

AUSTRALIAN

# RESEARCH

INDEPENDENT INVESTMENT RESEARCH

## Sheffield Resources Limited (ASX: SFX)

April 2017

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**Note:** This report is based on information provided by the company as at April 2017

Investment Profile	
Share Price as at 20 April 2017	\$0.60
Issued Capital:	
Ordinary Shares	181.0m
Options	9.13m
Performance Rights	5.80m
Fully Diluted	195.9m
Market Capitalisation	\$108.6m
12 month L/H	\$0.38/\$0.77

Board and Management	
Mr Will Burbury: Non-Executive Chairman	
Mr Bruce McFadzean: Managing Director	
Mr David Archer: Technical Director	
Mr Bruce McQuitty: Non-Executive Director	
Mr Stuart Pether: Chief Operating Officer	
Mr Mark Di Silvio: CFO/Company Secretary	
Mr Jim Netterfield: Project Manager	
Mr Neil Patten-Williams: Marketing Manager	

Major Shareholders	
Black Rock	9.0%
Mr. W Yovich & Mrs J Yovich	6.5%
Mr. W Yovich	5.2%
Sprott	2%
Other Institutions	4%
Top 20	49.6%
Board and Management	13.6%

### Share Price Performance



Senior Analyst – Mark Gordon

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## NEAR DEVELOPMENT HEAVY MINERAL SANDS

Sheffield Resources (“Sheffield” or “the Company”), an ASX listed heavy mineral sands (“HMS”) developer, is concentrating activities on its high value Thunderbird HMS Project (“Thunderbird” or “the Project”) located near Broome in Western Australia, close to target markets in Asia. The recently completed Bankable Feasibility Study (“BFS”) for Thunderbird highlights a globally significant project that potentially will produce readily marketable products and provide excellent returns for shareholders. Should permitting and financing go to plan we would expect to see first production in late 2019.

### KEY POINTS

**Robust, world class project:** The recently completed BFS for Thunderbird highlights a project that will give excellent returns to shareholders over the projected 42 years of operation, returning a pre-tax NPV<sub>10</sub> of \$676 million, with an IRR of 25%.

**Excellent financial metrics:** The estimated up-front Stage 1 capital cost of \$348 million is attractive when compared to the NPV, with the Project over the first 10 years providing a revenue to costs ratio of around 2:1 – this is in the 2nd quartile of global mineral sands producers, making Thunderbird a globally competitive operation.

**Improving HMS markets:** Recent price increases and forecasts point towards improving mineral sands markets, with Sheffield ideally placed to take advantage of this.

**Large, high value reserves:** With Ore Reserves of 680.5Mt, and a valuable heavy mineral (“VHM”) content of 4.5%, Thunderbird is a large, high grade deposit by any standard, and is expected to produce life of mine revenue of ~\$20/tonne of ore – sensitivity analysis indicates that the Project will comfortably absorb adverse 20% movements in any of the key inputs.

**Positive metallurgy:** Results of metallurgical test work, which has been carried out in production scale or readily scalable equipment, has highlighted the potential to produce quality, highly marketable products for the major proportion of the estimated sales value – this has now been supported by the signing of MoUs for 40% of the premium zircon stream to date.

**Access to Infrastructure:** The Project is located just 140km by road from the ports of both Derby and Broome, which are some of the closest in Australia to key Asian markets.

**Resource and reserve expansion potential:** The use of conservative pit shells in the BFS highlights the potential to enlarge reserves; also, exploration in the area has discovered additional potentially high value mineralisation that could significantly add to resources.

**Low sovereign risk jurisdiction:** Western Australia is a proven mining jurisdiction, with a well-developed mining law, and which ranked third globally in the 2016 Fraser Institute survey.

**Experienced and committed personnel:** Company personnel, including consultants, have extensive industry experience in varied regions and commodities including in building projects. In addition insiders hold significant shareholdings, and thus are motivated to produce strong returns for shareholders.

**Steady news flow:** Ongoing activities, which will be largely related to permitting, offtake and financing should provide steady news flow during 2017.

## VALUATION SUMMARY

We have completed a valuation for Sheffield, with this resulting in a Company valuation of \$452 million, or \$2.50/share, based on the current undiluted capital structure. Over 90% of the value is ascribed to the pre-tax, unfunded valuation of Thunderbird, and any funding scenario will most likely dilute the current capital structure or company equity in the Project, thus decreasing the per share valuation.

## SWOT ANALYSIS

### Strengths

- ◆ **Advanced project:** With Thunderbird being at the permitting and financing stage, the Project is well advanced and largely de-risked technically.
- ◆ **Very attractive economics:** The results of the BFS have resulted in very attractive and robust economics for Thunderbird, including the NPV/capex ratio, revenue/cost ratio and providing a long life, cash generating operation that will comfortably absorb adverse movements in key inputs.
- ◆ **Quality products:** Metallurgical test work has demonstrated that the Project has the capability to produce highly marketable products over most of the range of commodities to be produced.
- ◆ **Proven mining destination with low sovereign risk:** Western Australia is a proven mining destination and host to a number of world class deposits, with well developed mining legislation.
- ◆ **Experienced people with skin in the game:** Company personnel have significant experience in the resources game as well as significant shareholdings.
- ◆ **Quality register:** With institutions such as BlackRock and Spratt on the register, the Company is well supported.

### Weaknesses

- ◆ **Reliance on trucked LNG:** The area is not served by the electricity grid or a gas pipeline, hence gas needs to be liquefied, and trucked over 900km to site for regasification - this makes power relatively expensive, however it is the same system as used by the towns of Derby and Broome.

### Opportunities

- ◆ **Forecast price increases:** A key opportunity is to take advantage of forecast increasing HMS prices – it appears that we may have seen the worst in the market and Sheffield's timing will be ideal to take benefit from a projected supply deficit in a number of VHM products.
- ◆ **Resource expansion:** Exploration work in the Dampier Project area surrounding Thunderbird has discovered new high grade mineralisation, highlighting resource expansion possibilities.
- ◆ **Other project development:** In addition to Thunderbird Sheffield has the Eneabba and McCalls projects, which both have the potential to be developed into large scale operations.

### Threats

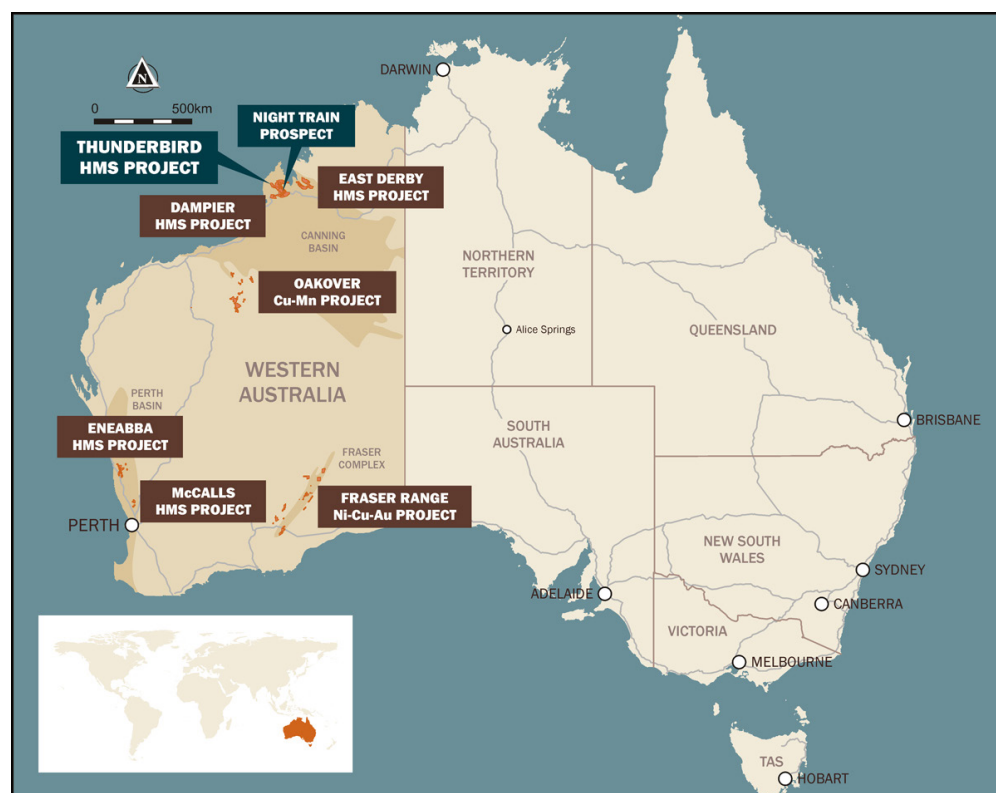
- ◆ **Prices and exchange rates:** These are threats facing any mining company, however the robust nature of Thunderbird somewhat shields it from these – the project is still viable when current spot prices are used in modelling.
- ◆ **Financing:** Securing financing is a major step, and although the current overall resource market is quite healthy, there is still some hesitancy in major project financing - countering this is the interest the Company has reported that it has had from potential financiers.
- ◆ **Costs:** Again a factor to consider when assessing a resources company, however as for prices the robustness of Thunderbird largely shields it against adverse movements in costs – one key part here may be energy prices, with these making up some 35% of the total operating costs, and with gas having to be delivered to site for electricity production and use in the low temperature roaster ("LTR").
- ◆ **Permitting:** Our view here is the main threat may be delays in permitting, and not a failure to get Thunderbird permitted - the Company has stated that it has strong community support (in no small part due to the closing and cancellation of other resources projects in the region), and also responses to the Public Environmental Review ("PER") were largely favourable. Also, the status of Thunderbird as a Level 2 Lead Agency Project should help facilitate the permitting.

