvals

The Thunderbird Project comprises 483 square km of mining tenure in the West Kimberley Mineral Field of Western Australia. All the mining tenements within the Project are 100% held by Sheffield.

Mining and processing operations will be conducted on Mining Lease 04/459 whilst the accommodation village will be located on Miscellaneous Licence 04/85. The Project's access roads and future power and pipeline corridors will be on Miscellaneous Licences 04/82, 04/83, 04/84 and 04/86. Miscellaneous Licence 04/83 has been applied for as a substitute for the southern sector of Miscellaneous Licence 04/82 should there be drainage issues with that portion of the road. Miscellaneous Licences 04/92 and 04/93 were applied for and subsequently granted to use for additional groundwater bore sites if required.

Mining Lease 04/459 and Miscellaneous Licences 04/82 and 04/83 are pending applications and will be granted subject to the conclusion of Native Title processes and consultation. The Mining Lease application and the granted miscellaneous licences are underlain by granted exploration licence E04/2083.

The Project straddles the boundary of two pastoral leases, Mining Lease 04/459, Miscellaneous Licences 04/84 – 04/86, the northern portion of Miscellaneous Licence 04/82 and Miscellaneous Licences 04/92 and 04/93 are within the Mt Jowlaenga Pastoral Lease (N050161), and the southern portion of Miscellaneous Licence 04/82 and Miscellaneous Licence 04/83 are within the Yeeda Pastoral Lease (N050691). Both pastoral leases are owned and operated by Yeeda Pastoral Company Pty Limited.

Sheffield is currently negotiating an agreement with the pastoral lessee in respect of the rights and obligations to mine and operate on the pastoral lease.

The southern portions of Miscellaneous Licences 04/82 and 04/83 where they intersect with the Great Northern Highway fall within the overlying Crown Reserve 9697 (Kimberley De-Grey Stock Route) managed by the Department of Regional Development and Lands. Sheffield has engaged the relevant authority and there are no issues with regard to the required construction and use of the entry.

Native Title

Thunderbird is co-located with two native title claims made under the Native Title Act 1993 (NTA):

- Application for the Mt Jowlaenga Polygon #2 Native Title Claim (WC2014/005) filed in November 2014.
- Nyikina Mangala Native Title Claim (WCD2014/003) determined May 2014.

Native Title claim application WC2014/005 affects mining lease area M04/459 and Native Title claim determination WC2014/003 affects miscellaneous licence applications L04/82 and L04/83 (which cover access roads).

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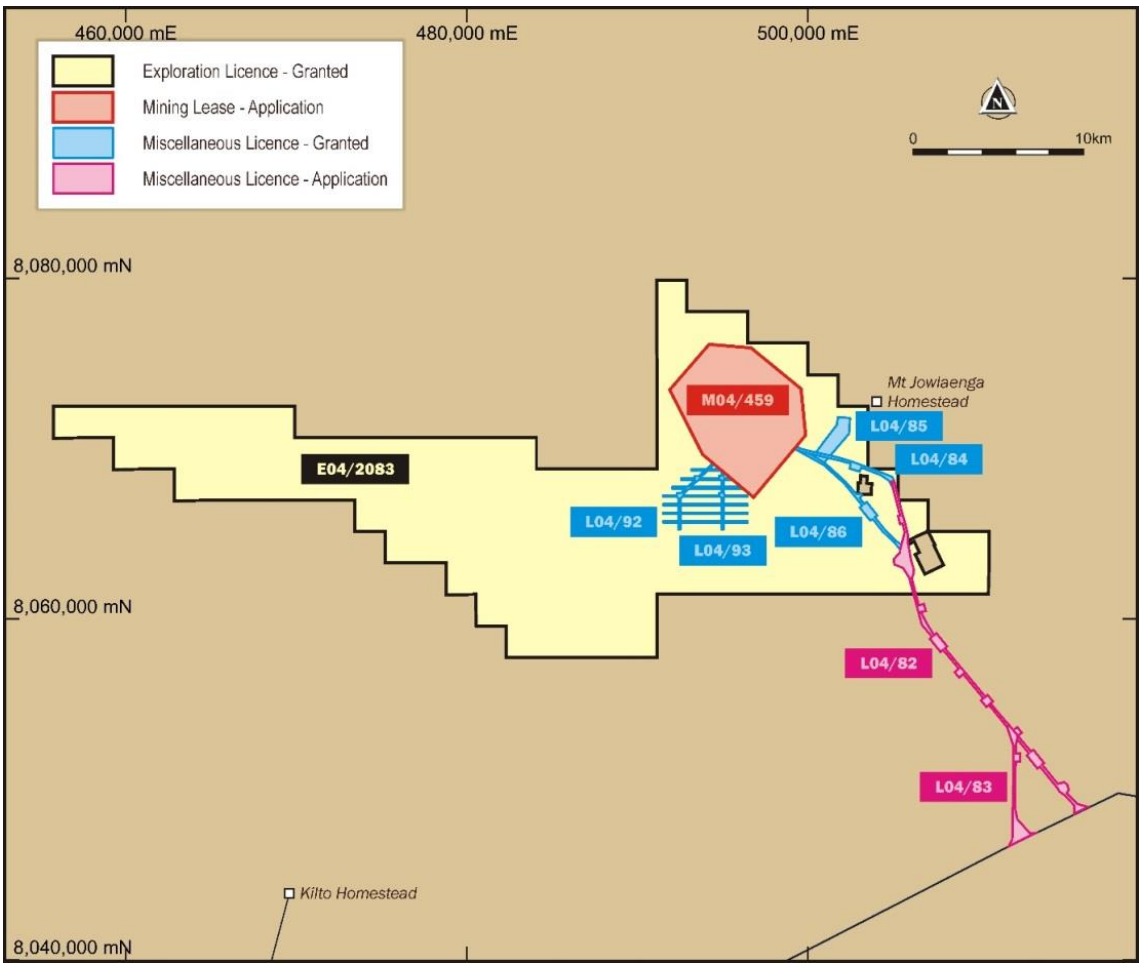

Figure 20: Thunderbird Mineral Sands Project Mining Tenements

Mining lease application M04/459 and miscellaneous licence applications L04/82 and L04/83 have been approved for grant by the Western Australian Department of Mines and Petroleum subject to successful conclusion of the relevant Native Title processes under the Native Title Act 1993 (NTA).

Proposed granting of mining titles are generally referred to in the NTA as "Future Acts" which are then subject to due processes under the NTA before a grant may be considered valid so far as it may affect Native Title. The three streams followed in the "Future Act" process are:

- The "Right to Negotiate" with respect to mining titles (RTN).
- The "Expedited Procedure" with respect to exploration and prospecting tenure.
- The "Right to be Consulted" with respect to infrastructure titles (miscellaneous licences and general purpose leases)

These processes are managed by the National Native Title Tribunal (NNTT).

In October 2016 RTN negotiations for Sheffield's application for Mining Lease 04/459 were referred to the NNTT as agreement could not be reached with the Native Title party affected by the proposed grant of the lease. Following this, Sheffield referred the case to the NNTT for determination and each party has

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submitted, or is in the process of submitting their respective contentions and a decision by the NNTT is expected during Q2 2017.

The Western Australia Department of Aboriginal Affairs (WADAA) is responsible for management and performance of implementing the Aboriginal Heritage Act 1972 (AHA) which covers legislation for management and protection of all Aboriginal heritage sites in the State of Western Australia.

A search of the WADAA Aboriginal Heritage Register was conducted prior to commencing any works at the Thunderbird Project site. The search showed no registered sites were recorded.

Sheffield has subsequently conducted extensive and robust Aboriginal heritage investigations with traditional owners which has enabled Sheffield's exploration programs to be carried out successfully over the past five years without any damage to, or disturbance of, any places or sites of cultural significance to Aboriginal people.

During 2016, a heritage clearance survey was carried out with the relevant Traditional Owners over the proposed lease areas where Thunderbird operations would take place. As a result of this survey, Sheffield was asked to avoid certain defined areas with significance to Traditional Owners which Sheffield has agreed to. Avoidance of these areas can be achieved with no material impact on construction or operations with appropriate planning.

Environmental Approvals

As at March 2017, significant work has been undertaken to characterise and mitigate against potential environmental impacts associated with the Project. The Project is based around traditional mining, processing and transportation technologies that have been implemented over decades at numerous operations within Australia. Sheffield has undertaken an extensive stakeholder consultation program to understand community and stakeholder matters with respect to the Project's potential impacts to the surrounding environment and responded by amending the Project where required. Within this context, Sheffield has established a high level of confidence in the feasibility of the Project from an environmental management and compliance perspective.

Western Australia State Government (State Government) and Australian Federal Government (Federal Government) environmental approvals for all components of the Project are significantly progressed, with both the Federal Government and State Government environmental approvals expected to be granted in the third quarter of 2017. The Project is being assessed under both Part IV of the Environmental Protection Act 1986 (EP Act) (State) and Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (Commonwealth). The EPBC Act assessment is being conducted by the State of Western Australia's Environmental Protection Authority (EPA) under a bilateral agreement made under Section 45 of the EPBC Act to accredit the state assessment process.

Sheffield has prepared a Public Environmental Review (PER) document for the combined port and mine development. The PER has been prepared in accordance with the EPA approved Environmental Scoping Document (ESD) and provides an assessment of potential impacts from the Project, based on a comprehensive knowledge base supported by technical and baseline studies conducted by Sheffield. The PER document has been reviewed by the EPA and deemed to have been completed in accordance with the ESD and to a standard satisfactory for assessment purposes. The EPA subsequently approved the PER's release for a four-week public review period in January 2017.

