VRX SILICA

28 August 2019

ASX ANNOUNCEMENT

Arrowsmith North BFS and Maiden Ore Reserve

VRX Silica Limited (**VRX Silica** or **Company**) (ASX: VRX) is pleased to announce details of its Bankable Feasibility Study (**BFS**) and maiden Probable Ore Reserve at its Arrowsmith North Silica Sand Project (**Arrowsmith North**), located 270km north of Perth, WA, one of the Company's three advanced silica sand projects.

Highlights:

- ***Arrowsmith North BFS demonstrates exceptional financial metrics and a World-class project***
- ***Ungeared NPV$_{10}$ of $242 million based on 25 years of a potential mine life of +100 years. Other key BFS outcomes:***

Post Tax, ungeared NPV$_{10}$	$242,300,000
Post Tax, ungeared NPV$_{20}$	$99,800,000
Post Tax, ungeared IRR	79%
Payback period (yrs) (post tax) (ramp up rate)	2.4
Exchange Rate US$/A$	$0.70
Life of Mine (yrs) (Scope of BFS)	25
EBIT	$1,144,000,000
Total Sales (initial 25 years) (no escalation)	$2,773,000,000
Cashflow after finance and tax	$835,000,000
Capex (2 mtpa)	$28,260,000
Capex contingency (inc)	20%
Life of Mine C1 costs, FOB Geraldton (inc royalties)	$30.18
Tonnes Processed (initial 25 years) (Mt)	53
Production Target (initial 25 years) (Mt)	47.7
Probable Ore Reserves @ 99.7% SiO_2 (Mt)	204
Ore Reserve life (yrs)	102
JORC Resources (million tonnes)	771

Notes:
1: The Ore Reserve underpinning the above production target has been prepared by a Competent Person in accordance with the requirements of the JORC (2012) Code.
2. Full summary of economic assumptions for the BFS set out in this announcement.
3. All figures are presented in Australian dollars, unadjusted for inflation

- ***Total Project Probable Ore Reserve of 223 Mt @ 99.7% SiO_2***
- ***Mining Lease application area Probable Ore Reserve of 204 Mt @ 99.7% SiO_2***
- ***Four saleable silica sand products suitable for international glass making, foundry and ceramic markets***
- ***Offtake discussions continuing***
- ***Full BFS annexed to this announcement***

ASX: VRX

Capital Structure

Shares on Issue:
404 million

Top 20: 47%

Unlisted Options:
72 million

Corporate Directory

Paul Boyatzis
Non-Executive Chairman

Bruce Maluish
Managing Director

Peter Pawlowitsch
Non-Executive Director

John Geary
Company Secretary

Company Projects

Arrowsmith Silica Sand Project, 270km north of Perth, WA.

Muchea Silica Sand Project, 50km north of Perth, WA.

Boyatup Silica Sand Project, 100km east of Esperance, WA.

Warrawanda HPQ Project south of Newman, WA.

Biranup base metals and gold Project adjacent to the Tropicana Gold Mine, WA.

The Company is actively assessing other silica sand projects in Australia.

VRX Silica Managing Director Bruce Maluish said: *"We are delighted with the results of ongoing work for Arrowsmith North and, following our BFS, the conversion of the Mineral Resource Estimate into a maiden Probable Ore Reserve. These results support our continued assessment of Arrowsmith North as a compelling silica sand project with world-class potential.*

"We expect Arrowsmith North to be a long-life mining project with a significant proportion of the Ore Reserve sitting within our Mining Lease application area.

Demand for identified saleable products remains strong and we have generated significant interest from potential customers across the Asia-Pacific region and continue to engage with potential customers," said Maluish.

Work continues on obtaining environmental and mining approvals for Arrowsmith North.

BFS Summary

The BFS details the project and financial attributes supporting the development of Arrowsmith North, located north of Eneabba, 270km north of Perth in Western Australia (see Figure 1).