## OVERVIEW

### STRATEGY AND PROJECT OVERVIEW

- ◆ Sheffield's activities are concentrated on their Thunderbird HMS Project, a Sheffield discovery, located in the broader Dampier HMS Project in the Canning Basin of WA, with the Company also holding a number of other projects as shown in Figure 1.
- ◆ The Company has recently completed a BFS on Thunderbird, with this defining a robust, long life operation, and is now in the permitting, offtake and financing stage for a planned late 2017/early 2018 commencement of construction and a production start-up in late 2019.
- ◆ Sheffield remains flexible with regards to project financing and development, considering various options including traditional debt/equity funding, offtaker funding and attracting an equity investor at the project level amongst others.
- ◆ The Company is also continuing exploration activities in the broader Dampier Project area, with this discovering the Night Train mineralisation, just 20km from Thunderbird and 2km from the proposed haul road.
- ◆ Other HMS projects include Eneabba and McCalls – these both have resources, however little recent work has been completed on them with HMS activities concentrated on Thunderbird; drilling however is planned at Eneabba later this year..
- ◆ The Oakover Cu-Mn Project includes recently applied for and granted tenements, with work to date being limited to reconnaissance site visits.
- ◆ The Company will look to realise value from Oakover, with options including a spin out or a sale.
- ◆ The East Derby HMS Project, located near Thunderbird, returned disappointing drilling results, with some of the area being retained for a potential sale due to the potential for diamondiferous paleo-channels – this will not be discussed further.
- ◆ The Company has entered into a JV/Farm-out Agreement with Independence Group (ASX: AGO) over the Fraser Range tenements, and thus these are not discussed further.

**Figure 1: Project location map**



Source: Sheffield

## FINANCIAL POSITION

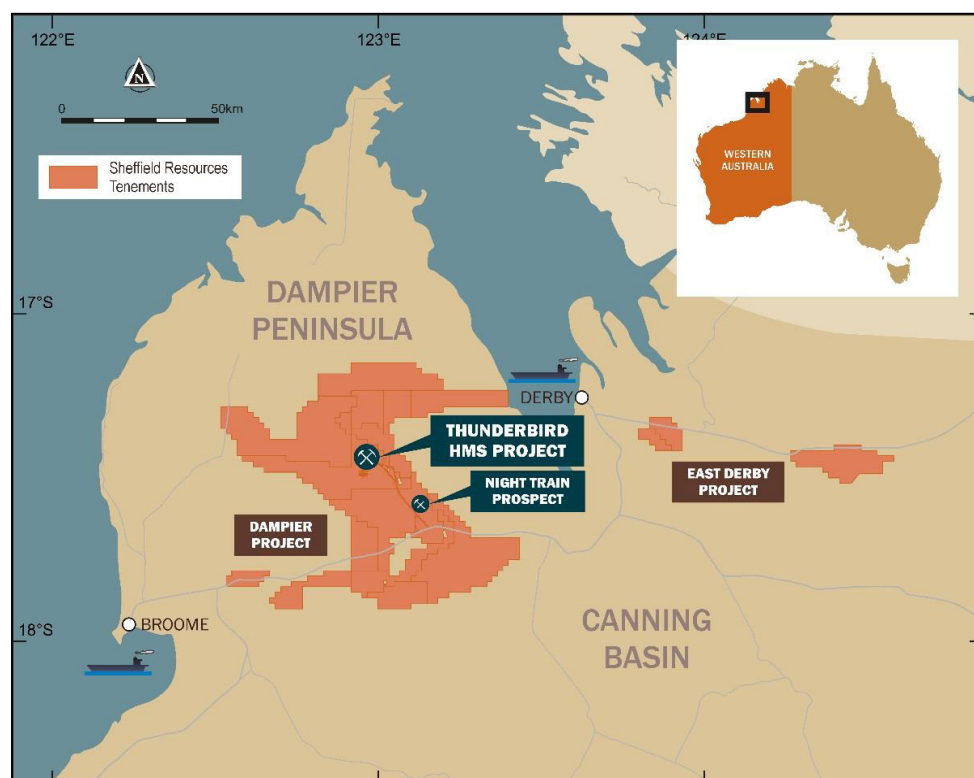
- ◆ As of March 31, 2017 the Company had \$10.982 million in cash and no debt.
- ◆ Over the twelve months to December 31, 2016, the Company raised \$17.1 million through the issue of 32.9 million shares @ \$0.52/share by way of a placement to sophisticated and professional investors.
- ◆ Major investors to come on board included BlackRock and Sprott.
- ◆ Over the same period the Company spent \$9.459 million on exploration and development activities, and \$3.350 million on staff and administration costs.

## THUNDERBIRD HMS PROJECT - SFX 100%

### Location and Tenure

- ◆ The Thunderbird HMS Project is part of the Dampier HMS Project which covers nine granted Exploration Licences ("EL") totalling 2,500km<sup>2</sup>, held 100% by Sheffield – the ELs over Thunderbird cover some 483km<sup>2</sup>.
- ◆ All granted tenements are in good standing.
- ◆ The Company has applied for a Mining Licence and a number of Miscellaneous Licences for the proposed Thunderbird operation – grant will be subject to the successful settlement of Native Title processes (and has been recommended by the relevant authorities), however some of the Miscellaneous Licences have already been granted.
- ◆ The Project is located on the Dampier Peninsula, midway between the regional towns of Broome and Derby, accessible from the Great Northern Highway via a 30km access road that meets the highway halfway between both towns – the Project is located approximately 140km by road from either town.

Figure 2: Thunderbird tenement and resource map



Source: Sheffield

### Project History

- ◆ After applying for the EL over what is now the Thunderbird Project in 2010, the EL, E04/2083 was granted on September 7, 2011.
- ◆ Following the discovery of Thunderbird, Initial and follow up drilling was used in the initial Mineral Resource Estimate ("MRE"), which was announced on December 18, 2012 – ongoing drilling has continued to increase both the size and confidence in the resource with this now standing at 3.23Bt @ 6.9% HM.

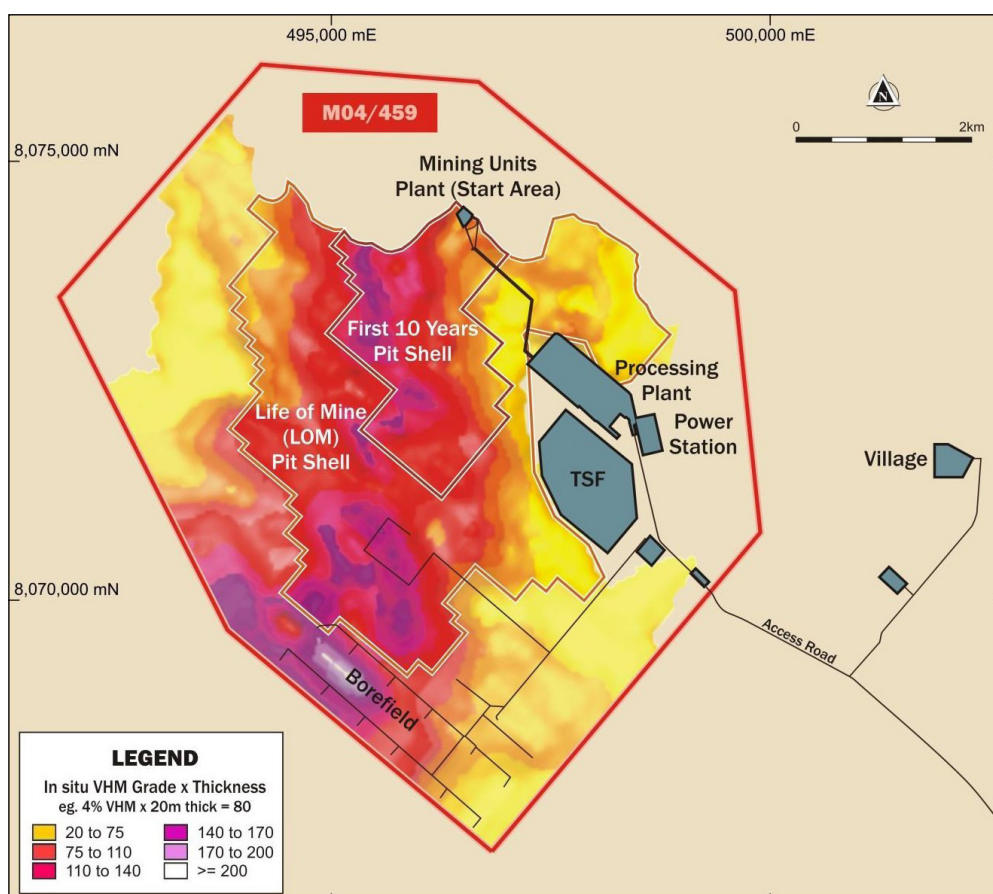


- ◆ Sheffield completed a Scoping Study in early 2014, which envisaged a 20.8Mtpa, 32 year operation, with an up front capital cost of \$294 million.
- ◆ This led into a Pre-Feasibility Study ("PFS"), as released to the market in May 2015, and which resulted in a capital cost of \$367 million – this was updated in October 2015, with the updated study delivering significantly reduced capital costs of \$271.3 million, for a 40 year life staged operation, initially mining at 12mtpa and then increasing to 18mtpa.
- ◆ Subsequent work has been incorporated into the BFS, released in March 2017 and discussed later in this report.

### Geology and Mineralisation

- ◆ The tenements are located over deeply weathered units of the Cretaceous Canning Basin, which in the vicinity of Thunderbird dip very gently to the southwest.
- ◆ The HMS mineralisation largely occurs in a unit referred to as the Broome Sandstone, characterised by brown/orange loose sands (free diggable) up to 90m thick – not all of the Broome Sandstone is mineralised however, with the mineralised part being locally referred to as the Thunderbird Formation.
- ◆ The mineralised horizon occurs as a laterally extensive, thick sheet like body, and has been defined for a distance of between 2.5km and 5.5km down dip (NE/SW), and 8km along strike (NW/SE).
- ◆ Structurally the basin units form a broad NW striking anticline, with stratigraphy being folded from flat to a very gentle 4° dip to the SW
- ◆ The deposit properties, including morphology and grade, are interpreted to indicate a potential off-shore, sub-wave base depositional environment.
- ◆ The average thickness of the mineralisation is 47m, with an average depth to the top of 21m - around 32% of the resource area is within 6m of the surface, with the mineralisation being open along strike and down dip.
- ◆ Figure 3 below shows the south trending high value area of mineralisation.
- ◆ The dominant valuable heavy minerals include ilmenite ( $\text{FeTiO}_3$ ), zircon ( $\text{ZrSiO}_4$ ), leucoxene (a weathering product of ilmenite, with higher but variable  $\text{TiO}_2$  grades), rutile ( $\text{TiO}_2$ ) and anatase ( $\text{TiO}_2$ ).