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The public comment period for the PER closed on 13 February 2017. During the public submission period 52 submissions were received, most of which were in support of the Project. Sheffield has prepared responses to matters raised in the submissions by stakeholders, and is confident that they can be appropriately managed, having submitted these to the EPA. The EPA is considering the information prior to releasing their report and recommendations to the Minister for Environment.

Sheffield has a comprehensive understanding of government approvals required to construct and operate Thunderbird and there is a well-defined strategy and work program to obtain these permits. If the Western Australian Minister for the Environment has granted approval for the Project under Part IV of the EP Act, it is expected that other decision making agencies will grant subsequent secondary approvals including:

- Department of Environment Regulation – works approvals and operating licences under Part V of the EP Act.
- Department of Water – grant the licence to abstract groundwater under section 5C of the Rights in Water and Irrigation Act 1914.
- Minister for Indigenous Affairs – approvals to disturb known heritage locations under Section 18 of the Aboriginal Heritage Act 1972.
- Department of Mines and Petroleum – mining proposal approvals under the Mining Act 1978.

Stakeholder Engagement

Sheffield has undertaken extensive engagement with the following stakeholders:

- Western Australia State Government (State Government)
- Australian Federal Government (Federal Government)
- Kimberley local government authorities (LGA)
- Kimberley communities
- Aboriginal organisations and representatives
- Non-government organisations (NGO)
- Media
- Special interest groups.

A sound understanding of community impacts, themes and sentiments has been developed and shall underpin a stakeholder management plan, in advance of construction.

Sheffield has high reputational values which are supported by its ongoing engagement strategy and on delivery of proposed benefits such as employment and local business opportunities.

Human Resources

Current market trends are favourable with a reversal in the supply shortages of construction trade workers experienced in Western Australia in recent years.

Extensive community engagement and consultation has indicated considerable interest from local communities in relation to employment, sub-contracting and business opportunities.

Sheffield Resources LIMITED

Sheffield will encourage local content with contractors during construction however the degree of local content will ultimately depend on the relationship between local business and the Project's major contractors rather than the relationship with Sheffield. Prior to awarding contracts for the operations Sheffield will require potential contractors to submit a local content policy that addresses local employment. Local content will form part of the contractual conditions for operations contractors.

Sheffield is committed to providing long-term benefits to local Aboriginal people. Sheffield will develop an Aboriginal Employment Strategy (AES) with community oversight to support their commitment and obligations to the Aboriginal community and provide a means to access, attract and retain an Aboriginal workforce through creating a culturally aware workplace.

When operational, Sheffield will assume responsibility for the Thunderbird operations site and all direct employees associated with Thunderbird. Sheffield's role with contractors and indirect employees will continue to be from the standpoint of ensuring contractors have appropriate systems in place to manage their employees from an employee relations and safety perspective and a reporting process is in place with Sheffield in relation to same.

Geology and Mineralisation

Thunderbird is the first significant mineral sand deposit to be discovered in the Phanerozoic Canning Basin, and is one of the largest and highest grade mineral sands deposits globally, including those currently in production. The Thunderbird deposit formed during an Early Cretaceous marine regression and is hosted by highly weathered Broome Sandstone.

Mineralisation occurs as a thick, broad sheet like body striking northwest, extending from surface to a maximum known depth of 155m over an area at least 11km by 7km. These extents have not been closed off with mineralisation remaining open to the north, south and west. The average depth to top of the main body of mineralisation is 24m and the average mineralised thickness 45m. The deposit is flat-lying along the north-eastern flank, but with a dip steepening to 4° along the south-western flank.

Enclosed within the Thunderbird formation is a continuous, very-high grade heavy minerals (>7.5%) zone named the "GT Zone". This zone is up to 43m thick (average 15m) over an area at least 9km by 7km, strikes approximately north-south, follows the dip of the Thunderbird formation and is open along strike to the south and north.

Regional drilling has resulted in discovery of four new substantial mineral sands prospects named Night Train, Nomad, Argo and Seagull. Night Train is a significant new discovery emphasising the excellent exploration potential of the Dampier project and confirming the Canning Basin as an emerging mineral sands province (refer ASX announcement dated 14 April 2016 for further details).

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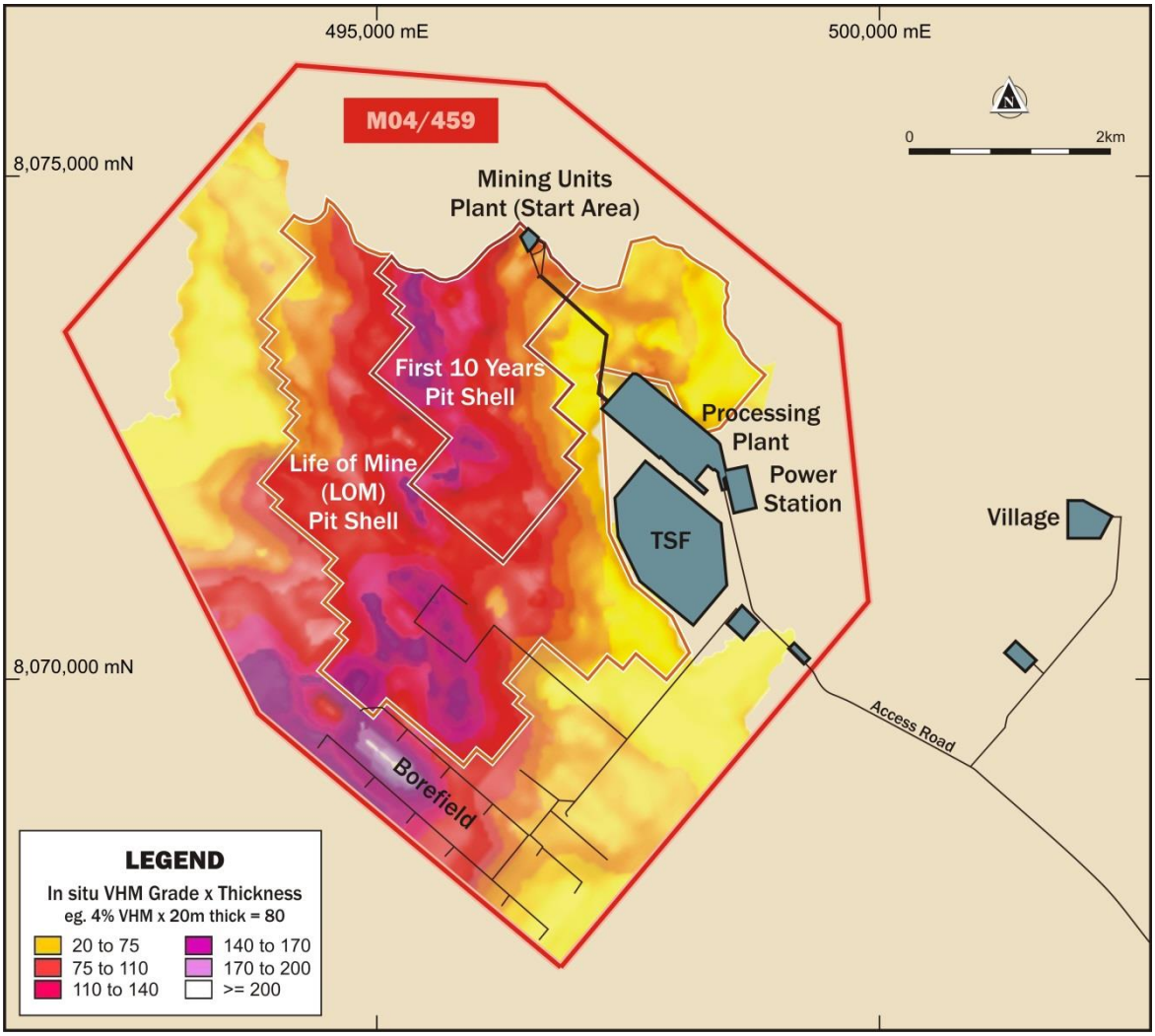

Figure 21: Thunderbird Site Layout over image of VHM Grade x Thickness (>7.5% HM)

Mineral Resource Estimation

Total Mineral Resources for Thunderbird comprise 3.23 billion tonnes at 6.9% HM (Measured, Indicated and Inferred) at a 3% HM cut-off, containing 92.6Mt of valuable heavy mineral (VHM). Mineral Resources reported in this announcement are inclusive of Ore Reserves. Within this Mineral Resource is a coherent high grade zone of 1.05Bt at 12.2% HM (Measured, Indicated and Inferred) at a 7.5% HM cut-off containing 50.4Mt of VHM (Table 16).

At a 3% HM cut-off, the Mineral Resource covers an area which is 8km long and between 3km and 6.5km wide and remains open in most directions. The average depth to the top of main body of mineralisation is 24m and the average mineralised thickness is 42m. At a 7.5% HM cut-off the Mineral Resource covers an area approximately 8km long by 2.5km to 6.5km wide, and remains open to the north and south. This higher grade mineralisation is enclosed within the 3% cut-off Mineral Resource envelope. The high grade mineralisation extends from surface to a maximum modelled depth of 124m. The average depth to the top of the high-grade mineralisation is 35m and the average mineralised thickness is 16m.