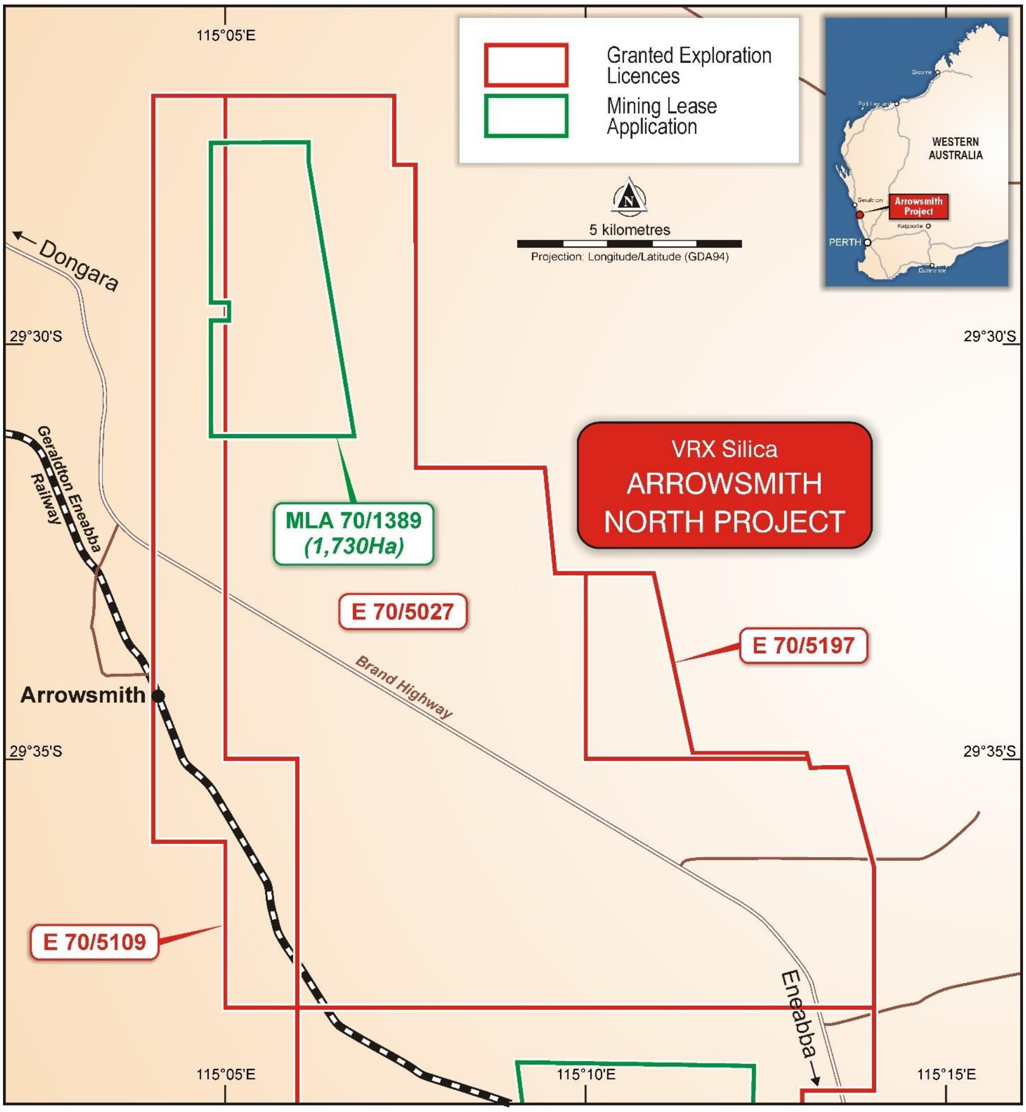

Figure 1: Arrowsmith North project and tenement location map

Silica sand markets

Globally, silica sand is in a growth phase due to increasing demand from the construction sector, with both volume and value having increased worldwide. Sales of silica sand experienced a compound annual growth rate of approximately 8.7% in value terms from 2009 to 2016, with a market value of US$6.3 billion. This was due to its applications across a range of industries, including glass making as well as foundry casting, water filtration, chemicals and metals, along with the hydraulic fracturing process.

Accelerations in construction spending and manufacturing output worldwide are expected to drive growth in important silica sand-consuming industries, including the glass, foundry and building products sectors. Significant growth is projected in the hydraulic fracturing market as horizontal drilling for shale oil and gas resources expands, largely in North America.

The Asia-Pacific region is expected to remain the largest regional consumer of industrial sand through 2025, supported by the dominant Chinese market. The country's container glass industry will drive further silica sand sales, supported by rising production of glass bottles, particularly in the alcoholic beverage sector including wine and beer.

In India, foundry activity has shown strong growth, driven by the production of sand moulds to manufacture metal castings. Indonesia will also register strong growth in silica sand sales through 2022, supported by rapid advances in the output of glass products and metal castings, combined with increased hydraulic fracturing activity.

Products

High-grade silica sand is a key raw material in the industrial development of the world, especially in the glass, metal casting, and ceramics industries. High-grade silica sand contains a high portion of silica (over 99% SiO_2) and is used for applications other than construction aggregates. Unlike construction sands, which are used for their physical properties alone, high-grade silica sands are valued for a combination of chemical and physical properties.

Global consumption of industrial silica sand is expected to climb 3.2% per year through 2022. Asia Pacific growth is higher than global growth and is expected to be around 5-6% per year. Ongoing economic and infrastructure development in the Asia/Pacific region will drive growth, as will hydraulic fracturing activity in North America. Frac sand will be used increasingly in Asia Pacific in future years but unlikely to match the use in North America where 100 million tonnes are used annually.

Glassmaking

Silica sand is the primary component of all types of standard and specialty glass. It provides the essential SiO_2 component of glass formulation; its chemical purity is the primary determinant of colour, clarity and strength in glass. Industrial sand is used to produce flat glass for building and automotive use, container glass for foods and beverages, and tableware. In its pulverised form, ground silica is required in the production of fibreglass insulation and for reinforcing glass fibres. Specialty glass applications include test tubes and other scientific tools, incandescent and fluorescent lamps.

Over the past 20 years growth in glass demand has exceeded GDP growth and continues to grow at circa 5% per annum.

Key points and assumptions

The BFS is based on only 25 years production from a considerable +100 year mine life.

The project will be a potentially new long-term industry for Western Australia with substantial economic benefits, including long-term employment and royalties with a significant economic contribution to the local and Mid West region.

The Company has met with the local Shires, Mid West Development Commission, Mid West Chamber of Commerce & Industry and various local Members of State and Federal Parliament with great support for the project.

The Company has engaged with the Department of Water and Environmental Regulation following preliminary environmental studies to identify key issues pertaining to the project environmental approvals for mining particularly the habitat for potential foraging by Carnaby's cockatoos.

VRX Silica has developed a mining and rehabilitation methodology specific to the environment at Arrowsmith North which will enable a successful restoration of mined areas.

A key challenge for industrial minerals projects is meeting market specifications. The silica sand market has specifications for parameters such as purity (e.g. SiO_2 content) in addition to tight specifications for trace elements such as Fe, Ti, Al and Cr in the glass industry.

The Company is confident that it can meet these specifications from Arrowsmith North.

Key economic assumptions for the BFS are as follows:

Currency	Australian dollars *Sales contracts in Asia for silica sand are invariably based $US and a A$0.70 exchange rate has been applied*
Project life	25 years Total probable Ore Reserve is well in-excess of this time period, however the model is conservatively restricted to 25 years
Depreciation	15% rate on capital
Corporate tax rate	27% on taxable profit
Production	Steady state of production from Probable Ore Reserves over life of mine, with the first 3 years at 1 million tonnes per year and thereafter at 2 million tonnes per year *The Company has currently expressions of interest and letters of intent to purchase 1.5 million tonnes per year of Arrowsmith North products and expects further interest once these products are made available to the market*
Shares on Issue	404,318,617
NPV estimation discount rates	Standard financial modelling conducted at both 10% and 20% discount rates. *The 20% rate is generally above standard reporting rates but demonstrates that the Project is still financially robust at this higher rate*
Capital cost	Based on estimates ±15% from engineering companies with extensive experience in sand separation
Operating costs	A$30.18 C1 costs, including royalties *Based on first principles and current rates for equipment*

Sales revenue	US$35-53 per dry metric tonne dependent on product type, product quality, contract terms and quantity *Revenue is constant based on current prices and ignores any projected growth in prices*
Maximum debt	A$26 million
Borrowing rates	12%
Accounts receivable	30 days
Accounts payable	30 days
Plant maintenance	5% of capital cost per year
Environmental bond	A$500,000 *May be substituted by the WA Department of Mines, Industry Regulation and Safety's "Mining Rehabilitation Fund"*
Capex contingency	20%
Recoveries	N40 (Foundry ASF 40) 40% N20 (Foundry ASF 20) 24% NF400 (Glass 400 ppm Fe_2O_3) 20% *Recoveries are based on CDE testwork at ±5%*

Probable Ore Reserve

The Probable Ore Reserve for Arrowsmith North totals **223 Mt @ 99.7% SiO_2** as reported in accordance with the JORC Code 2012 edition[1], (**JORC Code**) with **204 Mt @ 99.7% SiO_2** contained within the area of the Company's Mining Lease application (MLA70/1389).