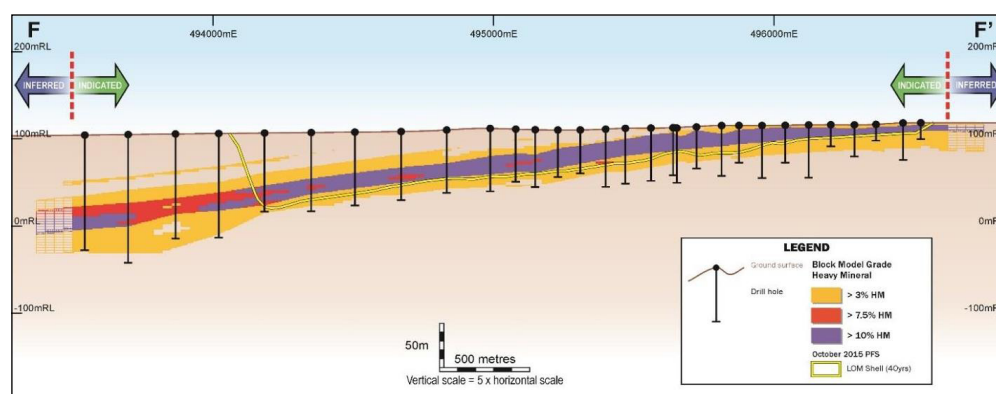
**Figure 3: Thunderbird plan showing grade x thickness and proposed site layout**



Source: Sheffield



Figure 4: Typical SW-NE cross section, Thunderbird



Source: Sheffield

## Resources and Reserves

- ◆ The most recent MRE was released to the market on July 5, 2016, with this presented in Table 1.
- ◆ This is shown at two cut-off grades – 3% total HM and 7.5% total HM, and provides two estimations – a global resource of 3,23Mt @ 6.9% HM and a high grade resource of 1.05Mt @ 12.2% HM.

Table 1: Thunderbird Mineral Resource Estimate

Thunderbird Mineral Resource Estimate										
Cut-off (HM%)	Category	Resource Tonnes (Mt)	Insitu HMS (Mt)	HM (%)	Zircon (%)	HiTi Leuc (%)	Leuc (%)	Ilmenite (%)	Slimes (%)	Osized (%)
> 3%	Measured	510	45	8.9	0.71	0.2	0.19	2.4	18	12
	Indicated	2,120	140	6.6	0.55	0.18	0.2	1.8	16	9
	Inferred	600	38	6.3	0.53	0.17	0.2	1.7	15	8
	Total	3,230	223	6.9	0.57	0.18	0.2	1.9	16	9
>7.5%	Measured	220	32	14.5	1.07	0.31	0.27	3.9	16	15
	Indicated	640	76	11.8	0.9	0.28	0.25	3.3	14	11
	Inferred	180	20	10.8	0.87	0.27	0.26	3	13	9
	Total	1,050	127	12.2	0.93	0.28	0.26	3.3	15	11

Source: Sheffield

- ◆ The most recent Ore Reserve update was released to the market on March 16, 2017, with this completed as part of the BFS.
- ◆ At 680.5Mt, including 35% in the Proved category, the Reserves are sufficient to carry the planned 42 year long life operation.
- ◆ In the BFS release, the Company has stated that the Reserves were calculated using a low value pit shell – the pit shell for the first 10 years of the proposed operation was based on product prices in the range of 50-55% of the weighted average of 2017 spot prices; that for the LoM is based on a range of 70-75% of the weighted average of 2017 spot prices.
- ◆ This is a conservative approach, and should prices increase and these be maintained there is the potential to significantly increase Reserves.

Table 2: Thunderbird Ore Reserves

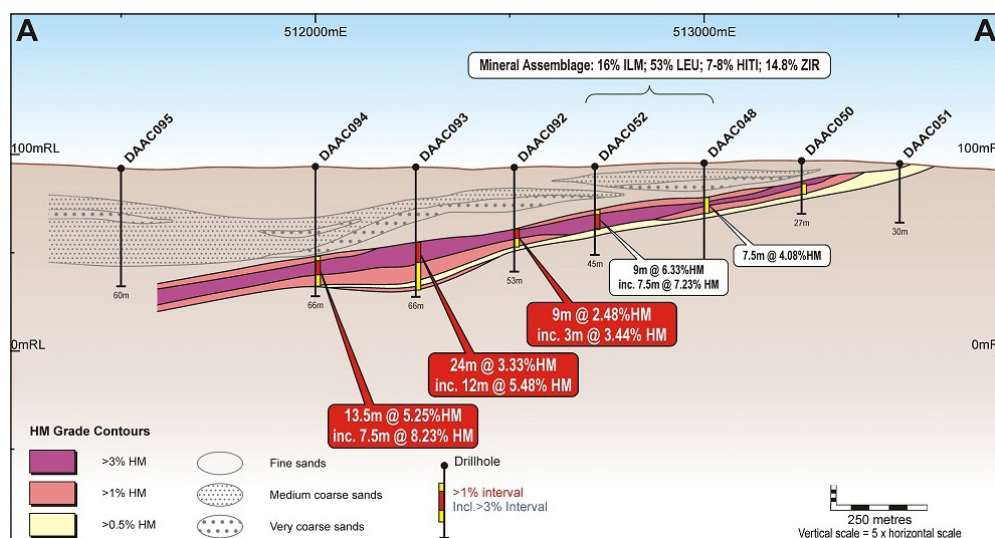
Thunderbird Ore Reserves									
Category	Resource Tonnes (Mt)	Insitu HMS (Mt)	HM Grade (%)	Zircon (%)	HiTi Leuc (%)	Leuc (%)	Ilmenite (%)	Slimes (%)	Osized (%)
Proved	235.8	31.4	13.3	1	0.29	0.26	3.55	16.5	13.7
Probable	444.8	45.4	10.2	0.8	0.26	0.26	2.85	15.2	11
Total	680.5	76.8	11.3	0.87	0.27	0.26	3.1	15.7	12

Source: Sheffield

## Exploration Potential

- ◆ Work by Sheffield has highlighted the potential for the discovery of additional resources in the broader Dampier Project area.
- ◆ This includes the discovery of the Night Train deposit, located some 20km SE of Thunderbird, and within 2km of the planned site access road – the location is shown in Figure 2 and a section in Figure 5.
- ◆ Although relatively early days, drilling to date has resulted in some very positive results, with this highlighting thicknesses varying from 4m to 24m (average 11m), with a high value mineral assemblage – overall average grades are 4.04% HM, with 92% of this being VHM, with an assemblage of 15% zircon, 53% leucoxene, 8% HiTi leucoxene and 16% ilmenite.
- ◆ This includes high grade mineralisation (using a 3% HM cut-off) with an average grade of 6.40% HM, a thickness of 3m to 12m (average 7.5m) and a width of 1km across strike.

**Figure 5: Typical E-W cross section, Night Train**



Source: Sheffield

## Bankable Feasibility Study

- ◆ Sheffield completed a BFS which was released to the market on March 24, 2017 – key financial metrics are provided in Table 3.
- ◆ As of the time of writing the full BFS was available for download from the Company's website.
- ◆ The BFS envisages an initial four year operation ramping up to a ~8.5Mtpa mining rate, then expanding to ~17Mtpa in the fifth year of operation, with this rate then continuing for the full proposed 42 year mine life – life of mine production is shown in Table 4.
- ◆ The study, which used prices as forecast by respected consulting group TZ Minerals International ("TZMI"), returned a pre-tax NPV<sub>10</sub> of A\$676 million (with an IRR of 24.9%), for an initial capital outlay of A\$348 million – this gives a robust NPV/capex ratio of 1.94.
- ◆ Using early 2017 spot prices the Project still returned a healthy NPV<sub>10</sub> of \$346, highlighting the robustness of the Project.
- ◆ We have used the Company's inputs in our valuation of Thunderbird – this is detailed later in our report.

**Table 3: Financial results and metrics, Thunderbird 2016 BFS**

Financial results and metrics, Thunderbird 2017 BFS			
\$Am, Real 2017 Prices	Financial Year 2019 – 2023	Financial Year 2024 – 2033	LOM 2018 - 2061
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

<b>Financial results and metrics, Thunderbird 2017 BFS</b>			
\$Am, Real 2017 Prices	Financial Year 2019 – 2023	Financial Year 2024 – 2033	LOM 2018 - 2061
Total Opex	-464	-1,905	-7,633
EBITDA	339	1,746	5,146
Ore Mined (Mt)	32	171	670
A\$ Site costs / tonne ore mined	14.65	11.11	11.40
A\$ Revenue / tonne ore mined	25.99	22.29	19.92
US\$ Site costs / tonne Premium Zircon equivalent	721	692	790
US\$ Revenue / tonne Premium Zircon equivalent	1,278	1,387	1,381
	Stage 1	Stage 2	LOM8
Capital Expenditure (\$Am)	348	195	543
Pre-Tax Project NPV (10% WACC)			675.6
Pre-Tax IRR %			24.9
Post-Tax Project NPV (8% WACC)			620.4
Post-Tax IRR %			20.6

Source: Sheffield

**Table 4: Forecast production and commodity prices**

<b>Forecast production and commodity prices</b>				
Production (Average tonnes per annum)	Financial Year 2019 – 2023	Financial Year 2024 – 2033	LOM 2018 - 2061	
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	
Commodity Prices (US\$/tonne)	Financial Year 2019 – 2023	Financial Year 2024 – 2033	LOM 2018 - 2061	Early 2017 Spot Prices
Premium Zircon	1,282	1,387	1,381	1,050
Zircon Concentrate	659	677	676	580
LTR Ilmenite	183	183	183	180
HiTi88	500	500	500	400
Titano-magnetite	48	48	48	58

Source: Sheffield

- ◆ The Stage 1 capital cost breakdown, which was undertaken in-house is presented in Table 5 below .
- ◆ It is expected that the Stage 2 capex of \$195 million may be largely funded out of cash flow.
- ◆ Our view, in comparisons with the estimated capital cost of other mineral sands projects, is that the estimate is reasonable.

**Table 5: Capital cost estimate, Thunderbird 2017 BFS**

<b>Capital cost estimate, Thunderbird 2017 BFS</b>		
Description	US\$M	A\$M
Direct Costs		
Plant Area Concrete, Civils & Buildings, Process Water Systems	19	25.3
Wet Concentrator Plant (WCP)	43.5	58
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	6.7

Capital cost estimate, Thunderbird 2017 BFS		
Description	US\$M	A\$M
Tailings Dams, HV Distribution, Bore field Infrastructure	12	16
Derby Port Facilities	5	6.6
Sub-Total	22	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

Source: Sheffield

- ◆ Operating costs for the first 10 years and life of mine are presented in Table 6 – as for capital costs, when compared with other mineral sands operations these appear reasonable.