At a 3% HM cut-off, the mineral assemblage of the total Mineral Resource comprises 8.3% zircon, 2.6% high-titanium leucoxene, 2.9% leucoxene and 28% ilmenite for a total VHM component of 42%. Process test work has shown that these valuable heavy minerals can be recovered using standard mineral sands processing techniques.

Significantly the Mineral Resource has high in-situ VHM grades totalling 2.9% (at 3% HM cut-off) and 4.8% (at 7.5% HM cut-off). This is further highlighted by the Measured category of the Mineral Resource of 220Mt at 14.5% HM (at a 7.5% HM cut-off) with very high in-situ zircon and ilmenite grades of 1.07% and 3.9% respectively.

The Mineral Resource estimate is based on drill hole data collected by Sheffield from 2012 to 2015 comprising 670 holes drilled for a total of 37,076m, with 24,688 samples assayed for HM, slimes and oversize. The heavy mineral assemblage dataset comprises results from 759 composite samples from 374 holes over 14,308m drilled, representing 63% of the total length of drill holes within mineralised zones of the Mineral Resource estimate.

The Mineral Resource estimate has been classified according to the definitions of the JORC Code (2012), into Measured, Indicated and Inferred Mineral Resources, taking into account data quality, data density, geological continuity, grade continuity and confidence in estimation of heavy mineral content and mineral assemblage.

Table 16: Thunderbird Deposit Mineral Resource as at 30 June 2016

Resource Category	Cut-off HM (%)	Qty (Mt)	Bulk Density	HM (%)	Slimes (%)	Oversize (%)	Valuable HM Grade (In-Situ %)				
							Zircon	HiTi Leucoxene	Leucoxene	Ilmenite	Total VHM
Measured	3.0	510	2.1	8.9	18	12	0.71	0.20	0.19	2.4	3.5
Indicated	3.0	2,120	2.0	6.6	16	9	0.55	0.18	0.20	1.8	2.8
Inferred	3.0	600	2.0	6.3	15	8	0.53	0.17	0.20	1.7	2.6
Total	**3.0**	**3,230**	**2.0**	**6.9**	**16**	**9**	**0.57**	**0.18**	**0.20**	**1.9**	**2.9**
Measured	7.5	220	2.1	14.5	16	15	1.07	0.31	0.27	3.9	5.5
Indicated	7.5	640	2.1	11.8	14	11	0.90	0.28	0.25	3.3	4.7
Inferred	7.5	180	2.0	10.8	13	9	0.87	0.27	0.26	3.0	4.4
Total	**7.5**	**1,050**	**2.1**	**12.2**	**15**	**11**	**0.93**	**0.28**	**0.26**	**3.3**	**4.8**

Notes:

- Total heavy minerals (HM) is within the 38µm to 1mm size fraction and has been reported as a percentage of the total material quantity.
- The valuable heavy mineral in-situ grade is reported as a percentage of the total material quantity and is determined by multiplying the percentage of total HM by the percentage of each valuable heavy mineral within the HM assemblage at the resource block model scale.
- All tonnages and grades have been rounded to reflect the relative accuracy and confidence level of the estimate, thus the sums of columns may not be equal.
- Estimates of mineral assemblage are determined by magnetic separation, QEMSCAN and XRF of the 38µm to 1mm size fraction. Magnetic fractions were analysed by QEMSCAN for mineral determination as follows: ilmenite: 40-70% TiO_2 >90% liberation; leucoxene: 70-94% TiO_2 >90% liberation; high titanium leucoxene (HiTi leucoxene): >94% TiO_2 >90% liberation; and zircon: 66.7% ZrO_2+HfO_2 >90% liberation. The non-magnetic fraction was submitted for XRF analysis and minerals were determined as follows: zircon: ZrO_2+HfO_2/0.667 and HiTi leucoxene: TiO_2/0.9.

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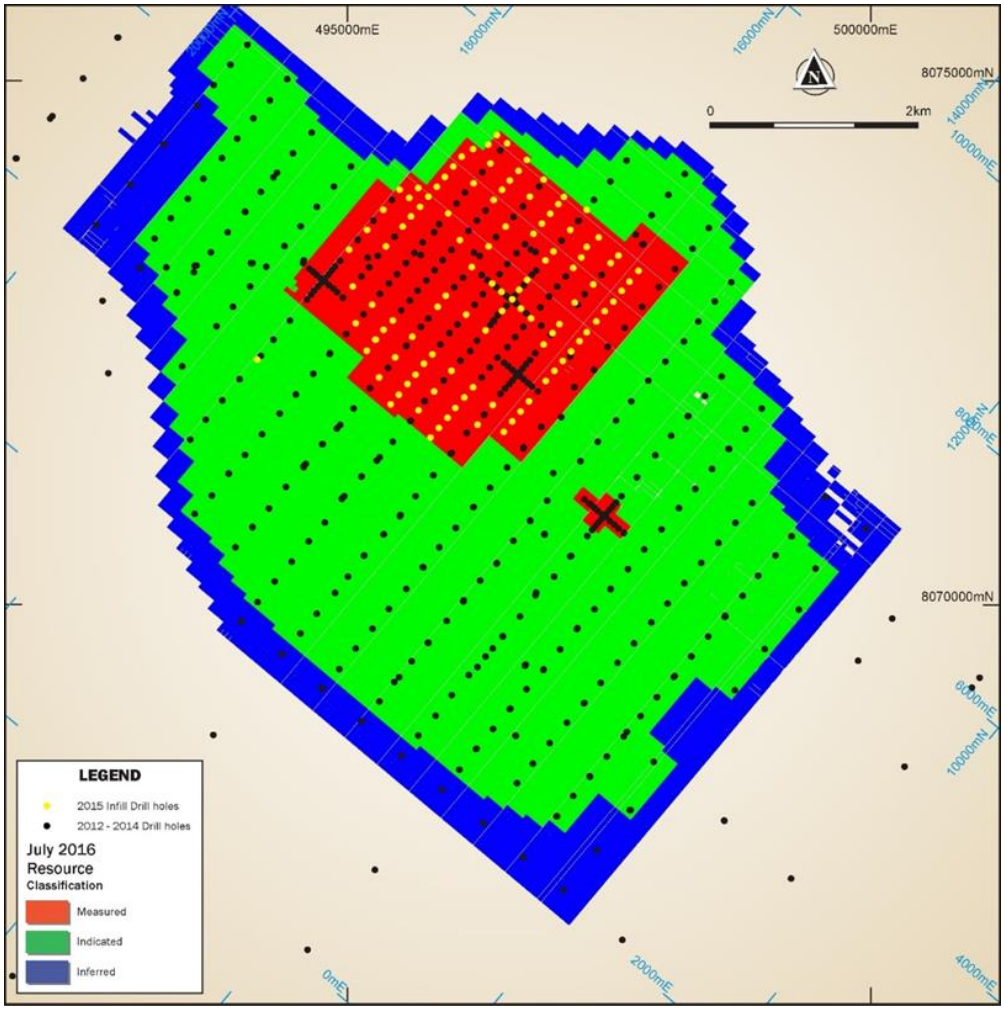

Figure 22: Mineral Resource Classification and Drill Hole Location Plan (MGA coordinates, Local Grid Shown in Blue)

Mine Geotechnical

The geotechnical characteristics of the Thunderbird deposit are specific to its geological setting, the most significant of which is a strong weathering overprint on the deposit which is not uncommon in mineral sands deposits around the world (e.g. Namakwa, Jacinth-Ambrosia).

Thunderbird mineralisation is hosted by highly weathered Broome Sandstone, locally referred to as the Thunderbird Formation. In the near surface environment where the mineralised horizon comes to within 12m of surface a weakly-indurated "crust" occurs. Below the crust the ore horizon becomes increasingly weathered and substantially softer with increasing depth, where it is classified as a tightly packed sand with variable degrees of induration.

Melligo Sandstone lies stratigraphically above the Thunderbird Formation and together with low grade mineralisation comprises the bulk of the overburden to the mineralisation. It is strongly weathered and comprises predominantly soft sandstone, jointed at the centimetre-scale. Melligo Sandstone is variably silcreted in places, forming a blocky siliceous sandstone requiring hard ripping. This material comprises about 6% of the overburden volume and is located predominantly adjacent to the margins of the deposit.

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Covering the deposit area is a 0.5 to 20m thick unit of red, sandy-silty soils referred to locally as the Pindan sand which is readily excavated by tracked Dozer, Scraper or hydraulic tracked Excavator.

Geotechnical investigations carried out at Thunderbird include:

- Sonic and large-diameter Bauer drilling.
- Costeaning.
- Geotechnical logging.
- Standard penetration tests.
- In-situ permeability testing.
- On site point load testing.
- Laboratory test work on soil (unconsolidated ore) and core samples.

Engineering appraisal has included observations on mine ability and Dozer productivity assessment from test costeaning and large diameter auger drilling and mining vehicle trafficability.

Mining and Excavatability

The sonic drilling test program indicated that host Broome Sandstone comprising predominantly silty sands and which form the majority of the material expected to be encountered in the deposit should be readily excavatable using conventional mining equipment.

Trafficability

Analysis suggests that the materials which will be encountered during mining operations are very dense and are expected to be readily trafficable in dry conditions.