This follows the Company's recent announcement of a Mineral Resource Estimate for Arrowsmith North of 771Mt @ 98.0% SiO_2, comprising an Indicated Resource estimate of 248Mt @ 97.7% SiO_2 and an additional Inferred Resource estimate of 523 Mt @ 98.2% SiO_2.

VRX Silica has previously announced[2] an upgraded Mineral Resource Estimate (**MRE**) for Arrowsmith North of an **Indicated Mineral Resource** of **248 Mt @ 97.7% SiO_2** in addition to an **Inferred Mineral Resource** of **523 Mt @ 98.2% SiO_2** for a **Total MRE** of **771 Mt @ 98.0% SiO_2** (see Table 1).

Classification	Domain	Million Tonnes	SiO_2%	Al_2O_3%	Fe_2O_3%	TiO_2%	LOI%
Indicated	White Sand	33	98.7	0.50	0.20	0.20	0.20
	Yellow Sand	215	97.5	1.10	0.40	0.20	0.50
	All Sand	248	97.7	1.00	0.40	0.20	0.50
Inferred	White Sand	280	98.7	0.50	0.10	0.20	0.20
	Yellow Sand	243	97.7	1.00	0.40	0.20	0.50
	All Sand	523	98.2	0.80	0.30	0.20	0.40
Indicated + Inferred	White Sand	**313**	**98.7**	**0.54**	**0.15**	**0.18**	**0.24**
	Yellow Sand	**458**	**97.6**	**1.08**	**0.40**	**0.17**	**0.52**
	All Sand	**771**	**98.0**	**0.86**	**0.30**	**0.17**	**0.41**

**Note: Interpreted silica sand mineralisation is domained above a basal surface wireframe defined based on drill logging data. The upper (Topsoil) layer within 0.5 m of surface is depleted from the modelled silica sand unit, being reserved for rehabilitation purposes. All classified silica sand blocks in the model are reported. Differences may occur due to rounding.*

Table 1: Arrowsmith North Silica Sand Mineral Resource Estimate as at July 2019

[1] 2012 edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves
[2] ASX announcement of 9 July 2019, "Arrowsmith North Mineral Resource Estimate Upgrade".

VRX Silica has completed the necessary work to convert the Indicated Mineral Resource to Probable Ore Reserves. A summary of the work undertaken is included in this document, and in Appendix 1, JORC Code Table 1 Sections 1 to 4 set out in full in the BFS (annexed to this announcement).

Table 2 below details the Probable Ore Reserve that will be produced from the mining of the Indicated Mineral Resource and processing in a purpose built, wet sand processing plant.

The plant will produce four saleable products for different markets with a **total Probable Ore Reserve of 223 Million tonnes**, with 204 Million tonnes contained within the mining lease application MLA70/1389.

Chemical Composition

Classification	Product	Recovery	Global Million Tonnes	Within MLA70/1398 Million Tonnes	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	TiO_2 %	LOI %
Probable	Arrowsmith-N20	24%	60	54	99.7	0.2	0.05	0.035	0.1
	Arrowsmith-N40/ NF500	60%	149	136	99.7	0.2	0.05	0.035	0.1
	Local Market	6%	15	14					
		Total Reserve	**223**	**204**					

Particle Size — **Sieve Opening (Mesh/µm Retained)**

Product	10 / 2mm	20 / 850	30 / 600	40 / 425	50 / 300	70 / 212	100 / 150	140 / 106	200 / 75	AFS No
Arrowsmith-N20	0.10%	3%	87%	8%	1%	0.10%	-	-	-	21
Arrowsmith-N40	-	0%	21%	36%	24%	13%	5%	1%	0%	36
Arrowsmith-NF500	-	-	0.50%	40%	42%	17%	1%	0%	-	38
Local Market	-	-	-	-	-	-	64%	22%	14%	-

Table 2: Arrowsmith North Silica Sand Probable Ore Reserve as at July 2019

Metallurgical Factors

As a part of the upgraded MRE, CSA Global reviewed the metallurgical testwork to comply with Clause 49 of the JORC Code. CSA Global has concluded that the available process testwork indicates likely product qualities for glass, ceramics and foundry sand are considered appropriate for eventual economic extraction from Arrowsmith North. Favourable logistics and the location of the Project support the classification of Arrowsmith North (in accordance with Clause 49) as an industrial mineral with an Inferred/Indicated Mineral Resource

The extensive metallurgical testwork which has been completed by CSA Global at their facility in Cookstown, Northern Ireland, and Nagrom in Kelmscott, Perth, allowed for the creation of a catalogue of silica sand products that could be produced from Arrowsmith North[3] (see Table 3).

[3]ASX announcement of 26 February 2019, "Testwork Update and product Catalogues".

Chemical Composition (%)

Product	Industry	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	K_2O
Arrowsmith-N20	Foundry	99.7	0.20	0.050	0.035	0.010	0.002	0.030
Arrowsmith-N40	Foundry	99.7	0.20	0.050	0.035	0.010	0.002	0.030
Arrowsmith-NF500	Glass	99.7	0.20	0.050	0.035	0.010	0.002	0.030

Particle Size **Sieve Opening (Mesh/µm Retained)**

Product	10 / 2mm	20 / 850	30 / 600	40 / 425	50 / 300	70 / 212	100 / 150	140 / 106	200 / 75	AFS No
Arrowsmith-N20	0.1%	3%	87%	8%	1%	0.1%				21
Arrowsmith-N40		0%	21%	36%	24%	13%	5%	1%	0%	36
Arrowsmith-NF500			0.5%	40%	42%	17%	1%	0%		

Table 3: Arrowsmith North saleable products from catalogue

These products become the recovered products which make up the Probable Ore Reserve detailed in Table 2.

The mass balance of the particle sizes was analysed allowing for the recoveries of these products in a wet processing plant to be estimated.[4]

The recovery of each product is shown in Table 4.