**Table 6: Estimated operating costs, Thunderbird 2017 BFS**

Estimated operating costs, Thunderbird 2017 BFS				
	Years 1-10	LOM	Years 1-10	LOM
	\$US/tonne of ore	\$US/tonne of ore	\$A/tonne of ore	\$A/tonne of ore
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	11.4

Source: Sheffield.

- ◆ Details of the various production phases are given below.

### Mining

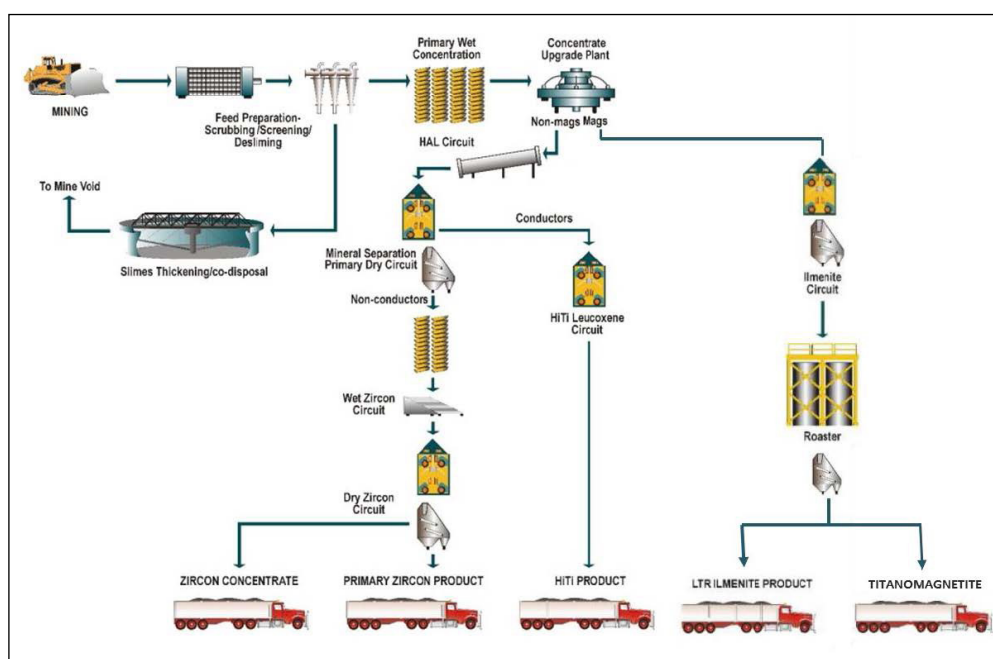
- ◆ Mining, will be largely free dig by industry standard dozer trap dry mining is planned to be contracted out.
- ◆ Soil and overburden will be removed and stockpiled using loaders and 100t off-highway trucks - ~6% of the overburden will require hard ripping.
- ◆ Ore, in the initial phase, will be fed through a dozer trap into a single in-pit mining unit plant ("MUP") – this will be expanded to two units in the second phase of operations, doubling the throughput.
- ◆ The MUP will then feed ore to the wet concentrator plant ("WCP") for the start of the beneficiation process.
- ◆ The pit will reach a maximum depth of up to 76m, with batter angles of 40° where rock layers are present and 34° elsewhere.
- ◆ The LoM stip ratio is 0.68:1.

### Metallurgical Processing

- ◆ The proposed process route has been designed to produce high quality products using industry standard processes – this is shown schematically in Figure 6.
- ◆ This has been based on ongoing metallurgical test work as well as testing a 40 tonne bulk sample using full scale or scalable equipment – this also involved variability test work on three 5 tonne samples from various areas of the deposit, which largely followed the full design flowsheet, with the exception of the gravity separation stage.

- ◆ Material is scrubbed and screened in the MUP, with the -38µm material being disposed of to slimes, and the +2mm being rejected as oversize.

**Figure 6: Proposed process route**



Source: Sheffield

- ◆ The rejected material will be deposited in a tailings storage facility ("TSF") until such time as a suitable mine void is developed for tailings disposal – this is expected to take around 2.5-3 years.
- ◆ Ore material is then conveyed to the WCP and concentrate upgrade plant, which use a combination of gravity (spirals) and magnetic circuits to concentrate and then separate the magnetic (ilmenite) and non-magnetic (zircon, leucoxene) minerals for further processing.
- ◆ Ilmenite is further treated through an LTR plant – this reduces any  $\text{Fe}_2\text{O}_3$ , thus upgrading the product and also producing a product with consistent specifications across a range of feed grades.
- ◆ Following separation from leucoxene, zircon is treated through an attritioning and hot acid leach ("HAL") plant to produce two products – a premium zircon and a zircon concentrate.
- ◆ Recoveries for the various products are as given below:
  - Primary zircon – 56.1% (2.6% higher the PFS).
  - Zircon concentrate – 33.0% - overall zircon recovery of 89.1%.
  - Ilmenite to LTR ilmenite – 71% (1.6% higher than PFS).
  - Leucoxene to HiTi88 – 7.4%.
  - High titanium to HiTi88 – 35.3%.

### Product Logistics

- ◆ Products are planned to be trucked to both Broome and Derby to be loaded onto ships for export largely to Asian markets.
- ◆ It is planned to ship both LTR ilmenite and titano-magnetite in bulk to Derby, where it will be stored in a purpose built shed for shipping – zircon concentrate will also probably be delivered in bulk.
- ◆ Derby has historically been used as a bulk terminal, using both direct loading and transshipment – the Company's activities will require refurbishment of the current ship loader and conveyor, with transshipment using barges to the customers' vessels.
- ◆ Given the relatively small volumes, it is planned to load premium zircon and HiTi88 into 2,5t "bulka bags" at the processing site, for truck transport to Broome for loading into ships holds in volumes as required by customers.

## Infrastructure

- ◆ The location of various infrastructure facilities is shown in Figure 3.
- ◆ The Company will look at supplying the expected 15.5MW of power through a Build-Own-Operate (“BOO”) gas fired power station, with expected power costs of \$0.19/kWh.
- ◆ Gas for the power station, as well as for the LTR plant, will be supplied by a “virtual” pipeline from the Pilbara gas supply centre at Karratha – it is expected that the LTR plant will use 45% of the LNG.
- ◆ It is planned to liquefy natural gas at the source, truck 923km to a storage facility on site for gasifying and use in the power plant and LTR facility – this is the same method that is used to supply gas to the Broome (40MW) and Derby (12MW) power stations - the Company also has access to storage facilities in Broome and Derby.
- ◆ Estimated gas requirements are 2,140TJ/annum, with a delivered unit price of \$15/GJ, with storage on site for 10 days use.
- ◆ Operations at the port facilities are expected to be supplied from the existing power infrastructure.
- ◆ It is expected that Sheffield will engage a BOO contractor for the on-site accommodation camp, which is planned to be located some 8km from the processing plant – this will be able to cater for 300 construction workers and 180 operations personnel.
- ◆ The Company expects the BOO operation phase to be 12-15 years for the camp, with ownership passing to Sheffield at the end of this period with little or no transfer payments.
- ◆ The operation will be largely drive-in/drive-out (“DIDO”) from regional towns and localities, with some key personnel on a fly-in/fly-out (“FIFO”) roster.
- ◆ Water will be supplied from both mine dewatering and make-up bore fields adjacent to the mining void, however after 32 years it is expected that the dewatering volumes will exceed process water requirements, and thus will need to be injected back into the aquifer.
- ◆ Steady state operation water requirements are ~10.7GL/year, with the water being of good quality and low salinity.

## Product Specifications and Marketing

- ◆ Expected product grades are presented in Table 7.

**Table 7: Estimated product specifications, Thunderbird 2017 BFS**

Estimated product specifications, Thunderbird 2017 BFS					
Item	TiO <sub>2</sub> (%)	Fe <sub>2</sub> O <sub>3</sub> (%)	SiO <sub>2</sub> (%)	ZrO <sub>2</sub> (%)	ZrO <sub>2</sub> +HfO <sub>2</sub> (%)
Ilmenite	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		

Source: Sheffield.

- ◆ TZMI have carried out a product and marketing assessment of the potential Thunderbird products, with these largely meeting or exceeding acceptable specifications, and therefore being saleable.
- ◆ This has been supported in the case of the premium zircon with offtake MoU's recently being signed for 40% of proposed production.
- ◆ There are some potential issues with the HiTi88 product, however as this makes up only 4% of expected revenue this is not a critical issue – comments from TZMI are as follows:
  - The TiO<sub>2</sub> content of 87.7% is slightly lower than most product on the market, however chemically is comparable to MZI Resources (ASX: MZI) L88 product that has been accepted by a global chloride TiO<sub>2</sub> producer.
  - The fine average size of 71µm is considered low for western style chlorinators, however could potentially be used as a blending feedstock.
  - The other potential use is in the welding electrode market, although the P<sub>2</sub>O<sub>5</sub> content of 0.16% is at the limit of generally acceptable industry specifications, and also this is a relatively small market.