For wet conditions (high topography wet season category), analysis indicates 'good' to 'excellent' wet season trafficability is inferred, with >90% probability of heavy mining vehicles and all-wheel-drive trucks and trailed vehicles with low contact pressure remaining mobile. Light vehicles (all - wheel drive and rear-wheel drive trucks and trailed vehicles intended primarily for highway use), would have 50 to 70% chance of being mobile on sandy silt/clay material in wet conditions, but should be fully mobile on silty sand material. In extreme rainfall events, it is likely that mining would temporarily cease, and based on experience on other Kimberley mines, it could take up to a few days for the site to drain sufficiently to remobilise equipment.

Open Pit Stability

Using various analyses, pit depths between 66 and 76m have been considered, depending on location. The analyses indicate that overall design slopes between 40 and 60 degrees should be feasible. Batter angles of 40 degrees were used except in the case where rock layers are not present, the overall safe slope angle reduces to approximately 34 degrees.

Costeans

Three costeans were excavated in June 2016, to provide samples to further evaluate the likely particle size distribution, effects of oversize on ore feed processing and investigate the excavatability of the shallow, high grade area of the deposit, dozer/excavator productivity. Excavation was supervised by consultant mining engineers Entech Mining Pty Ltd (Entech).

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Figure 23: Costean THTP002

Figure 24: Mobile Screening Plant

Dozing was confirmed as a suitable mining method with the observation that productivity was most impacted by constraints on the width of the working face. Productivity in the upper parts of the test costeans was high.

Geotechnical logging indicated the excavated material below topsoil and subsoil to comprise weathered, weak to very weak rock with UCS levels below 5.

Screening of the stockpiled ore has provided a particle size distribution which will assist in final feed preparation process design in the upper, more cemented areas of the Thunderbird deposit.

Hydrology and Hydrogeology

The Dampier Peninsula's Broome aquifer has good quality groundwater. The average groundwater salinity at Thunderbird is 160 mg/L; Perth tap water has an average salinity (depending on the suburb) of 150–500 mg/L. Water supply and dewatering will temporarily lower the water table locally. Groundwater levels will recover post-mining, with groundwater levels largely recovered after 10 years post-mining. Perched groundwater systems will be unaffected by groundwater pumping.

The Thunderbird Project catchments largely comprise flat sandy plains with some small rocky hills approximately 50m high, with ground elevations from 88–120m (Australian Height Datum). The Thunderbird Project is located on sand plains, including Pindan silty sand, with some areas of sandstone outcrop and irregular sand dunes. The majority of the Thunderbird Project is within the Fraser River South catchment. There are no declared surface water areas in either the Thunderbird Project area or the Logue and Fraser River catchments. The nearest public drinking water reserves are near Broome and Derby.

Thunderbird lies within the Broome aquifer – a regional, unconfined aquifer that extends across a large portion of the Dampier Peninsula. The Broome aquifer is hosted in the Broome Sandstone and the saturated parts of the overlying Emeriau Sandstone and Mowanjum Sand. It is a major unconfined to semi-confined aquifer that supplies groundwater to the Broome town site, rural subdivisions, horticultural areas and pastoral properties. The Thunderbird Project is located in the Canning–Pender sub-area of the Canning-Kimberley Groundwater Area, which has 95.4% of its available groundwater resources of 50 GL/yr available for allocation.

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The depth to groundwater is in excess of 20m over most of the Project area. The Broome aquifer has moderately high hydraulic conductivity, ranging from 2–42 m/d. Aquifer systems on the Dampier Peninsula are recharged by direct rainfall infiltration.

Up to 120 m^3/h of water will be required for construction activities. Steady-state operational water demand is up to about 1219 m^3/h (10.7 GL/yr). Excess dewatering volumes (from about Year 32 onwards) will be discharged via aquifer injection. Process water will be sourced from a make-up borefield adjacent to the mining void for the first 15 years of operation. From year 32 the dewatering volumes exceed water demand and aquifer injection will occur, peaking at 22 GL/yr injection in mining year 47. Drawdown of up to about 2m may be expected at the Fraser River South valley, about 8km south-east of the mine. Groundwater drawdown is not predicted to impact on existing licensed groundwater users. Drawdown results are relatively insensitive to future climate scenarios and model-parameter uncertainty. Dewatering volumes are predicted to peak in later stages of the mining sequence, with about 30 GL/year dewatering predicted in mining year 47. Post-mining aquifer recovery simulations show residual drawdown of <7.5 m after 2 years and <2.5 m after 10 years.

Mining

Based on the results of the fieldwork studies undertaken to assess excavatability (Sonic core, Bauer drilling and costeans) bulk mining techniques have been chosen for ore mining at the Thunderbird project, incorporating dozer traps and in-pit feed preparation units. Topsoil and overburden will be excavated and transported using truck and excavator. Oversize material rejected from in-pit feed operations will be rehandled by Wheeled Loader to locations within the active mine void. Following excavation and classification, ore will be slurried and pumped to a nearby wet concentration plant. Retaining cells will be constructed in the developed mine void from waste material for the return of process tails for consolidation into backfill. Following consolidation, topsoil will be returned in a continuous rehabilitation process. The mining techniques and equipment proposed are conventional and well tested dry mining techniques employed in existing similar mineral sands operations worldwide.

A three stage pit design has been undertaken based on guide shells generated from open pit optimisation. These stages represent those required for an initial starter void, a ten year pit and a 42 year life of mine pit.

Table 17: Summary of Life of Mine (LOM) Material Movements and Type

Pit Stage	Ore				Ore Valuable HM Grade, % (In-Situ)				Waste, Mt		
	Material (Mt)	HM (%)	Oversize (%)	Slimes (%)	Zircon	HiTi Leucoxene	Leucoxene	Ilmenite	Topsoil	Un-mineralised	Mineralised
Starter Void	0.21	11.7	17.6	19.9	1.08	0.30	0.25	3.56	0.01	0.00	0.00
10 Year Pit	149.69	14.3	13.1	16.3	1.04	0.30	0.28	3.85	1.63	20.15	31.73
LOM Pit	530.77	10.4	11.6	15.5	0.82	0.26	0.26	2.88	4.80	344.66	126.84
Total	**680.67**	**11.3**	**12.0**	**15.7**	**0.87**	**0.27**	**0.26**	**3.10**	**6.44**	**364.81**	**158.57**

Detailed scheduling within the ten year design has been undertaken on 200m by 100m blocks based on a proposed bulldozer push operation. Beyond this area, coarser 600m by 600m size blocks have been used (see Figure 25).

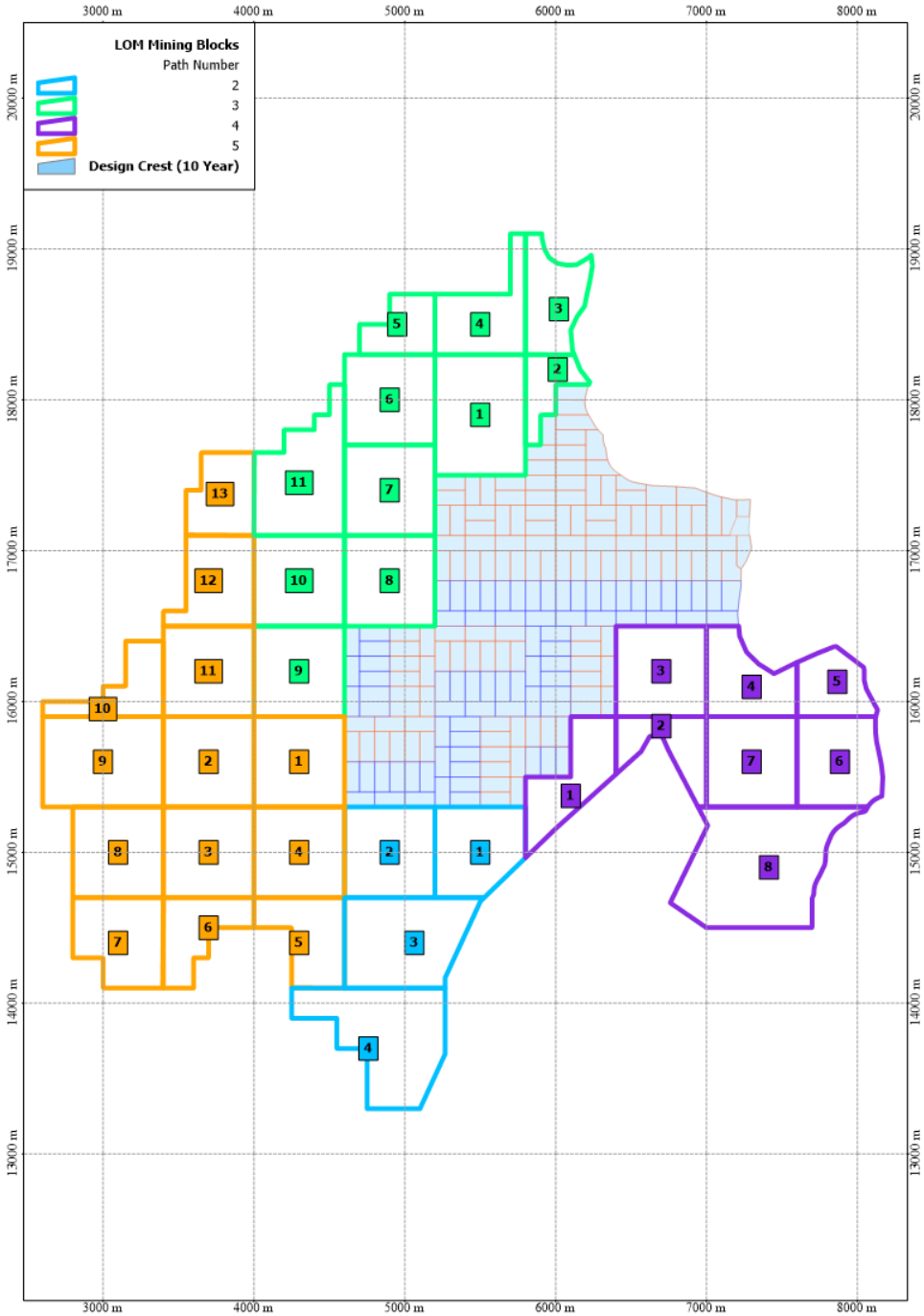

Figure 25: Life of Mine and Detailed Mine Blocks

A single in pit feed unit has been scheduled for production during the initial four years of operations, supplemented thereafter by the introduction of a second unit, doubling production. Mine scheduling is based on providing target feed rates to the Wet Concentrator Plant (WCP) roughers of 788tph for each in pit feed unit and material movement rates in the pit vary on a period basis to meet design process targets.