Product	Industry	Recovery
Arrowsmith-N20	Foundry	24%
Arrowsmith-N40 / NF500	Foundry / Glass	60%
Local Market	Fine sand	6%
	Total Recovery	**90%**

Table 4: Arrowsmith North Product Recovery

Material Modifying Factors – Mining Factors

The mining method chosen for Arrowsmith North is a rubber wheeled front-end loader, feeding into a 3 mm trommel screen to remove oversize particles and organics. The undersize sand is slurried and pumped to a sand processing plant which is located proximal to the Eneabba to Geraldton railway line. After processing, the silica sand is loaded into railway trucks for bulk export from the Geraldton Port.

Mining of the dune sand will extract to the base of the Indicated Resource/Probable Ore Reserve. This level is roughly the same as the freehold land boundary on the western side of the mining area and will leave a slightly undulating surface. On the eastern side of the mining area the sand will slope upward as a 10% gradient to the top of the adjacent dunes. The pre- and post-mining topography is shown in Figures 2 and 3.

100% of the material in the Mining Lease application area is considered to be sand that can be beneficiated to a saleable silica sand project. The top 500mm has been excluded from the MRE as it will be reserved for rehabilitation purposes. As there is no waste material, the recovery factor is considered to be 100% and ore loss therefore is considered to be 0%.

[4]ASX announcement of 3 May 2019, "High Recovery from Silica Sand Process Plant Design".

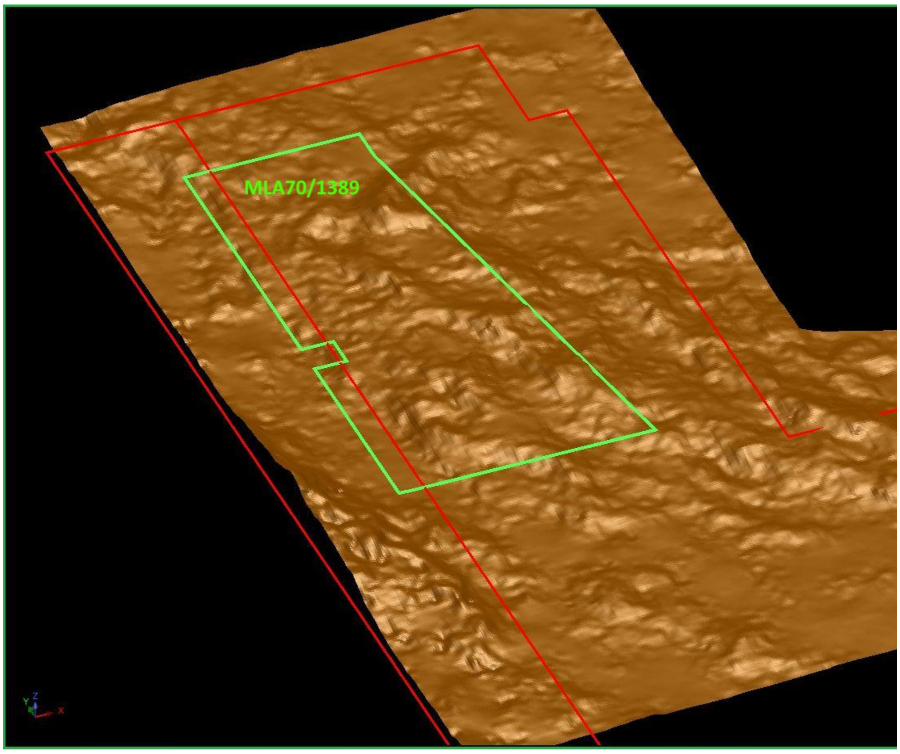

Figure 2: Arrowsmith North Pre-Mining Topography (10:1 vertical exaggeration)

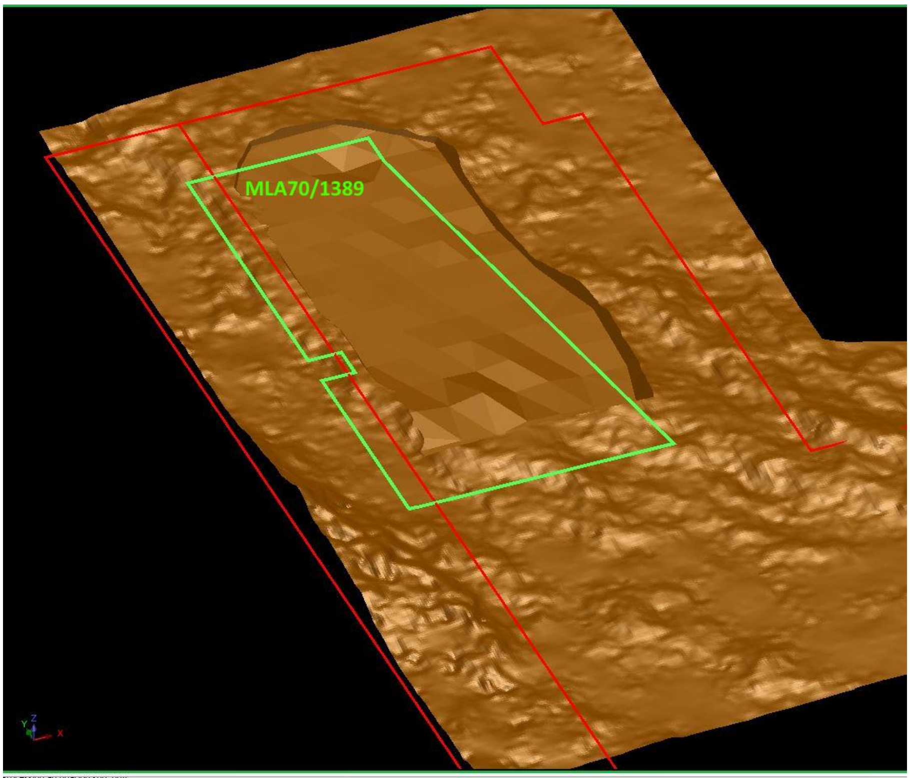

Figure 3: Arrowsmith North Post-Mining Topography (10:1 vertical exaggeration)

Material Modifying Factors – Environmental Studies

Development location:

- South of the Yardongo Nature Reserve
- Approximately 10 km inland of the coast
- North of the Arrowsmith River (Registered Aboriginal Heritage Site)
- Outside of World Heritage Areas, National Heritage Places, Ramsar Wetlands, Conservation Reserves or Commonwealth Marine Reserves

The Probable Ore Reserve is located within an area of deep sands, leached of nutrients. The vegetation is coastal low scrub heath (known as Kwongan heath). There are relict dune structures which are represented as low rolling hills.