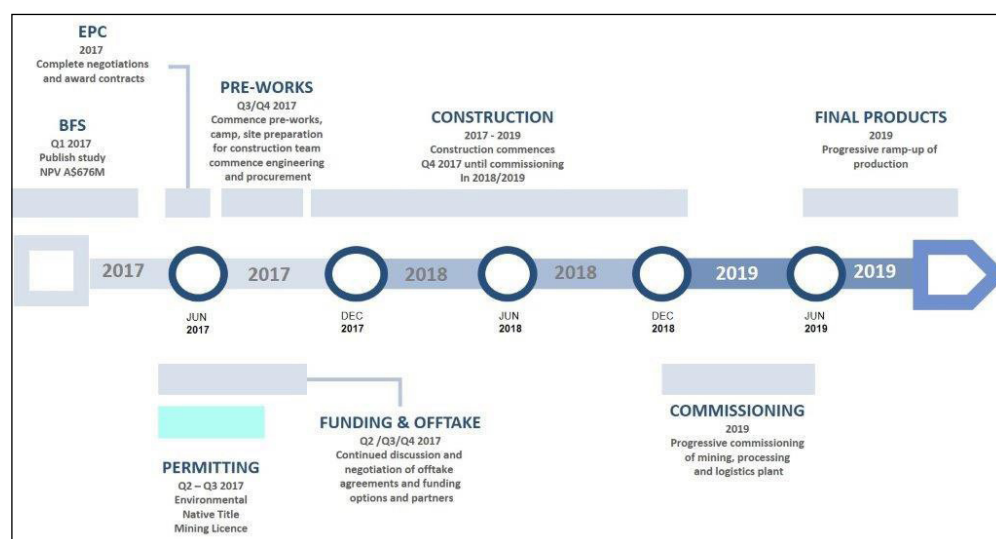
## Permitting and Stakeholder Engagement

- ◆ The Project has been granted “Level 2 Lead Agency Status” by the Government of Western Australia, which provides for assistance with and coordination of project approvals by one government department, the lead agency.
- ◆ The Project is still in the permitting stage, with this including Native Title determinations amongst others.
- ◆ The Company has applications in for the Mining and Miscellaneous Leases, with the grant of a number of these dependent upon successful outcomes with negotiations with the Traditional Owners and pastoral lessees – these however have been recommended for grant by the Western Australian Department of Mines and Petroleum (“DMP”).
- ◆ Previous negotiations between the Company and the Native Title party affected by the future grant of ML04/459 failed to reach agreement, and thus the matter was referred to the National Native Title Tribunal (“NNTT”) for a final determination – this is expected in Q2, CY17.
- ◆ As part of the process, the Company has undertaken Aboriginal heritage surveys with the Traditional Owners – this has outlined some areas that the Company has been asked to avoid, however these are well outside the area of proposed operations.
- ◆ Both Federal and State Government environmental approvals are expected in Q3, CY2107, with the Company’s Public Environmental Review (“PER”) recently being subject to the required 30 day exposure period.
- ◆ Some 52 submissions were made as part of the exposure, with the majority being in support of Thunderbird.
- ◆ The Company has stated that the Project has strong community support - this is partly due to the closure and cancellation of a number of resource projects in the region.

## Current and Planned Activities

- ◆ The proposed Thunderbird time line is shown in Figure 7.
- ◆ Current activities are focussed on permitting, offtake and financing.
- ◆ Dependent upon the successful completion of permitting and financing, the Company is looking towards commencement of construction in late 2017/early 2018.
- ◆ In anticipation of permitting Sheffield is also in the final stages of negotiating Engineering, Procurement and Construction (“EPC”) contracts, with this expected to be completed in late April or May, at which time it is expected that pre-construction works, including camp and road construction will commence.

Figure 7: Proposed Thunderbird timeline

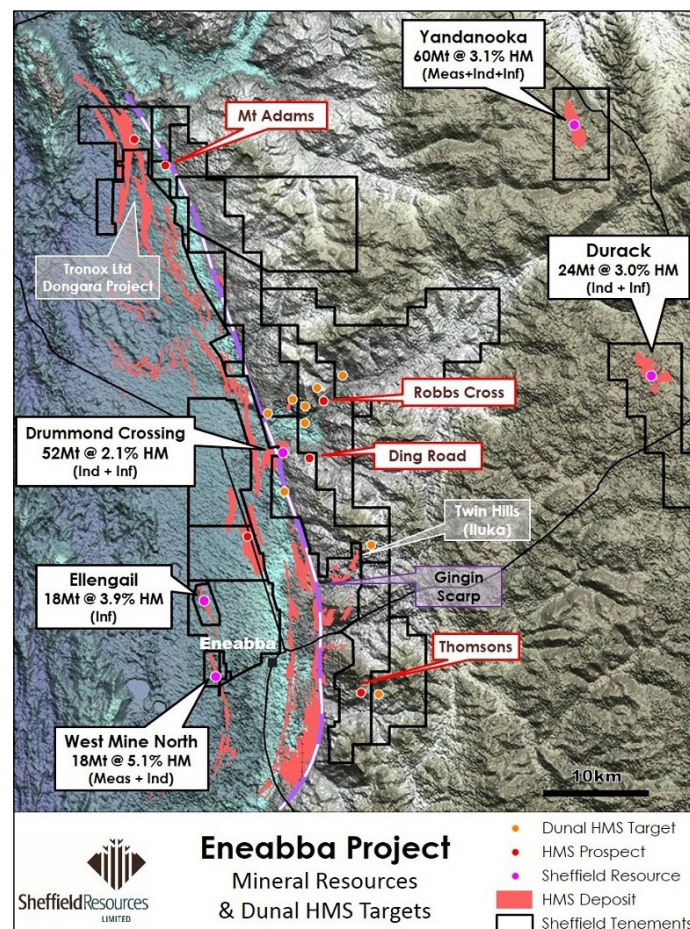


Source: Sheffield

## ENEABBA AND MCCALLS HMS PROJECTS – SFX 100%

- ◆ Sheffield holds two other HMS projects in WA, Eneabba and McCalls, with resources shown in Table 8 and a map of Eneabba shown in Figure 8.
- ◆ Eneabba is Sheffield’s second mineral sands project, located in the Perth Basin centred approximately 140km south of Geraldton.

Figure 8: Eneabba Project



Source: Sheffield

- ◆ The Eneabba Project, which comprises five defined dunal sand deposits and a number of prospects is located near existing mineral sands operations in an area of world-class HMS mineralisation and is well connected by road and rail to Kwinana/Fremantle and Geraldton Ports.
- ◆ Sheffield's strategy is to build up a resource base of at least 10Mt of contained HMS, which will be amenable for sequential mining and treatment using a mobile plant – four new discoveries (Mount Adams, Robbs Cross, Ding Road and Thomson's) were made in 2015.
- ◆ The deposits in the region are typically zircon and rutile rich, with ilmenite also generally being high grade (>60% TiO<sub>2</sub>) and thus suitable for chloride pigment or synthetic rutile feedstock, and broad and up to 20m thick mineralisation.
- ◆ Deposits are also at surface and typically sit above the water table.
- ◆ Retention Licences were granted over Durack and Yandanooka in 2016.
- ◆ The Company is planning a drilling programme in Q2/Q3 CY17 targeting Robbs Cross and Thomson's.
- ◆ Large tonnage, low grade mineralisation was identified in the McCalls area by BHP in the 1970's, with Sheffield announcing a maiden resource in 2012 – McCalls is located approximately 100km north of Perth.
- ◆ The mineral assemblage is dominated by ilmenite, and characterisation studies on one sample indicated TiO<sub>2</sub> grades of 60-68%, making it potentially a high grade chloride feedstock - in addition grainsize is relatively coarse at 125 microns.
- ◆ The contained chloride ilmenite tonnage of +40Mt makes it one of the largest concentrations of this material in the world.
- ◆ Sheffield's plan is to continue evaluation of the project as a large scale bulk mining operation, and is seeking a strategic alignments with chloride pigment off-take groups to progress McCalls.

**Table 8: Eneabba and McCalls Mineral Resources**

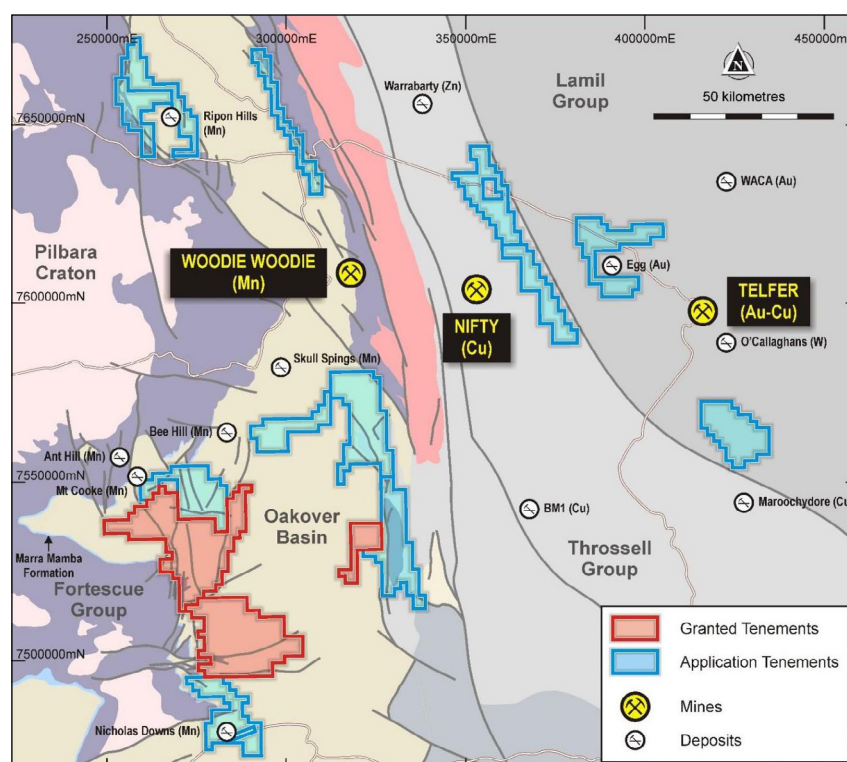
Eneabba and McCalls Mineral Resources										
Deposit, Cut-off	Category	Resource Tonnes (Mt)	Insitu HM (Mt)	HM Grade (%)	Zircon (%)	Rutile (%)	Leuc (%)	Ilmenite (%)	Slimes (%)	Osize (%)
Yandanooka (> 0.9% HM)	Measured	3	0.1	4.1	10	1.9	2.2	72	15	14
	Indicated	90	2.1	2.3	12	3.7	3.7	69	16	15
	Inferred	3	0.03	1.2	11	3.9	4.6	68	18	21
	Total	96	2.2	2.3	12	3.6	3.7	69	16	15
Durack (>0.9% HM)	Indicated	50	1	2	14	2.8	4.6	70	15	21
	Inferred	15	0.2	1.2	14	2.4	6.7	67	14	17
	Total	65	1.2	1.8	14	2.8	4.9	70	15	20
Drummond Crossing (>1.1% HM)	Indicated	49	1	2.1	14	10	3.6	53	16	9
	Inferred	3	0.05	1.5	13	9.9	2.8	55	16	8
	Total	52	1.1	2.1	14	10	3.6	53	16	9
Ellengail (>0.9% HM)	Inferred	46	1	2.2	9	8.7	1.9	64	16	2
	Total	46	1	2.2	9	8.7	1.9	64	16	2
West Mine North (>0.9% HM)	Measured	6	0.4	5.6	4	9.6	9.5	54	15	1
	Indicated	36	0.8	2.3	7	9.6	5.4	60	13	3
	Total	43	1.2	2.8	6	9.6	6.6	58	13	3
All Eneabba (various)	Measured	9	0.5	5.2	6	7.7	7.7	59	15	5
	Indicated	225	5	2.2	12	5.8	4.2	64	15	13
	Inferred	68	1.3	1.9	10	7.7	2.7	64	15	6
	Total	302	6.8	2.2	11	6.3	4.1	64	15	11
McCalls (>1.1% HM)	Indicated	2,214	31.7	1.4	5.1	3.2	2.7	76.8	21.7	1.3
	Inferred	1,436	18.7	1.3	5	3.2	3.1	80.3	25.5	1.1
	Total	3,650	50.4	1.4	5.1	3.2	2.9	78.5	23.2	1.2