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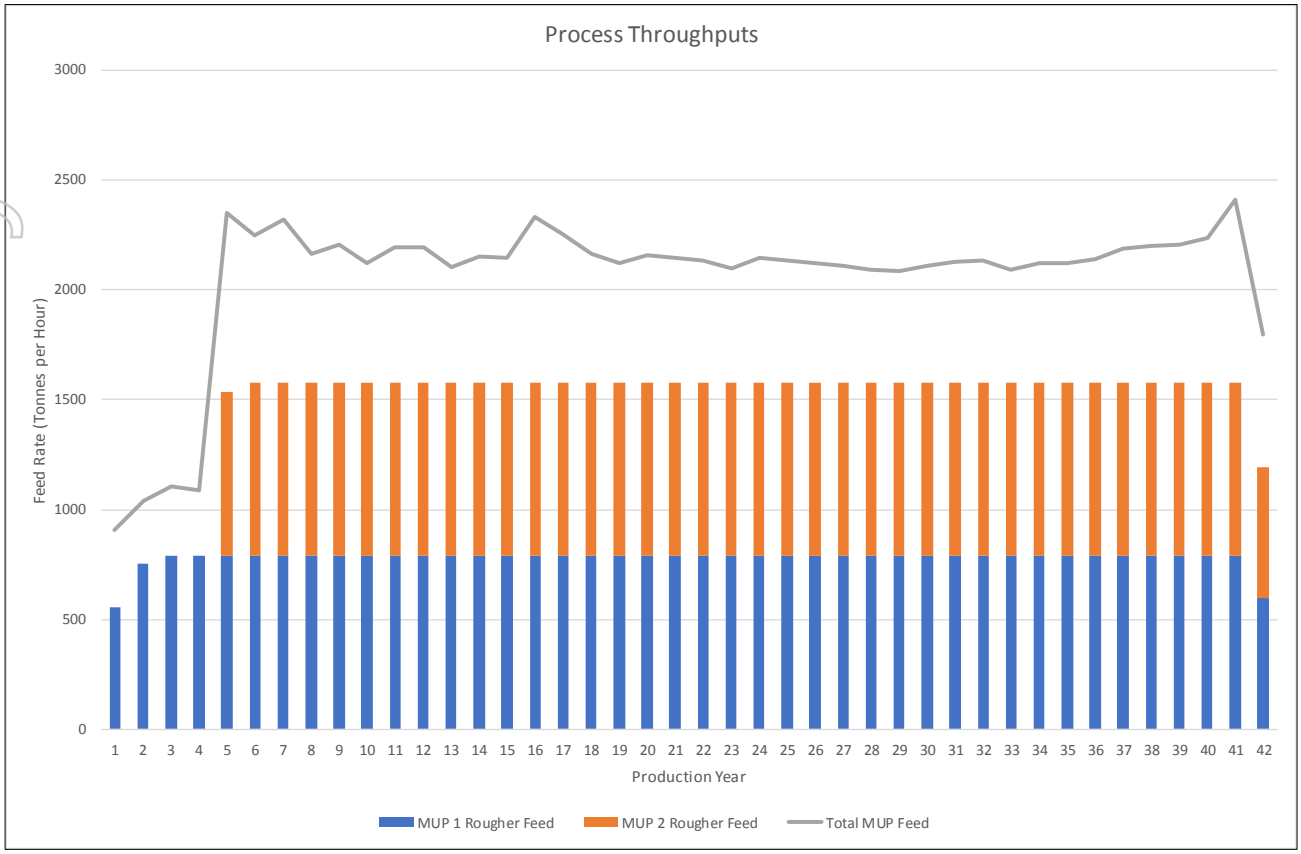

Figure 26: Process and In Pit Feed Rates

Primary ore mining is to be undertaken by a fleet of up to 6 x 100t Tracked Dozers including Stage 2 expansion. Overburden mining will be undertaken by 70t and 120t Hydraulic Tracked Excavators loading 100t Off-Highway Haul Trucks. Ore feed and topsoil stockpile rehandle operations will be supported by 100t Large Wheel Loaders. Additional 65t Tracked Dozers will support surface clearing, waste mining and in pit tails embankment wall building operations. Ancillary support equipment will include graders, integrated tool carrier, water carts, mobile lighting towers, in pit sump dewatering pumps and service trucks.

Ore Reserve

The Ore Reserve estimate is based on the current, July 2016 Thunderbird Mineral Resource estimate. Measured and Indicated Mineral Resources were converted to Proved and Probable Ore Reserves respectively, subject to mine designs, modifying factors and economic evaluation.

The Ore Reserve estimate for the Thunderbird Project, as at March 2017, is outlined in Table 18 below, as detailed in the Company's ASX release dated 16 March 2017:

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Table 18: Thunderbird Ore Reserve March 2017

Ore Reserve			Valuable HM Grade (In-Situ)					
Reserve Category	Material (Mt)	HM (%)	Zircon (%)	HiTi Leuc (%)	Leucoxene (%)	Ilmenite (%)	Oversize (%)	Slimes (%)
Proved	235.8	13.3	1.00	0.29	0.26	3.55	13.7	16.5
Probable	444.8	10.2	0.80	0.26	0.26	2.85	11.0	15.2
Total	**680.5**	**11.3**	**0.87**	**0.27**	**0.26**	**3.10**	**12.0**	**15.7**

The in-situ grade is determined by multiplying the percentage of HM by the percentage of each valuable heavy mineral within the heavy mineral assemblage at the resource block model scale. Tonnes and grades have been rounded to reflect the relative accuracy and confidence level of the estimate, thus the sum of columns may not equal.

Detailed mine design and schedules, supported by pit optimisation and strategic scheduling studies were generated for the Ore Reserve estimate. A 98% mining recovery factor was applied to ore material, no additional dilution factor has been applied given the bulk nature of the proposed mining operations and the removal of overburden and mineralised waste well in advance of ore mining. Geotechnical analyses form the basis of pit design criteria. The life-of-mine average strip ratio (waste: ore) is 0.78: 1.00.

An initial high value area was identified, representing approximately 10 years of production, with detailed design and scheduling completed in this area. The 10 year pit contains 144.5 Mt of Proved Ore Reserve and 4.4Mt of Probable Ore Reserve confirming the high confidence in the mining schedule.

Additional details on the modifying factors used to estimate the Ore Reserve are contained in the Company's ASX release dated 16 March 2017.

Tailings

As part of producing heavy mineral concentrates at the proposed processing plant, two tailings streams will be produced: one a coarser, sandy, fraction, the other a finer fraction, labelled as 'slimes'. The two tailings streams will be collectively produced at around 760 dry tonnes per hour per processing train. These tailings streams require permanent storage in tailings storage facilities (TSF). With establishment of a mining void, all tailings produced will be deposited 'in-pit' to backfill this void.

The deposition methodology required to ensure a stable, suitably dense, tailings mass means that an auxiliary TSF will be required to store tailings before adequate mining void volume and surface area is available in-pit. This auxiliary facility has been labelled the Initial TSF.

The Initial TSF shall be constructed so it is available for tailings deposition at commencement of production at the processing plant. It is expected that the Initial TSF will be in operation for ~2.5 to 3 years, initially as the sole tailings deposition location, but later in parallel to deposition in-pit, before eventually being left for tailings to dry and consolidate as tailings deposition moves entirely in-pit. The Initial TSF would then undergo reshaping to form the final landform to be rehabilitated.

The Initial TSF has been located as close as practical to the processing plant and will be constructed with embankments largely above ground.

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Metallurgy and Process Selection

During the course of the BFS, full-scale or scalable metallurgical test work was carried out on the full separation process, including LTR continuous feed pilot test work. Variability test work demonstrated robust metallurgical performance of the separation and LTR processes across the range of expected ore feed.

The processing flowsheet uses the application of proven metallurgical processes and standard mineral sand separation techniques (spirals, magnetic and electrostatic separators) to enable production of ceramic grade zircon (Premium Zircon) and high quality ilmenite (LTR Ilmenite) along with valuable co-products of leucoxene (Hi-Ti88), zircon concentrate and Titano-magnetite.

The treatment of the zircon-rich (non-magnetic stream) with a mild Hot Acid Leach (HAL) followed by an attritioning process is sufficient to enhance the effectiveness of the primary high tension separation circuit, and remove iron coatings on the zircon grains producing a Premium Zircon product.