Assessment Process:

- Referral submission to the Federal Department of the Environment and Energy (**DotEE**);
- Submission of Section 38 referral to State Environmental Protection Authority (**EPA**)
- Seek an Accredited *Environment Protection and Biodiversity Conservation* Act 1999 (Cth) Assessment under the State *Environmental Protection Act* 1986 (WA) via an Environmental Review Document with public comment
- Undertake any further studies required
- Submission of Environmental Review Document

Mitigation Strategies

- Proposed Action lies within a large Development Envelope, allowing for the flexibility to target areas of lower significance to matters of national environmental significance (**MNES**)
- Disturbance will be kept to a minimum, up to 35 ha per year and 14 ha at any one time
- Progressive rehabilitation using topsoil re-location to ensure topsoil and plants are translocated intact to previously mined areas
- Conduct further surveys to identify Matters of National Environmental Significance
- Use findings to steer the project and avoid MNES where possible

There are no mine tailings storage requirements.

There are no waste dumps.

Processing requires no chemicals.

Material Modifying Factors – Infrastructure

The project is located on unallocated crown land which is east of freehold land and bounded to the north by a Nature Reserve and South by a proposed Nature Reserve. The east boundary of the project area is the limit of tenure. The Brand Highway is proximal to the area and access is via the Mount Adams Road from the north or Brand Highway to the south. The Eneabba/Geraldton rail line lies to the south west of the project and will be used to transport the processed silica sand to the Geraldton Port for bulk export.

The project will require its own installed power and water infrastructure.

Labour will be sourced from the nearest towns Dongara and Eneabba (approximately 30km from the mine site) and there will be no accommodation installed at the mine site.

Costs

Operating costs

Operating costs have been determined from first principles and are estimated to include all costs to mine, process, transport and load product on to ships. They are estimated on 1 million tonnes per year throughput, with expected unit cost savings if throughput is increased as anticipated to potentially 2 million tonnes per year.

Royalties

The prevailing rate of royalty due to the State is used in the Company's economic assessments. The State Royalty rate is A$1.17 per dry metric tonne and reviewed every 5 years with the next review due in 2020. There are no other royalties payable (including private) though a royalty may be negotiated with Native Title claimants.

Revenue

Product Quality

Multiple products will be differentiated during processing subject to required particle size distribution by screening. Recovery of products has been independently assessed by CDE Global, a world leading silica sand testing laboratory.

Commodity Prices

Commodity prices for silica sand products have been determined by independent industry source Stratum Resources. The industry standard is that sales contracts are in US dollars. The exchange rate to convert to Australian dollars will be the prevailing rate at the time of payment.

Subject to final quality produced, the prices for the commodity will range from US$38 to US$58 per dry metric tonne Free on Board (**FOB**). There are no shipping cost estimates with all contracts to be based on FOB rates.

Revenue will be based on a negotiated per shipment basis per dry metric tonne FOB with payment by demand on an accredited bank letter of credit.

There will be no other treatment, smelting or refining charges.

Market Assessment

The Company has commissioned an independent assessment of the current market prices for proposed products by industry leader, Stratum Resources. The assessment includes projections for future demand and supply of silica sand and concludes that there is a future tightening of supply of suitable glassmaking silica sand with a commensurate future increase in price.

Sales volumes have been estimated as a result of received letters of intent and expressions of interest to purchase products.

Economic Factors

The Company's economic analysis has calculated a 10% and 20% discounted ungeared post tax net present value (**NPV**). A 20% discounted NPV has also been calculated to demonstrate the strength of the economic analysis.

The assessment has not considered any escalated future product prices nor any inflation to operating costs. The analysis has used a US$/A$ exchange rate of US$0.70/A$1.00.

The analysis is based on a 25-year production profile despite the Probable Ore Reserve far exceeding that project life.

Capital requirements are based on independent estimates.

The analysis is most sensitive to the exchange rate and sales prices.

The analysis indicates the financials of the project are very robust and there is a high confidence that a viable long-term mining operation can be justified.

Social Factors

The Company made an application for a mining lease (M70/1389) on 21 December 2018. The application lies within the Southern Yamatji Native Title claim boundaries (WC2017/002), which replaced a pre-combination claim (WC2004/002) by the Amangu People. The Company is currently in negotiations with the claimant group with respect to the mining lease application and the Company expects that an agreement will be reached between the parties allowing for the mining lease to be granted.

The project is wholly on unallocated crown land therefore there is little negative impact on local communities.

Project Funding

The financial model summarised in the BFS sets out the project metrics and provides a basis for the potential capital structure of the Company for the development of the Project. Total capital expenditure at Arrowsmith North (for a 2 million tonnes per annum processing plant) is estimated at approximately A$28 million (the BFS details capital cost estimates).

The Company anticipates that the source of funding the capital investment at Arrowsmith North will be any one, or a combination of, equity, debt and pre-paid offtake from the project. Whilst no final decision has been made in that regard, the financial model assumes a maximum A$26 million in debt.

The Company has received a number of enquiries and expressions of interest from debt financiers for the Project. As noted above, the financial model provides for debt capacity and is designed to meet the expectations of any providers of potential debt funding for their due diligence and other internal requirements.

In addition, VRX has also received enquiries and expressions of interest from organisations across Asia for silica sand products from the project and holds signed letters of intent for substantial tonnages. A number of these organisations have expressed interest in becoming a funding partner of the Company for development of a mine by way of pre-paid offtake arrangements.

The balance of the Company's capital requirements will be funded from equity capital.

Whilst the envisaged project development requires a low capital intensity relative to a greenfields hard rock mining project, and any one of, or a combination of equity, debt and pre-paid offtake is planned, VRX has not as yet secured the required capital. The positive financial metrics of the BFS and feedback from potential funding partners provides encouragement as to the likelihood of meeting optimum project and corporate capital requirements.

Financial model

Based on the capital and operating cost estimates a financial model was developed for the purpose of evaluating the economics of the Project.

Key economic assumptions for the model are set out above and in detail in the BFS.

Key outcomes from the BFS and summary financial model outputs are set out in the "Highlights" section on the first page of this announcement. The BFS contains further details, including a life of mine production profile and sensitivity analysis for the model.