Source: Sheffield

**OAKOVER CU-MN PROJECT – SFX 100%**

- ◆ Oakover, located over the Archaean to Proterozoic Eastern Hamersley Basin and Paterson Province of Western Australia comprises 3 granted ELs and 12 ELA's for 3,580km<sup>2</sup>.
- ◆ The tenements are considered prospective for the following styles of mineralisation:
  - Sediment hosted copper Cu-Co-(Zn-Pb) (i.e. Nifty, Warrabarty)
  - Proterozoic gold-copper systems Au-Cu-(Ag-W) (i.e. Telfer, Calibre)
  - Manganese Mn (i.e. Woodie Woodie, Ripon Hills)
  - Iron Fe (i.e. Christmas Creek, Roy Hill)
- ◆ Field work to date has been limited to reconnaissance site visits over the granted tenements, however this has highlighted the prospectivity for manganese and copper mineralisation.
- ◆ Ongoing work will include data compilations and further reconnaissance field work.

Figure 9: Oakover Project



Source: Sheffield

## VALUATION

- ◆ We have completed a pre-tax and pre-funding DCF valuation for Sheffield using a discount rate of 10% and an AUD/USD exchange rate of 0.75.
- ◆ The “per share” valuation should be considered as indicative only as it is based on the current company share structure – funding will lead to changes in the share structure of Sheffield and/or changes in the equity holding of Thunderbird with the result that shareholders will be diluted, and the value will decrease - this cannot be quantified until such a time as a realistic funding package is known and can be modelled.
- ◆ Thunderbird has been valued using DCF as the primary method – we have also included an EBITDA multiple using 5x, a multiple that we view as suitable for non-gold resources producers, which supports the un-risked project valuation.
- ◆ Forecast product prices, operating costs and capital cost figures are those as used by the Company in the BFS – our view is that these are reasonable and comparable for other HMS companies.
- ◆ We have used average production rates for the two Stages - Stage 1 ramps up to 8mtpa, with Stage 2 operating at 17.1mtpa.
- ◆ We have assumed total royalties of 6% - these include a State Government royalty of 5% and royalties payable to other parties of 1% - these latter royalties are most likely to be in the order of 0.5% to 1%.

Table 9: SFX indicative valuation

SFX indicative valuation			
Asset	Value (A,\$m)	Value/Share	Notes
Thunderbird	\$413 m	\$2.28	Pre-tax NPV <sub>10</sub> risked at 61%
Eneabba	\$15 m	\$0.08	Nominal
McCalls	\$5 m	\$0.03	Nominal
Oakover	\$5 m	\$0.03	Nominal
Fraser Range	\$0.5 m	\$0.00	Based on first tranche of farm-out
Cash	\$14 m	\$0.08	As of 31/12/2016
Total	\$452 m	\$2.50	Current capital structure

Source: IIR analysis



- ◆ The Thunderbird valuation, which makes up some 90% of the total Company valuation is risked for resource stage, with this being 61% using our multiples (100% weighting for Proven Reserves and 35% for Probable Reserves) - pre-tax and post-tax risked and un-risked valuations for Thunderbird are presented in Table 10 – this also includes a valuation using current spot prices, which highlights the robustness of Thunderbird.
- ◆ Using a DR of 8% increases the pre-tax un-risked, forecast price valuation to \$963m.
- ◆ The values for Eneabba and McCalls are indicative only, however we have based these on the EV's of companies with similar pre-development assets.

**Table 10: Thunderbird valuation ranges**

Thunderbird valuation ranges			
Price Scenario	Pre-Tax NPV10	Post-Tax NPV8	Av EBITDA pa
Forecast Prices	\$679 m	\$632 m	\$134 m
Spot Prices	\$346 m	\$323 m	\$92 m
Risk Factor/EBITDA Multiple	61%	61%	5 x
Risked Forecast Prices	\$413 m	\$384 m	\$669 m <sup>1</sup>
Risked Spot Prices	\$211 m	\$196 m	\$459 m

1: EBITDA multiples are un-risked

Source: IIR analysis

- ◆ Forecast production and cash flow figures are presented in Table 11.
- ◆ One figure of interest is the “revenue to cost” ratio – this is a factor commonly used in HMS operations given different product mixes, and figure of 1.8:1 and better from 2020 places Thunderbird in a very competitive position amongst global producers.

**Table 11: Thunderbird production and cashflow profile**

Thunderbird production and cashflow profile								
Year	2018	2019	2020	2021	2022	2023	2024	2025
Tonnes Mined	0 t	1.6 mt	6.4 mt	8.0 mt	8.0 mt	8.0 mt	17.1 mt	17.1 mt
Premium Zircon	0 t	10,300 t	41,200 t	51,500 t	51,500 t	51,500 t	88,700 t	88,700 t
Zircon Concentrate	0 t	9,820 t	39,280 t	49,100 t	49,100 t	49,100 t	80,100 t	80,100 t
LTR Ilmenite	0 t	52,900 t	211,600 t	264,500 t	264,500 t	264,500 t	481,600 t	481,600 t
HiTi88	0 t	2,560 t	10,240 t	12,800 t	12,800 t	12,800 t	23,000 t	23,000 t
Titano-magnetite	0 t	31,320 t	125,280 t	156,600 t	156,600 t	156,600 t	285,300 t	285,300 t
Revenue	\$0 m	\$40 m	\$168 m	\$218 m	\$223 m	\$223 m	\$387 m	\$387 m
Royalties	\$0 m	\$2 m	\$10 m	\$13 m	\$13 m	\$13 m	\$23 m	\$23 m
Operating Costs	\$0 m	\$23 m	\$94 m	\$117 m	\$117 m	\$117 m	\$190 m	\$190 m
EBITDA	\$0 m	\$14 m	\$64 m	\$88 m	\$92 m	\$92 m	\$174 m	\$174 m
Revenue/Costs	0.0:1	1.7:1	1.8:1	1.9:1	1.9:1	1.9:1	2.0:1	2.0:1
Capex	\$248 m	\$107 m	\$7.0 m	\$2.5 m	\$0.7 m	\$197.7 m	\$0.8 m	\$0.7 m

Source: IIR analysis

- ◆ We have completed a sensitivity analysis, with this indicating that Thunderbird is most sensitive to prices and exchange rates – these are shown in Table 12.

**Table 12: Un-risked Thunderbird sensitivity analysis**

Un-risked Thunderbird sensitivity analysis					
Change	Revenue	Opex	Capex	Exchange Rate	Grade
-20%	\$166 m	\$963 m	\$773 m	\$1,321 m	\$166 m
-15%	\$294 m	\$892 m	\$750 m	\$1,132 m	\$294 m
-10%	\$423 m	\$821 m	\$726 m	\$964 m	\$423 m
-5%	\$551 m	\$750 m	\$703 m	\$814 m	\$551 m
0%	\$679 m	\$679 m	\$679 m	\$679 m	\$679 m
5%	\$807 m	\$608 m	\$656 m	\$557 m	\$807 m
10%	\$936 m	\$537 m	\$632 m	\$446 m	\$936 m
15%	\$1,064 m	\$466 m	\$609 m	\$344 m	\$1,064 m
20%	\$1,192 m	\$396 m	\$585 m	\$251 m	\$1,192 m

Source: IIR analysis

- ◆ Given the high expected operating cash flows the Project is least sensitive to capex.
- ◆ As expected the Project is most sensitive to revenue (which is affected by prices, grade, recovery and exchange rates).

## PEER GROUP ANALYSIS

- ◆ There are only a handful of ASX-listed mineral sands companies, as shown in Table 13 below, and ranked in decreasing order of EV.
- ◆ Resource figures are for 100% of all projects that the relevant companies have an interest in, and grades are for total potentially saleable zircon and titanium dioxide feedstock minerals.

**Table 13: Sheffield peer group comparison**

Sheffield peer group comparison							
Company	Key Project	Stage	Equity Share	EV <sup>1</sup>	Global Resources - All Deposits	Global Payable HM Grade <sup>2</sup>	Contained Payable HM
Iluka Resources	Various	Producing	100%	\$3,973 m	2,424 Mt	5.40%	130.8 Mt
Base Resources	Kwale, Kenya	Producing	100%	\$444 m	143 Mt	3.16%	4.5 Mt
MZI Resources	Keysbrook, WA	Producing	100%	\$169 m	155 Mt	1.61%	2.5 Mt
Sheffield Resources	Thunderbird, WA	BFS Complete	100%	\$98.7 m	7,182 Mt	1.99%	142.7 Mt
Mineral Deposits	Grande Cote, Senegal	Producing	50%	\$68.3m	1,900 Mt	1.23%	23.4 Mt
Astron Corporation	Donald, Murray Basin Victoria	Optimisation of FS	100%	\$16.9 m	4,780 Mt	2.92%	139.7 Mt
Metallica Minerals	Point Urquart, Queensland	On hold	50%	\$13.0 m	3 Mt	2.01%	0.1 Mt
Strandline Resources <sup>3</sup>	Various, Tanzania	Exploration, resources estimated	100%	\$12.6 m	383 Mt	1.38%	5.3 Mt
Diatreme Resources	Cyclone, WA	PFS complete	100%	\$7.6 m	211 Mt	2.15%	4.5 Mt

1: EV is defined as market capitalisation less cash plus debt – no allowance has been made for the value of non-HMS projects in the companies' portfolios

2: Payable grade is the published grade of valuable zircon and titanium dioxide minerals

3: Strandline's mineralisation includes the 308Mt Coburn deposit in Western Australia – activities however are focussed on Tanzania.