The treatment of the Primary ilmenite (conductor magnetic stream) concentrate with a reductant roast gas (Low Temperature Roast (LTR)) changes the oxidation state of contaminant ferric iron oxides in the concentrate, enabling subsequent clean separation of these iron-rich minerals from the ilmenite with conventional magnetic separation equipment. This step produces a high-grade, low impurity, LTR Ilmenite product. This LTR Ilmenite product demonstrates high solubility, reactivity and $FeO:Fe_2O_3$ ratio to match the best sulphate ilmenite available globally.

The LTR process effectively acts as a homogenisation step, producing a consistent product across a range of feed grades, and can accommodate variable levels of iron oxide in the feed. Furthermore, adjustment of operating parameters (syngas makeup, temperature and residence time) enables control of final product characteristics.

Metallurgical process development test work programs completed during 2015 resulted in the development of process flow diagrams capable of producing potential products. These process flow diagrams formed the basis of the PFS completed by Sheffield in 2015.

Metallurgical test work completed during the BFS on a 40 tonne bulk sample utilising full scale or scalable processing equipment, confirmed the process flow sheet as appropriate. In particular, the use of Rare Earth Roll Magnetic separators ahead of the HAL process has resulted in increased ilmenite recovery to the ilmenite dry circuit and critically, reduction of iron levels in the non-magnetics entering the HAL process.

Generated products are of high quality and in-line with that achieved during the PFS test work.

Overall zircon recovery, into a primary zircon product is calculated at 56.1% which is 2.6% higher than that achieved during the PFS. This improvement is mainly associated with the improved recoveries associated with the wet concentration process, concentrate upgrade process and HAL process.

Overall zircon distribution into a zircon concentrate (zircon enriched rejects streams, excluding monazite rejects and HAL gravity rejects) is substantial and calculated at 33.0%. Taking this into consideration the overall zircon recovery is calculated at 89.1%.

Overall ilmenite recovery into the LTR Ilmenite product after low temperature roasting is calculated at 71%, which is 1.6% higher than that achieved during the PFS test work.

Titanium mineral recoveries for leucoxene and high titanium into the Hi-Ti88 product is calculated at 7.4% and 35.3% respectively. A marginal increase of 2.9% is noted for the leucoxene whilst a reduction of 3.3% is noted for the high titanium mineral as compared to the PFS test work.

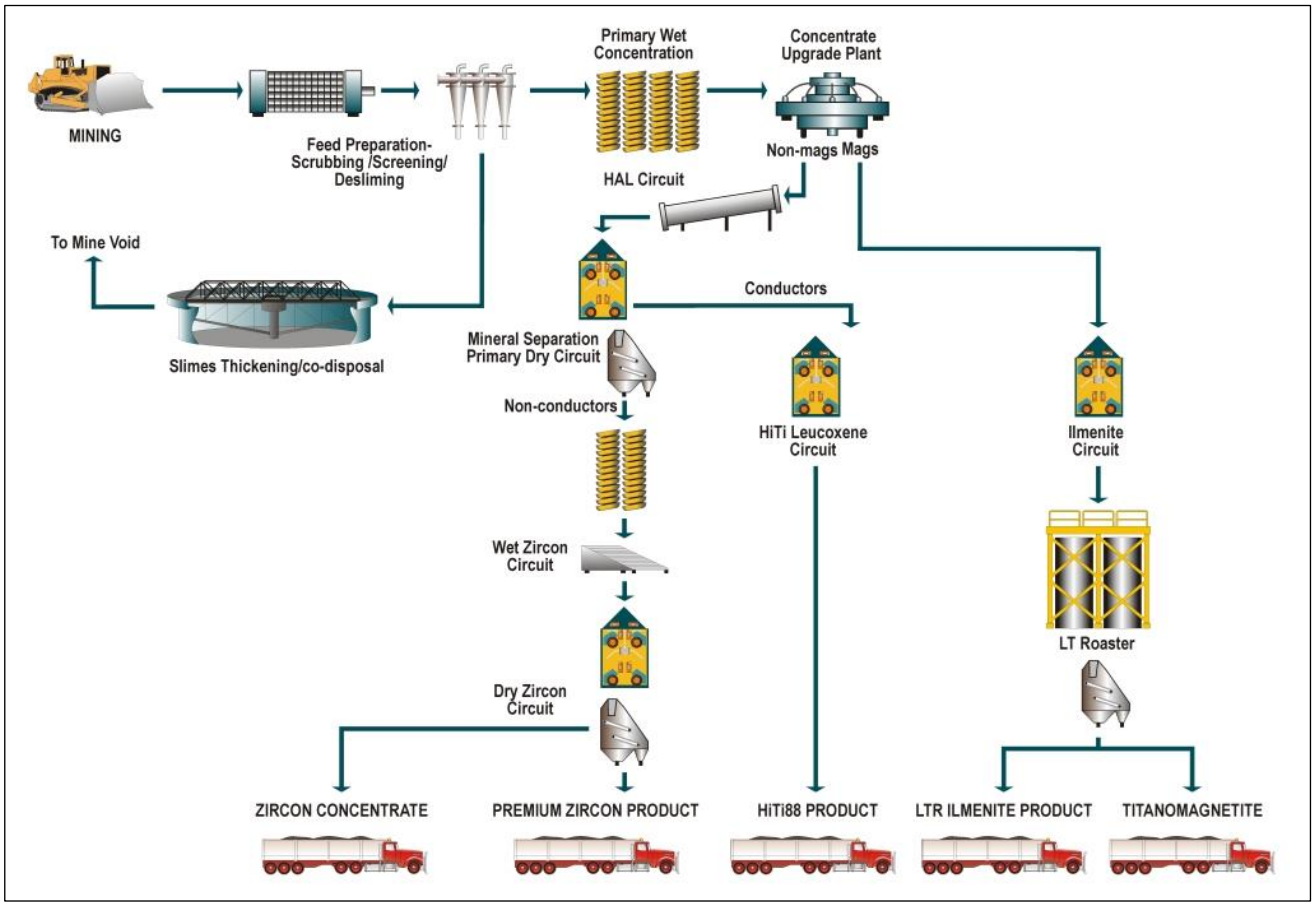

Figure 27: Simplified Process Flow Diagram

Metallurgy Variability Test Work

To confirm the process's ability to accommodate mineral grade variations, whilst maintaining product grades and recoveries, three individual 5-tonne samples derived from different geographical locations within the planned mining area were provided for testing. The three samples (THMSV01, 02 and 04) were processed through the developed flowsheet, except for gravity separation (spiral circuits) exchanged for wet shaking tables in the CUP, HAL and Wet Zircon stages because of the low mass takes to these circuits from the 5-tonne samples.

Metallurgical variability test work, using an abbreviated flowsheet, completed on the three samples derived from different areas within the optimised pit shell has confirmed the material processes readily using standard mineral sands process methodologies.

The metallurgical processing flowsheet tested during the bankable feasibility study metallurgical test work program is effective and able to accommodate variations in heavy mineral and mineralogy.

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Produced final products are of high quality and in-line with that achieved during the pre-feasibility study test work and bankable feasibility study test work, and recoveries are also in-line with that achieved during the BFS work, notwithstanding the different derivation of the samples (air-core sample composites versus Bauer sample composites). On each occasion, high quality Premium Zircon and LTR Ilmenite was produced from the variability bulk samples.

Processing Plant – WCP and MSP

The metallurgical process plant comprises three distinct sections:

1. The Mining Unit Plant (MUP) where run-of-mine (ROM) material from the mining pit is recovered by a series of dozer traps and fed to a screening plant to remove +2mm coarse material in a series of screening stages prior to pumping to the Wet Concentrator Plant (WCP). As part of the operating factor calculation, an additional stockpile feeding the WCP was recommended to include in the base case design to reduce downtime.

2. The WCP where ROM material is initially treated to produce heavy mineral concentrate (HMC) which is then fed to the Mineral Separation Plant (MSP).The WCP is designed with a throughput feed rate of 750 tph dry solids and comprises of de-sliming, screening, seven stage spiral gravity separation and slimes disposal. Finally, HMC is de-watered by hydrocyclones and stockpiled onto a 20,000t stockpile creating a buffer between the WCP and the MSP.

3. The MSP where HMC is separated into ilmenite and non-magnetic minerals, such as zircon, rutile and leucoxene. The MSP operation comprises several different processes in a very complex, although fairly typical application of appropriate technology. The HMC is initially screened and separated into a magnetic fraction (ilmenite) and a non-magnetic fraction (zircon, rutile and leucoxene) using low intensity magnetic separation (LIMS) and wet high intensity magnetic separation (WHIMS) techniques.

The non-magnetic fraction separated in the WHIMS section is further processed by wet gravity and dry electrostatic / magnetic separation techniques to produce a zircon product, zircon concentrate and a HiTi product. The magnetic fraction from the WHIMS is further processed to produce a final roasted ilmenite, undergoing drying electrostatic separation, low temperature roasting (LTR) and magnetic separation. The LTR is uniquely added to the Thunderbird process plant to enhance the production of high quality Ilmenite. The magnetic fraction after the LTR circuit forms a Titano-magnetite product.

The final product qualities for the five products to be produced have been compiled based on test work completed by Robbins Metallurgical. Typical product analyses are provided in Table 19 below.