COMPETENT PERSONS' STATEMENTS

The information in this report that relates to Arrowsmith North Exploration Results is based on data collected and complied under the supervision of Mr David Reid, who is a full time employee of VRX Silica. Mr Reid, BSc (Geology), is a registered member of the Australian Institute of Geoscientists and has sufficient experience that is relevant to the style of mineralisation and type of deposit under consideration and the activity being undertaken to qualify as a Competent Person under the 2012 edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (JORC Code). Mr Reid consents to the inclusion of the data in the form and context in which it appears.

The information in this report that relates to Arrowsmith North Mineral Resources is based on information compiled by Mr Grant Louw who is a full-time employee of CSA Global, under the direction and supervision of Dr Andrew Scogings, who is an Associate of CSA Global. Dr Scogings is a Member of the Australasian Institute of Mining and Metallurgy and a Member of the Australian Institute of Geoscientists. He is a Registered Professional Geologist in Industrial Minerals. Dr Scogings has sufficient experience relevant to the style of mineralisation and type of deposit under consideration and to the activity which he is undertaking to qualify as Competent Person as defined in the 2012 Edition of the Australasian Code for the Reporting of Exploration Results, Mineral Resources, and Ore Reserves (JORC Code). Dr Scogings consents to the disclosure of information in this report in the form and context in which it appears.

The information in this report that relates to the Probable Ore Reserve is based on data compiled by Mr David Reid, who is a full time employee of VRX Silica. Mr Reid, BSc (Geology), is a registered member of the Australian Institute of Geoscientists and has sufficient experience that is relevant to the style of mineralisation and type of deposit under consideration and the activity being undertaken to qualify as a Competent Person under the 2012 edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (JORC Code). Mr Reid consents to the inclusion of the data in the form and context in which it appears.

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About VRX Silica

VRX Silica Ltd (**VRX Silica**) (ASX: VRX) has significant silica sand projects in Western Australia.

The Arrowsmith Silica Sand Project, located 270kms north of Perth, comprises five granted exploration licences and two mining lease applications pending. The Muchea Silica Sand Project, located 50kms north of Perth, comprises one granted exploration licence, with one exploration licence and one mining lease application pending. Testwork has confirmed a range of silica sand products which are capable of production at both projects. A feasibility study for Arrowsmith Central is also being compiled.

The Boyatup Silica Sand Project, located 100kms east of Esperance, comprises two adjacent granted exploration licences. Initial indications are that this project will complement both Arrowsmith and Arrowsmith while adding to the silica products VRX Silica will potentially produce. A POW for a drilling program has been approved and the Company is currently arranging a Heritage Survey for drilling clearance.

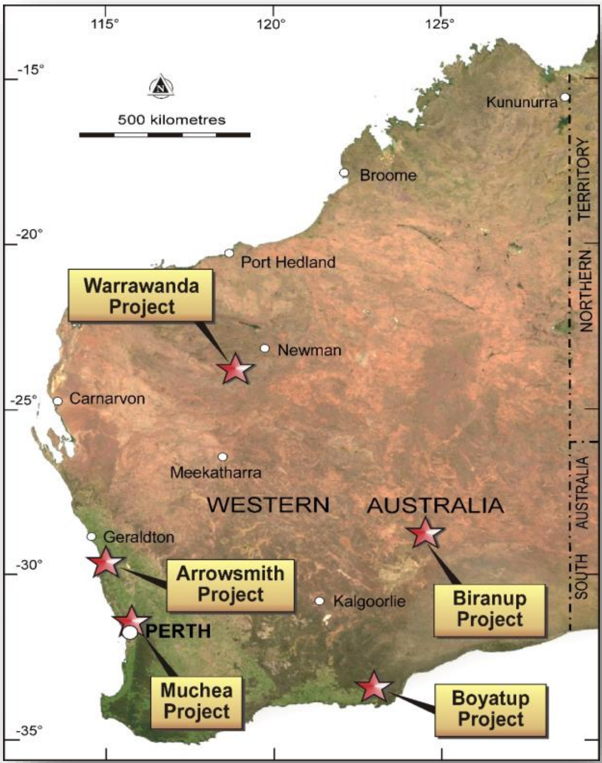
Also, in Western Australia, 40km south of Newman, is VRX Silica's Warrawanda Project, which is prospective for high purity quartz and nickel sulphides. A POW for a drilling program has been approved and the Company has undertaken a Aboriginal Heritage Survey with a proposed drilling program cleared.

VRX Silica also has granted tenements at its Biranup Project, adjacent to the Tropicana Gold Mine in Western Australia's Goldfields that are prospective for gold and base metals.

Proven Management

The VRX Silica Board and management team have extensive experience in mineral exploration and mine development into production and in the management of publicly listed mining and exploration companies.

Project Locations



Bankable Feasibility Study

Arrowsmith North

Silica Sand Project

28 August 2019

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Important Information

Nature of Document

This document has been prepared and issued by VRX Silica Limited (**Company**) to provide general information about the Company and the Arrowsmith North Silica Sand Project (**Project**). The information in this document is in summary form and should not be relied upon as a complete and accurate representation of any matters that a reader should consider in evaluating the Company or the Project. While management has taken every effort to ensure the accuracy of the material in this document, the Company and its advisers have not verified the accuracy or completeness of the material contained in this document.

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Contents

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1 Overview

VRX Silica Limited (**VRX** or **Company**) is an ASX-listed silica sand exploration and development company (ASX: VRX). VRX is focused on developing silica sand assets in Western Australia.

This Bankable Feasibility Study (**BFS**) details the project and financial attributes supporting the development of VRX's Arrowsmith North Silica Sand Project (**Arrowsmith North** or **Project**).

Arrowsmith North is one of three separate, advanced silica sand projects being progressed by the Company, being Arrowsmith North, Arrowsmith Central and Muchea. This BFS is solely for Arrowsmith North.

The Company is proposing to mine and process raw sand from Arrowsmith North. The raw sand can be processed to a quality suitable for the glass making and foundry industries.

The silica sand Probable Ore Reserve is considerable and considered to be World class. This will support a very long-life mining and processing project with substantial benefits to the region and Western Australia generally.

Silica sand products will be transported by rail from Arrowsmith North to the Geraldton Port for export to Asian glass manufacturing and foundry industries.

Glass manufacturing product specifications are centred around the silica dioxide content of the silica sand, with consideration specifically attributed to other contained elements such as iron, titanium, aluminium and calcium, all of which affect the quality of the final glass products. Foundry industry product specifications are mostly centred around the size and shape of the silica sand grains.

Arrowsmith North can produce saleable products that meet the required specifications for both industries.