Source: IRESS, Company reports: Company reports

- ◆ Table 14 presents a range of published mineral sands resources with a theoretical in ground value based on AUD prices as given in the table footnotes - this is not exhaustive but provides a sample of the resources.
- ◆ The in ground value does not reflect potential realisable values – this will depend on other factors, including the metallurgy/recovery and marketability of the VHM's.
- ◆ This is intended as an indicative guide only, however shows the high relative value of Thunderbird and the potential at Night Train.

**Table 14: HMS deposit comparisons**

HMS deposit comparisons								
Coy	Project/Area	Deposit	Total Tonnage	HMS Grade	Ti Mins %	Zircon %	Total Potentially Payable HMS Grade	Value/t <sup>1</sup>
ILU	Murray Basin	West Balranald	36 Mt	32.99%	24.01%	3.58%	27.59%	\$142.45
ILU	Murray Basin	All	189 Mt	16.83%	11.54%	1.81%	13.65%	\$73.46
SFX	Dampier	Night Train <sup>3</sup>	N/A – average drilling	6.40%	4.93%	0.93%	5.89%	\$32.04
SFX	Eneabba	West Mine North High Grade	10 Mt	7.70%	5.83%	0.61%	6.44%	\$30.73
ILU	Eucla Basin	All	386 Mt	4.89%	0.28%	1.11%	4.11%	\$26.69



HMS deposit comparisons								
Coy	Project/Area	Deposit	Total Tonnage	HMS Grade	Ti Mins %	Zircon %	Total Potentially Payable HMS Grade	Value/t <sup>1</sup>
SFX	Dampier	Thunderbird High Grade	1,040 Mt	12.20%	3.96%	0.93%	4.89%	\$23.23
ILU	Sri Lanka	All	690 Mt	8.16%	5.90%	0.29%	6.19%	\$21.00
MuZi <sup>2</sup>	WIM150	WIM150	1,650 Mt	3.72%	1.82%	0.77%	2.59%	\$19.44
ATR	Donald	All	4,780 Mt	3.70%	2.22%	0.70%	2.92%	\$19.25
ILU	Perth Basin	All	1,041 Mt	5.49%	3.56%	0.60%	4.16%	\$19.03
MLM	Cape York	Urquhart Point	3 Mt	5.94%	1.40%	0.61%	2.01%	\$18.05
BSE	Kwale	All	143 Mt	4.52%	2.89%	0.27%	3.16%	\$16.04
SFX	Dampier	Thunderbird All	3,230 Mt	6.91%	2.30%	0.57%	2.88%	\$14.13
STA	Tanzania	Fungoni	16 Mt	3.11%	1.35%	0.69%	2.03%	\$13.78
STA	Tanzania	Tajiri	59 Mt	3.70%	3.03%	0.19%	3.22%	\$13.28
ILU	USA Atlantic	All	118 Mt	4.43%	2.87%	0.49%	3.35%	\$13.27
MuZ <sup>2</sup>	Mindarie	All	244 Mt	3.09%	1.80%	0.52%	2.32%	\$13.19
MZI	Keysbrook	Keysbrook	90 Mt	2.20%	1.67%	0.31%	1.98%	\$12.41
SFX	Eneabba	All	302 Mt	2.23%	1.66%	0.26%	1.91%	\$8.88
MZI	Keysbrook	Yangedi	51 Mt	1.50%	1.22%	0.16%	1.38%	\$7.54
STA	WA	Coburn	308 Mt	1.20%	0.72%	0.28%	1.00%	\$6.49
MDL	Grande Cote	All	1,900 Mt	1.40%	1.08%	0.15%	1.23%	\$4.95

1: Values based on the following AUD prices per tonne: Zircon - \$1,400, Rutile \$1,200, High Ti leucoxene \$533, Low Ti Leucoxene \$400, Ilmenite \$225.

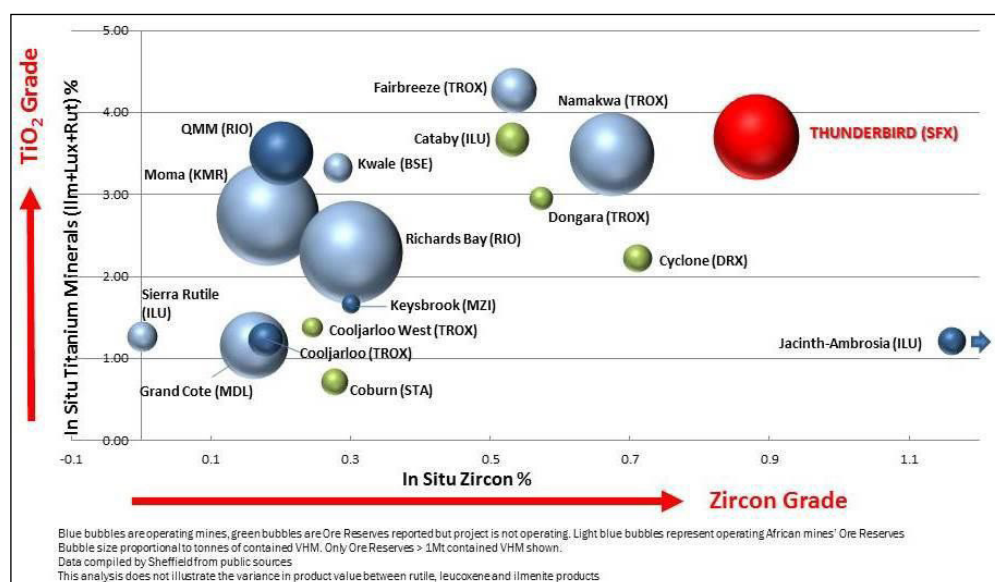
2: Mu Zi is Murray Zircon, now privately owned – this was previously Australian Zircon.

3: Night Train grades are based on numbers published on Sheffield's website – no resource has yet been published

Source: IRESS, Company reports: Company reports

- ◆ Figure 15 shows a comparison of zircon and titanium dioxide feedstock mineral grades in Ore Reserves – this clearly shows the quality of Thunderbird.

**Figure 9: Reserve grades of HMS projects**



Source: Sheffield

## CAPITAL STRUCTURE

- ◆ Sheffield currently has 181.0 million shares, 9.13 million options (including employee options) and 5.80 million performance rights on issue.
- ◆ The top shareholder is the BlackRock Group, with a 9.0% holding.
- ◆ Total insiders interests are 13.6%, with the top 20 holding 49.63%
- ◆ The Company has 1,575 shareholders.

## RISKS

- ◆ **Offtake and funding:** this is the key non-technical risk at the moment, however the recent signing of zircon MoUs and the reported interest in Thunderbird by other offtake and funding parties goes some way to mitigating this. The Company will need to work to get more MoUs in place and also to convert them to binding agreements, however the quality of the major products is such that offtake should not be a problem. The main risk may lie with the HiTi88 and titanomagnetite products, however these provide between them only 9% of the expected revenue, and thus are not critical to the Project's success.
- ◆ **Permitting:** This is a risk facing any potential developer, however being located in Western Australia, a state that has permitted a number of HMS operations should largely mitigate this risk – the main threat here is potentially in delays, and not a failure to permit. The largely favourable response during the PER exposure period is also positive.
- ◆ **Project Implementation:** Delays and cost over runs are common in the construction of new projects, and also unforeseen issues are often uncovered in the commissioning phase of a project. This latter point is partly mitigated through Sheffield planning to use industry standard processing equipment and mining techniques.
- ◆ **Fine grain size:** This has caused some issues at other mineral sands deposits (particularly in the Wimmera), and also has negative perceptions with some investors, however testwork done to date at Thunderbird indicates that the fine to medium grained material is readily treated at a pilot scale, and that the slimes are readily handled.
- ◆ **Prices and exchange rates:** These are factors outside of a company's control, and can severely affect a project's viability – this is not as much an issue as at some other operations, with our modelling suggesting that the Project can handle 20% adverse movements in either and still remain viable.
- ◆ **Costs:** Again factors that can severely impact on the viability of a project, however given the robustness of Thunderbird it can absorb adverse movements in costs.

## BOARD AND MANAGEMENT

- ◆ **Mr Will Burbury – Non-Executive Chairman:** Mr Burbury practised as a corporate lawyer with a leading Australian law firm prior to entering the mining and exploration industry in 2003. During his career, he has been actively involved in the identification and financing of many Australian and African resources projects. He has held senior management positions and served on the boards of several private and publicly listed companies. Mr Burbury was previously Chairman of Warwick Resources Limited prior to its merger with Atlas Iron Limited in 2009. He was also formerly a director of Lonrho Mining Limited (ASX: LOM) and an executive of Nkwe Platinum Ltd (ASX: NKP).
- ◆ **Mr Bruce McFadzean – Managing Director:** A qualified mining engineer with more than 35 years' experience in the global resources industry, Mr McFadzean has led the financing, development and operation of several new mines around the world and his skills will drive progress of Sheffield's world-class Thunderbird minerals sands project through to production.

Bruce McFadzean's professional career includes 15 years with BHP Billiton and Rio Tinto in a variety of positions and four years as Managing Director of successful Western Australia gold miner Catalpa Resources Limited (ASX:CAH). Under his management, Catalpa's market capitalisation grew from \$10 million to \$1.2 billion following the Evolution merger. He has raised in excess of A\$350 million in debt and equity from Australian and overseas markets

- ◆ **Mr David Archer – Technical Director:** David Archer is a geologist with 24 years' experience in exploration and mining in Australia. He has held senior positions with major Australian mining companies, including Renison Goldfields Consolidated Limited, and has spent the last ten years as a director of Archer Geological Consulting specialising in project generation, geological mapping and project evaluation. Mr Archer was a consultant to Atlas Iron Limited (ASX: AGO) and Warwick Resources Limited and was responsible for significant iron ore discoveries for both companies in the Pilbara. He was also involved in the discovery of the Magellan lead mine and the Raleigh and Paradigm gold mines.
- ◆ **Mr Bruce McQuitty – Non-Executive Director:** Mr McQuitty has over 30 years' experience in the mining and civil construction industries and was previously Managing Director of Warwick Resources Limited prior to its merger with Atlas Iron Limited in 2009. Prior to that he held senior positions with Consolidated Minerals Limited, Renison Goldfields Consolidated Limited and Gympie Gold Limited. Mr McQuitty has significant technical expertise in exploration, project generation, feasibility, underground mining and engineering geology and has managed exploration teams in Australia and overseas. Mr McQuitty holds a Masters of Economic Geology and a Bachelor of Science.
- ◆ **Mr Stuart Pether – Chief Operating Officer:** Mr Pether is a qualified mining engineer with over 25 years' experience in the resources industry, both in Australia and overseas. Stuart has extensive experience in project development, technical studies, mine operations and corporate management; including executive engagements as CEO of Kula Gold Limited, VP Project Development - Evolution Mining and COO at Catalpa Resources..
- ◆ **Mr Mark Di Silvio – CFO/Company Secretary:** Mr Di Silvio is a CPA with over 25 years' experience in the resources sector working across Africa and Australia. He has led financing and restructuring initiatives, holding senior finance and executive positions with RGC/Goldfields, Woodside Energy, Centamin and Mawson West.
- ◆ **Mr Jim Netterfield – Project Manager:** Mr Netterfield brings more than 20 years' experience in the resources industry to the role and has a proven track record in successfully managing mineral development projects through to production. He will take responsibility for delivering the definitive feasibility study (DFS) for Thunderbird, the world's best undeveloped mineral sands deposit.  
  