Table 19: Expected Product Grades

Item	TiO_2 %	Fe_2O_3 %	SiO_2 %	ZrO_2 %	ZrO_2+HfO_2 %
Ilmenite[2]	56.1	18.5	0.9	0.1	
Hi-Ti88	87.8	2.9	3.4	3.2	
Premium Zircon	0.14	0.08	32.5		66.3
Zircon Concentrate	20.1	0.9	23.3		43.7
Titano-magnetite	11.4	81.1	7.8		

[2] Refers to Ilmenite grade of LTR Product

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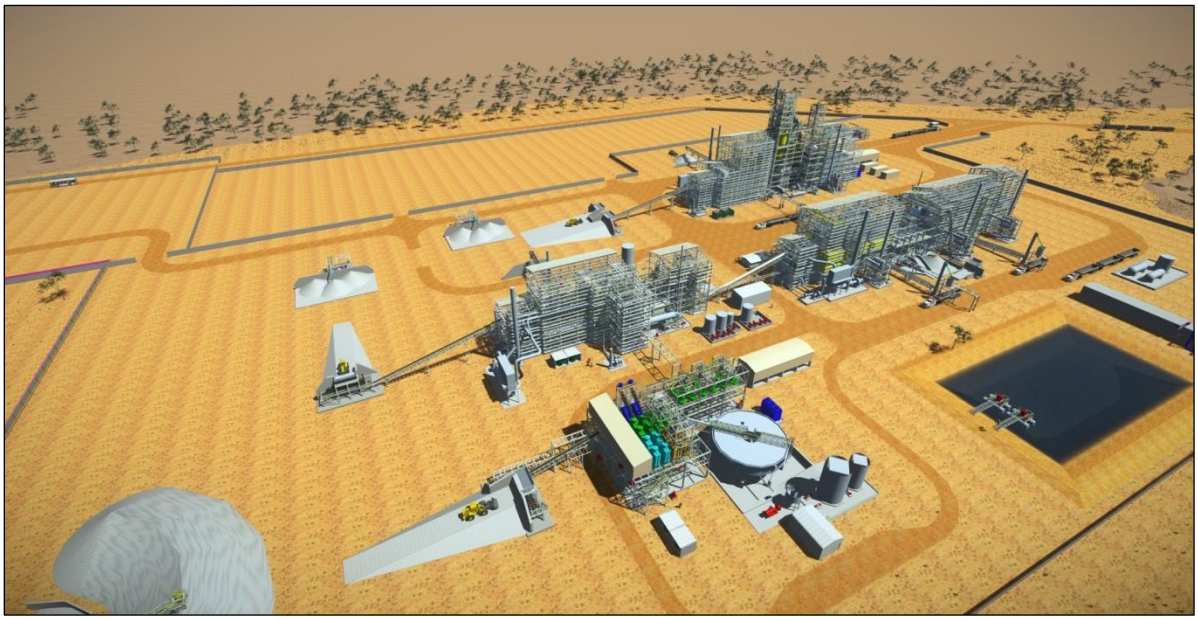

Figure 28: Schematic of Thunderbird Process Plant Layout

The final LTR Ilmenite product reports to final product storage bins from where it is loaded directly into load out trucks for bulk product shipment. The Hi-Ti88 product reports to the final product bin from where the product will be bagged into 2t bulk bags for global export. The Primary Zircon and Zircon Concentrate products report to final product storage bins from where the products can either be bagged into 2t bulk bags or loaded into trucks for bulk product shipment.

Coarse and fine tails generated during the processing of the ore is handled in the wet concentrator plant tails co-disposal system. This system is designed to combine the coarse (WCP tails) and fine tails (slimes) and generate a single non segregating tails stream for final disposal in the mined out pit / mining void. Dry rejects / tails generated from the MSP dry processing circuits are also transferred to the mining void.

During the early start-up period, the tails will be disposed of in a dedicated initial Tailings Storage Facility (TSF) to allow the mining void to progress or develop sufficiently before the tails are placed in the back of the mining pit. Water released from the WCP co-disposal mixture is collected in the mining void/TSF and pumped back to the process water dam which is then recycled back to the plants. Approximately 60% of the water is reclaimed and pumped back to the WCP settling dam.

Project Infrastructure and Services

No infrastructure presently exists at the Project location. The key Project infrastructure components are power generation and gas supply, process water and mine dewatering bore fields, initial surface tailing storage facility, road access to the Great Northern Highway, concentrate loading facilities and the accommodation village.

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Support Infrastructure

The mine complex provides support infrastructure to the operations and consists of the following:

- Borefield
- Plant Administration Office
- Change Rooms and Ablution block
- Crib room
- Laboratory
- Mechanical Workshop
- Electrical Workshop
- Stores
- Central Control Room
- Communications mast
- Sewerage treatment plant
- Potable water treatment plant
- Scrap waste skip collection
- Waste disposal landfill

Thunderbird and Other Access Roads

The main access to Thunderbird will be via an unsealed road from the intersection with the Great Northern Highway, approximately half way between Broome and Derby. The Thunderbird access road is approximately 30 km in length, of which 19 km will be an upgrade of the existing Mt Jowlaenga Homestead Road and a dedicated 11 km branch road to provide a heavy haul unsealed mine site access road. Access roads to the mine pit area, the Village accommodations and the process and mine dewatering bore fields will be established during construction.

Suitable road construction materials will be won from screening of selected sands and oversize material from within the mining area waste materials. A scheduled road maintenance program will be established at the commencement of construction to ensure roads are well maintained and provide continued access during season weather conditions.

In plant roads provide vehicular access to all applicable areas. The layout also ensures minimal interface between heavy mining vehicles and light vehicles.

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Figure 29: Mt Jowlaenga Homestead Road (left). Site Access Road (right).

Power Generation and Gas Supply

The power supply at Thunderbird will be provided under a Build Own Operate (BOO) arrangement for a 16.5 megawatt (MW) gas-fired power station, with the average power absorbed at 11.5 MVA. Fuel supply for power and as a heat source for the LTR will be by a virtual gas pipeline from Pilbara gas supply centres of Dampier and Port Hedland. Natural gas will be liquefied at the supply source and transported approximately 700 km by road to an onsite storage facility prior to being gasified for use at the Project.

At the port facility there is an existing power supply from an overhead line operated and maintained by the electrical distributor. Based on the BFS load requirements, the forecast is that the demand will not exceed the existing allocated power.

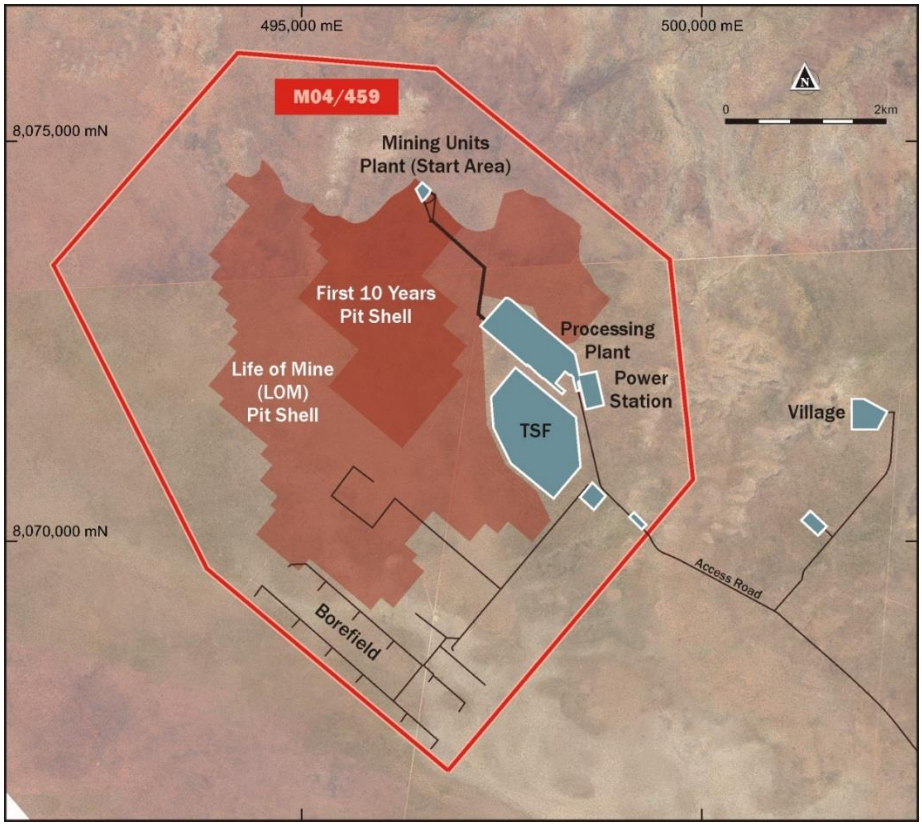

Figure 30: Thunderbird Site Plan

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Permanent Accommodation Village

The Project location is on a pastoral lease and approximately 140 km by road from the nearest town capable of accommodating the expected workforce required for operations. Accordingly, a permanent accommodation village will be required to accommodate 300 construction and 180 operational personnel. A suitable site has been nominated, approximately 8 km by road in an easterly direction from the plant site.

Accommodation units and central service buildings will be sourced and Sheffield will consider the opportunity to acquire second hand units, taking advantage of a significant quantity of stock available. Opportunities may also exist closer to Project implementation to source other components of the village.