The Company has received enquiries and expressions of interest from organisations and also agents across Asia for these products and holds signed letters of intent for substantial tonnages. Subject to completion of the approvals process for mining, offtake agreements will be finalised before the Company makes a decision to proceed to mine.

VRX has lodged a Mining Lease application for the Project. The Company is currently undertaking negotiations for a mining agreement with the Native Title holders, which is required before the grant of the Mining Lease.

The Company is progressing the environmental approval process for the Project with both State and Federal Government authorities and completing additional requisite studies necessary for the grant of a Mining Permit.

Details of the work undertaken on the Project by the Company to-date and an economic evaluation that supports development of a mining operation follows.

2 Project Background

2.1 Project Location

Arrowsmith North is located 270 km north of Perth, WA and is between the regional towns of Dongara and Eneabba, WA (Figure 1).

The Project is located adjacent to the Brand Highway and the Geraldton-Eneabba Railway, with a rail connection direct to Geraldton Port.

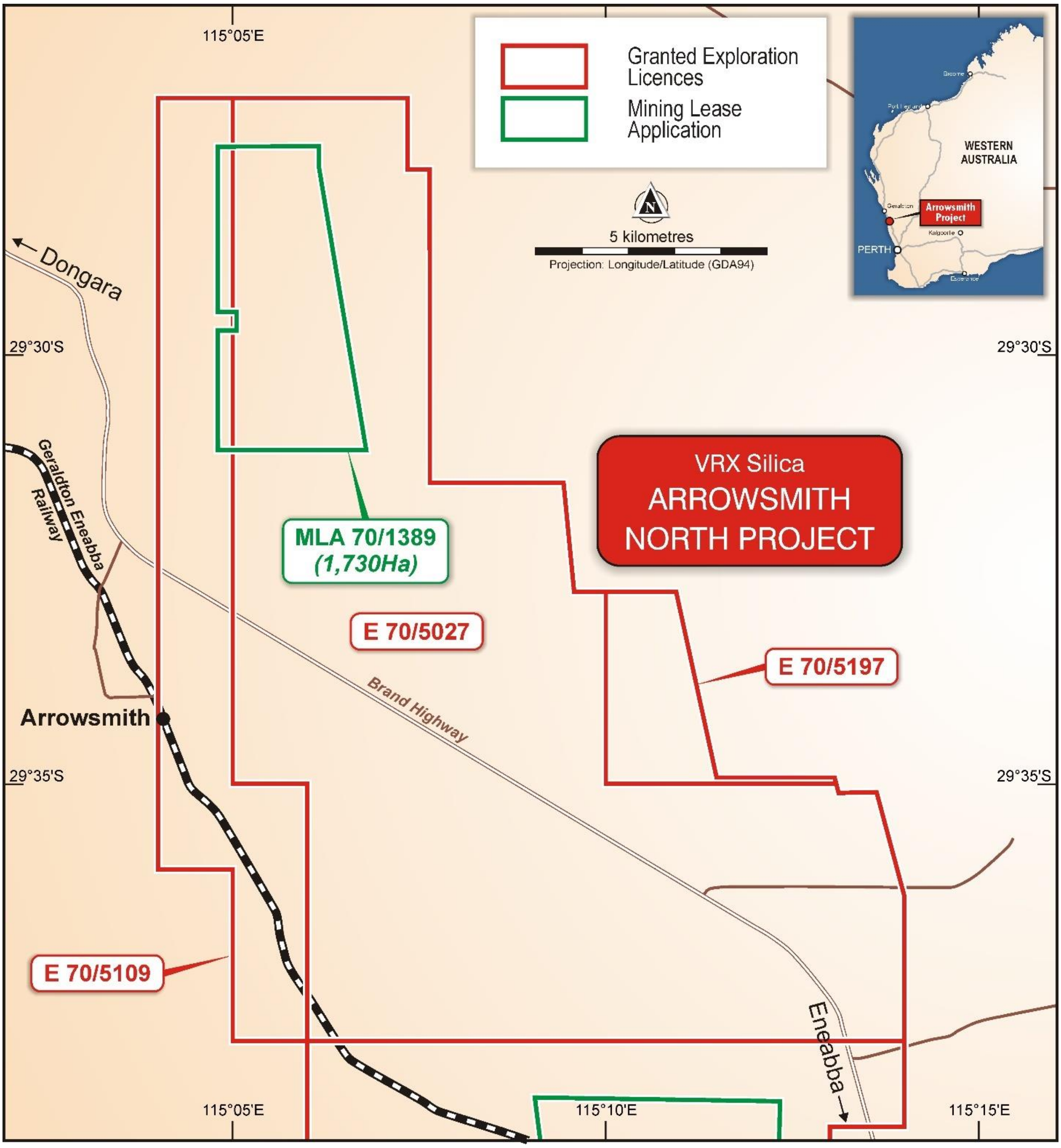


Figure 1: Arrowsmith North project and tenement location map

2.2 Environmental Data

Arrowsmith North is located on the Lesueur Sandplain subregion.

The climate is warm Mediterranean with a hot, dry summer and a cool, wet winter. Median and mean annual rainfall in this region are 481 mm and 489 mm respectively. The Lesueur Sandplain is dominated by proteaceous heath on sand over deeper limestone; the dominant land uses are dryland agriculture, conservation and crown reserves.

Vegetation over the Project area primarily consists of scattered eucalypts over mixed kwongan shrubland on sand. There is a seasonal drainage line running through the southern part of the Project area.

Fauna assemblage is typical of the Lesueur Sandplains subregion and is moderately rich, but incomplete with some species locally extinct. The area is notable for a rich reptile assemblage and high proportion of non-resident birds, many of which are nectarivorous and exploit seasonal abundance of nectar and pollen from the species-rich flora. Few species of high conservation significance are present or expected, but the Carnaby's Black-Cockatoo is important, with known roost sites nearby and the species very likely to be a regular foraging visitor to the Project area.

2.3 Site Topography and Drainage

The Project area lies within the northern Perth Basin, containing a succession of Quaternary to Permian age deposits up to a total of 12,000 m thick. It comprises a topographic high atop an aeolian sand dune system up to 15 m thick from the western edge of the deposit with a gentle west and east sloping erosional surface from 80mRL to 60mRL.

The surface is leached loose sand with very high transmissivity and drains from the centre of the Project to the west and east. To the west is the seasonal Arrowsmith River which flows only during very high rainfall events and to the east are low land swamps.

A topographic image (pre-mining) is shown in Figure 13.