Mr Netterfield's professional career includes 11 years with BHP Billiton and Rio Tinto in a variety of senior operations roles, including Vice President – Railway & Ports, Vice President Operations and Manager Operations, Dampier. He recently served for four years as acting CEO and Operations Director at Oakajee Port & Rail Pty Ltd, leading the feasibility studies for Mitsubishi's \$10 billion magnetite iron ore project. In addition, he has held senior operations roles with Minara Resources, Tomago Aluminium Company and Janus Consulting Australia.
- ◆ **Mr Neil Patten-Williams – Marketing Manager:** Mr Patten-Williams is a professional with over 18 years' experience in the resources industry, including five years as Sales and Marketing Manager for established mineral sands producer the Doral Group, where he was responsible for marketing, logistics and sales globally. Mr Patten-Williams has a strong background in both zircon and titanium mineral products. Prior to his appointment as Sales and Marketing Manager at Doral, he was Operations Manager of the Doral Fused Materials Plant in WA for five years responsible for all aspects of safety, operations and maintenance and also spent five years as the company's Zirconia Operations Manager. As a metallurgist with hands-on operational experience Mr Patten-Williams has a unique blend of commercial, global marketing and operational skills in the mineral sands industry.

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## BACKGROUND – THE MINERAL SANDS INDUSTRY

### Introduction

- ◆ The mineral sands industry is the key supplier of zircon and titanium dioxide minerals worldwide - these are key feedstocks for industrial uses, with Australia being a major global producer, particularly of zircon.
- ◆ In 2014 global production included 1.1Mt of zircon and 7.25Mt of titanium dioxide feedstock.

## Zircon

- ◆ The zircon market is supplied by the one product, zircon.
- ◆ The major use for zircon is in ceramics, with this comprising some 50% of the 2014 global demand of 1.1Mt, with approximately 90% of the ceramics demand from tile manufacture.
- ◆ Other uses include chemicals (21%) and in refractory products (17%) - the chemical demand is currently the largest growing, with a 10 year CAGR of 11%.
- ◆ China is the largest market, comprising 40% in 2014, with this region seeing significant growth, largely due to the rapid urbanisation during the 2000's driving increased demand for tiles and other ceramics – tiles comprise approximately 75% of all floor coverings in China (source: Iluka).
- ◆ Other major markets include Europe (20% in 2014) and North America (9% in 2014).
- ◆ Urbanisation is seen to be the key driver of zircon demand, largely due to increasing demand for tiles and other ceramic products.
- ◆ Australia is the largest supplier globally, providing 43% of the world's production in 2014, with Iluka alone supplying 32% of the global demand.
- ◆ Australia's (and Iluka's) shares of global production were significantly down on the 2011 figures (50% and 38% respectively), largely due to weakening demand and lower prices.

## Titanium Dioxide

- ◆ The majority (90%) of titanium dioxide is used in the pigment industry, being used in various products, including paints, coatings, paper and inks.
- ◆ It is a key white pigment in that it has a high refractive index (whiteness), provides UV protection and is non-toxic.
- ◆ Other uses include as a metal (military, aerospace and specialty applications) and for welding rod core wire.
- ◆ There are two main pigment production routes – chloride and sulphate, with chloride generally being cleaner and requiring higher grade feedstocks.
- ◆ The majority of Chinese capacity is for sulphate grade feedstock; western producers generally use the chloride process.

**Table 15: Titanium dioxide products sold, 2014**

Titanium dioxide products sold, 2014			
Product, approximate market share	TiO <sub>2</sub> %	Notes	End Uses
Rutile – 10%	95-97	Mined product	Pigments, metal
Synthetic rutile – 3%	88-95	Upgraded from ilmenite in a furnace	Pigments
Ilmenite			
Sulphate – 42%	52-54	Processed to pigment - sulphate processing	Pigments
Chloride – 12%	8-62	Processed to pigment - chloride processing	
Slag			
Sulphate – 11%	80-85	Upgraded from sulphate ilmenite in a furnace	Pigments
Chloride – 19%	85-90	Upgraded from chloride ilmenite in a furnace	
Upgraded – 3%	95	Upgraded from ilmenite	

Source: Iluka

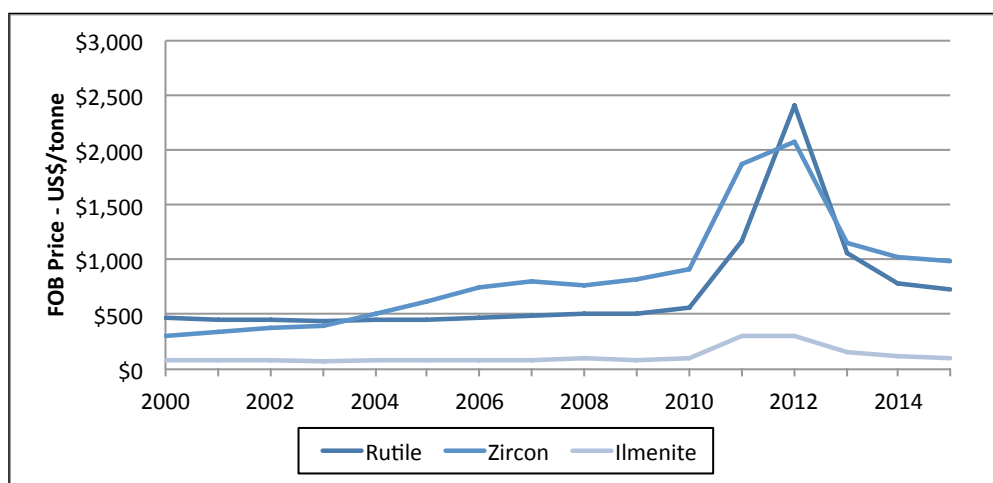
- ◆ In 2014 (total production 7.25Mt) the major titanium dioxide producers were China (19%), Australia (17%), South Africa (15%) and Canada (11%).
- ◆ Like zircon, Australian share of production had fallen from 24% of 6.5Mt in 2011 (1.6Mt) to 17% of 7.25Mt in 2014 (1.2Mt), again largely due to Iluka curtailing production and sales.
- ◆ Rio Tinto (24% in 2014) is the largest producer, with operations in South Africa (Richards Bay), QIT (Canada) and QMM (Madagascar).
- ◆ In 2014 Iluka was the second largest producer (9%), with operations in Australia and Virginia in the US – the latter was idled at the end of 2015 and closed in 2016.
- ◆ Unlike zircon, where the market is supplied by a single product, the 7.25Mtpa (2014) titanium dioxide market is fed by a number of products feeding the different processing routes.

- ◆ Key products sold by producers are shown in the table below. What can be seen is that 36% of the products sold to end users and pigment manufacturers are upgraded products, with the remaining 64% being raw materials.
- ◆ In addition, approximately 52% of feedstocks are chloride grade and 48% sulphate grade.

### Pricing

- ◆ The mineral sands market is relatively opaque – prices are generally fixed between the producer and buyer, and until 2009-2010 were largely on long term contracts, leading to relatively stable prices.
- ◆ More recently, changes in demand and supply have led to contracts more commonly being negotiated quarterly or half yearly.
- ◆ Indicative product prices are shown below – rutile and zircon prices largely are as published in Iluka reports, ilmenite prices are derived from various sources.

**Figure 11: Zircon and Titanium Dioxide Prices FOB Australia (US\$/tonne)**



Source: Iluka, various public documents

- ◆ The noticeable feature is the sharp decrease in prices in 2013, which continued into 2016 – this followed slowing in demand during 2012, largely due to weakening global economic conditions.
- ◆ Also apparent are significant price increases in all commodities starting in 2010. As mentioned, this was as a result of supply constraints enabling producers to renegotiate prices away from long term contracts, which were a disincentive on bringing on new production.
- ◆ The steady increase in zircon price from 2000 to 2010 of around 12% CAGR was largely due to the rapid urbanisation in China driving demand for ceramics, and hence zircon - there was a minor blip during the GFC, largely due to non-Chinese factors.
- ◆ Until 2010 price increases in the titanium dioxide products tended to follow annual GDP growth of around 3%.
- ◆ Reduced prices in 2014-2016 saw curtailing of operations, and also, especially in the case of zircon, selling from stockpiles (particularly by Rio Tinto) which saw prices remain depressed.
- ◆ TZMI expect that in the case of sulphate ilmenite, feedstock inventories have peaked, and will be depleted by early 2017, with this also to coincide with increasing demand, and with the possibility of no new operations coming on stream.
- ◆ They forecast that this will lead to a deficit of up to one million  $TiO_2$  units (around 2 Mt of feedstock) by 2020-2021, with prices now increasing due to tightening markets.
- ◆ In addition, some Chinese supply has historically come as a by-product from domestic magnetite mines – with falling iron ore prices a number of these are closing and thus also affecting ilmenite supply.
- ◆ With regards to zircon, the forecast is for significant reduction in production from existing operations, with this pointing to a reduction in existing supply to ~750,000t by 2025 – this provides an excellent opportunity for new projects such a Thunderbird.
- ◆ This has followed a period where potential supply has been greater than demand due to overstocking and hence weighing on prices.

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