A Build-Own-Operate (BOO) style contract will be utilised for the accommodation village package. Prices were obtained from various independent sources, including a request for proposal process issued and evaluated by Sheffield and third party consultants. The primary purpose for employing this strategy is to minimise upfront capital expenditure and utilise specialised contractor skills and capacity. The operating phase duration is expected to be of the order of 12-15 years, at which time ownership would be transferred to Sheffield with little or no residual transfer payment required.

Personnel will be transported by bus in and out of the village from Broome or Derby.

Operations Management

The operating philosophy for Thunderbird mine is based on an Owner and Contractor Operate and Maintain (O&M) model. This allows specialist contractors to operate and or own and maintain the mining, concentrate haulage and other support activities, while Sheffield will maintain overall management oversight and control, operate and maintain all fixed plant and infrastructure and provide a legislative framework and permits for the business.

To facilitate the organisational development and the establishment of service contracts, Sheffield will have defined principles that underlie successful contract management. These principles are described as follows:

- Sheffield owns the resources and provides the license to operate the entire value chain, from pit to customer.
- Sheffield owns and or provides operating facilities including mining, ore-handling, accommodation and processing facilities.
- Operations and maintenance contracts (OMC) will be sourced to perform direct operational and maintenance activities across the value chain.

It is proposed that the Company will operate and maintain all fixed plant from WCP to the final product including mine dewatering and process bore field. Contractors will operate and or own and maintain mining, MUPs, laboratories, concentrate haulage, ship loading, marine and power equipment and infrastructure. Subsequent lifts to the initial Tailings Storage Facility infrastructure will be constructed by specialist contractors.

Multiple contractors will be utilised and Sheffield will reserve the right to separate out any portion of the contracts where required. This will enable the Company to suitably de-risk contracts and engage local

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and specialist contractors where required, or where relevant contractors are unable to deliver an adequate service.

Project Implementation

The execution phase of the Project incorporates engineering design, procurement, construction and commissioning of various facilities and infrastructure in order to generate saleable products. In achieving these objectives, Sheffield will engage an EPC contractor to build the process plant and associated infrastructure and will self-perform the non-process plant Project infrastructure and associated early works by using local and specialized contractors and labour.

Early works consist of supporting the total Project and pre EPC award activities. Such works include Front End Engineering Design (FEED) for the LTR and any associated engineering process reviews, engagement of geotechnical engineers, construction water establishment and survey works; and supporting the ongoing land tenure, heritage, mining proposal and Thunderbird access road upgrade approvals. The non process plant infrastructure includes access roads, village accommodations, HV distribution outside process plant battery limit, process water and dewatering bore field, power supply and other infrastructure.

The Project execution strategy has identified a number of EPC contractors who are appropriately skilled for the construction of the process plant. The selection process will ensure the EPC Contractor has the following capacity and skills to safely and cost effectively complete the work, including

- Suitable work breakdown structure
- Project organisation structure
- Health, safety and security systems
- Environment and community systems
- Project controls
- Design and procurement
- Quality management
- Document control

A suite of specific project management plans and procedures will be developed by the EPC contractor for the Project.

Conclusions

The BFS case for Thunderbird producing high quality products from a two-stage development of a large-scale dry mining and onsite mineral processing operation is technically sound and demonstrates reasonable bases for anticipating financial returns.

The technical solutions for mineral processing, mining and product logistics are all based on proven methods and technology whilst non-production infrastructure is modest in scope and entirely within that typically associated with mineral projects in Australia.

During the course of the BFS relevant studies and/or changes to the technical solution were implemented to address the highest ranking risks to ensure no residual risks would be rated as extreme

or high. No extreme or high risks pertaining to the technical solution remain at the completion of the BFS.

The process design derived during the Prefeasibility Study (PFS) has been validated during the BFS and can be considered final. There is no foreseen change in the process design, product types, product mix, technical solution (technology) or scale and there is a high confidence of the ore feed.

Risks

In addition to the risk factors described in the Cautionary Statements and Risk Factors section above, key residual risks (rated as tolerable) relate primarily to ensuring the suitability of final selection of solutions (and award of capital and operating service contracts) to adequately address known constraints. Examples include:

- Confirmation of selected transhipment service at Derby to fit within known constraints of King Sound marine conditions and bathymetry (high tides and currents)
- Confirmation of selected dozer trap to handle the known oversize component of the ore
- Confirmation of selected physical infrastructure at Derby – new shed to meet known ground conditions and restoration works for known wharf structural condition
- Finalisation of lease negotiations for port access in Derby in line with known conditions outlined in Memorandum of Understanding with Shire of Derby - West Kimberley
- Completion of detailed design for the interim tailings storage solution, including accounting for infrastructure of Temporary Storage Facility itself, mine planning optionality, and tailings makeup optionality.

The key risk to project commitment is potential delay in schedule. Common causes of delay of mineral projects relate to timing of approvals and funding. The key outstanding approvals at the date of the BFS is from the Environmental Protection Authority (EPA) and granting of the Mining Licence which is subject to Native Title determination. Subsequent approvals and licences in turn take time and will require close management to ensure timely applications are made and bureaucratic response time meets expectations.

The key risks to the construction and commissioning phase are potential for increase in capital cost due to any changes to scope across the mine, process plant and associated infrastructure. Further potential for construction delays resulting in late commissioning and ramp-up, will have direct impact to the Project economics. Mitigation involves appropriate contracting and packaging strategy, contractor selection, project oversight and reporting as well as the owner discipline on scope creep and development of operational readiness planning.

Opportunities

The financial analysis section provides insight into relevant Project sensitivities.

A number of opportunities to improve design aspects and implementation strategies were identified and subsequently incorporated in the BFS. Beyond these, opportunity exists for Sheffield to:

- Implement early works in a manner that expedites the Project and maximises local benefit

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- Reduce LTR nitrogen sealant gas costs by substituting a generated inert gas.

A number of strategic opportunities exist to seek to improve the financial performance of the Project in the longer term through the following strategies aimed to reduce operating costs:

- Revert Build-Own-Operate-Transfer (BOOT) or Build-Own-Operate (BOO) contracts to Owner-Operate dependent upon financial benefit
- Implement alternative energy sources as capital becomes available and the "stand-alone" capital project meets investment hurdles
- Improve outbound logistics costs through defraying fixed costs with higher utilisation of port and marine assets and/or improve market offering with higher throughput
- Transport product to nearby South-East Asia distribution point from Derby when not transhipping to customer vessels in King Sound
- Increase opportunities for improved feed through exploration of known and currently unknown mineral sand prospects

Further Work

No further study is needed to support the BFS as presented.

Studies planned to support detailed design and operation planning include:

- a mining test pit has been planned and budgeted and awaits the relevant environmental and mining approvals
- metallurgical test work to better understand ore feed characteristics to assist detailed design of feed preparation (trommel residence time)

Studies planned to improve the Project include:

- ongoing regional and site exploration to improve current knowledge of the potential feed to Thunderbird and open possible further utilisation of the Derby export infrastructure.
- develop an alternative inert gas to reduce the amount of nitrogen used as the sealant gas for LTR.

ENDS

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Appendix 1: BFS Final Product Specifications

Premium Zircon

ZrO_2+HfO_2	TiO_2	Fe_2O_3	SiO_2	Al_2O_3	D_{50}
66.3%	0.14%	0.08%	32.5%	0.1%	59µm

- High grade 66.3% ZrO_2+HfO_2
- Low in key impurities iron and titanium
- Very low in aluminium impurities
- Good opacity, similar to other competing products

LTR Ilmenite

TiO_2	FeO	Fe_2O_3	$FeO:Fe_2O_3$	Cr_2O_3	CaO	MgO	D_{50}
56.1%	22.0%	18.5%	1.2	0.03%	0.01%	0.21%	67µm

- High titanium grade (56.1% TiO_2)
- Low in key contaminant Cr_2O_3
- Very low in alkalis CaO and MgO
- Consistent homogenous product
- LTR Ilmenite feedstock can produce high grade TiO_2 slag (88% TiO_2) and HPPI co-product
- Soluble in sulphuric acid, TiO_2 solubility > 95%
- Highly reactive ($FeO:Fe_2O_3$ of 1.2)

Hi-Ti88

TiO_2	Fe_2O_3	Cr_2O_3	CaO	MgO	SiO_2	Al_2O_3	D_{50}
87.8%	2.9%	0.07%	0.04%	0.00%	3.4%	0.5%	71µm

- High titanium grade (87.8% TiO_2)
- Suitable for flux cored wire welding market or titanium sponge markets.
- Blended feedstock for processing via the chloride process.
- Low in key contaminants Cr_2O_3
- Very low in alkalis CaO and MgO

Zircon Concentrate

ZrO_2+HfO_2	TiO_2	Fe_2O_3	SiO_2	Al_2O_3	CeO_2	D_{50}
43.7%	20.1%	0.9%	23.3%	1.7%	0.2%	62µm

- Initially focussing on a ZrO_2 rich (~44%) concentrate for process upgrading by the customer.
- Target zirconium chemicals industry

Titano-magnetite

Fe	TiO_2	P	SiO_2	Al_2O_3	Cr_2O_3	MnO	D_{50}
56.2%	11.3%	0.05%	7.8%	0.9%	0.05%	0.20%	67µm

- Co-product produced as from magnetic separation post the LTR process
- Targeting steel feeds industry, protection against erosion of the blast furnace hearth

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