2.4 Existing Infrastructure

Aside from road and rail, there is limited infrastructure in or around the Project area.

There are no established power, water or sewerage services and the Company will have to install all of its required services.

The site can be accessed via an existing road that extends south to the Brand Highway. South of Brand Highway is the Eneabba–Geraldton Railway line.

Employees will be stationed at Eneabba and Dongara and there will be no requirements for site accommodation.

2.5 Ownership and Leases

Land in the Arrowsmith North area is vacant, unallocated Crown land with the State and Native Title claimants the only stakeholders.

The entire Arrowsmith Silica Sand Projects area (incorporating Arrowsmith North and VRX's other silica sand projects adjacent to the Project, namely Arrowsmith Central and Arrowsmith South) has five granted exploration licences covering 420 km^2.

The granted tenements are held in a VRX 100% owned subsidiary, Ventnor Mining Pty Ltd, and comprise E70/5027 (Arrowsmith North), E70/4987 (Arrowsmith Central), E70/4986 (Arrowsmith South), E70/5109 adjacent to the west of Arrowsmith North and E70/5197 adjacent to the east of Arrowsmith North. All tenement holdings are contiguous with combined reporting status.

For Arrowsmith North, the Company also has pending applications for a Mining Lease (MLA70/1389), two Miscellaneous Licenses, one for the Search for Water over the Mining Lease area and the second for an access route south from the Mining Lease area to a location adjacent to the rail line reserve.

Table 1 sets out tenement details for Arrowsmith North.

Tenement	Holders	Grant date	Expiry date	Area (km^2)
E70/5027	Ventnor Mining Pty Ltd	14/06/2018	13/06/2023	179.2
E70/5109	Ventnor Mining Pty Ltd	14/08/2018	13/08/2023	35.9
E70/5197	Ventnor Mining Pty Ltd	07/06/2019	06/06/2024	25.6
MLA70/1389	Ventnor Mining Pty Ltd	20/12/2018*	Mining Lease	17.3
L70/199	Ventnor Mining Pty Ltd	13/03/2019*	Search for water	
L70/208	Ventnor Mining Pty Ltd	1/07/2019*	Access route	

Table 1: Arrowsmith North tenement details

** Application date (not yet granted)*

2.6 Political Overlay

The location of Arrowsmith North is within the jurisdiction of Western Australia and the Commonwealth of Australia.

Current Government positions relevant for the Project area and operations include:

Federal Minister

Melissa Price; MHR Durack

State Ministers

Premier; Minister for State Development; Jobs and Trade; Mark McGowan; MLA for Rockingham

Treasurer; Ben Wyatt; MLA for Victoria Park

Minister for Transport; Rita Saffioti; MLA for West Swan

Minister for Energy; Mines and Petroleum; Industrial Relations; Bill Johnston; MLA for Cannington

Minister for Ports; Alannah MacTiernan MLC for the North Metropolitan Region

Minister for Environment; Stephen Dawson MLC for Mining and Pastoral Region

State MPs

MLA for Moore; Shane Love

MLA for Geraldton; Ian Blayney

MLC for the Agricultural Region Darren West

Government Departments

Department of Transport (Includes Ports); Richard Sellers; Director General

Department of Mines, Industry Regulation and Safety (DMIRS); David Smith; Director General

Department of Jobs, Tourism, Science and Innovation (includes State Development) (DJTSI); Rebecca Brown; Director General

Department of Water and Environmental Regulation (DWER); Mike Rowe; Director General

Environmental Protection Authority; Chairman Dr Tom Hatton

Mid-West Development Commission; Chief Executive Officer; Gavin Treasure

Midwest Chamber of Commerce & Industry; Chief Executive Officer; Joanne Fabling

Mid-West Ports Authority; Chief Executive Officer; Dr. Rochelle Macdonald

Local Government

Shire of Carnamah; Chief Executive Officer; Kate Oborn

Shire of Irwin; Executive; Darren Simmons

City of Greater Geraldton; Chief Executive Officer; Ross McKim

3 Native Title and Aboriginal Heritage

3.1 Claimant Parties

Arrowsmith North is located wholly within the Southern Yamatji Native Title Claim (WC2017/002).

3.2 Surveys

The Company has in place a standard Heritage Agreement which covers all of the Company's Exploration Licences at Arrowsmith North.

The Company has conducted an extensive Aboriginal Heritage clearance survey on all drill lines used in the March 2019 drill program. All lines were walked, and no sites of significance were noted. This was confirmed in a clearance report.

The Arrowsmith River and Beharra Springs, which are not within the Project area, are noted as sensitive areas.

3.3 Existing Registered Aboriginal Sites

The closest Registered Aboriginal Sites are the Arrowsmith River, to the south of Brand Highway, Registered Site 30068 which is an unrestricted mythological unprotected site and north of Brand Highway, the Beharra Springs artefact scatter site.

The sites are not within the Mining Lease area.

3.4 Negotiations

The Company is currently undertaking its Right to Negotiate with both the claimant group (Southern Yamatji) and the Government Party (Tenure and Native Title Branch of the Department of Mines, Industrial Regulation and Safety). The Company has no reason to believe that an agreement will not be reached between the parties.

Upon successful completion of the negotiations the Mining Lease will be granted, and a State Deed executed.

4 Community

Arrowsmith North is located on vacant, unallocated Crown land.

The closest communities are Dongara, 40 km by bitumen road to the north and Eneabba, 42 km by bitumen road to the south. Both towns are expected to be the main source of personnel for mining and processing operations.

Dongara is located at the mouth of the Irwin River, contiguous with the town of Port Denison and is in the seat for the Shire of Irwin. It has a population of approximately 2,800 people. The main industries are the rock lobster fishery and agriculture (broadfield grain production).

Eneabba is the centre of what was once an extensive mineral sand industry. Major mineral sand operators still in the district are Iluka Resources and Tronox Holdings. The sand plains to the east of Eneabba are used predominately for agricultural purposes.

5 Geology, Resources and Reserves

5.1 Geology

Most economically significant silica sand deposits in Western Australia are found in the coastal regions of the Perth Basin, and the targeted silica sand deposits are the aeolian sand dunes that overlie the Pleistocene limestones and paleo-coastline, which also host the regional heavy mineral deposits.

Within the Project area, data obtained from the Department of Agriculture soil mapping shows there are pale and yellow deep sands predominating with lesser swampy areas and occasional ironstone ridges (Figure 2).

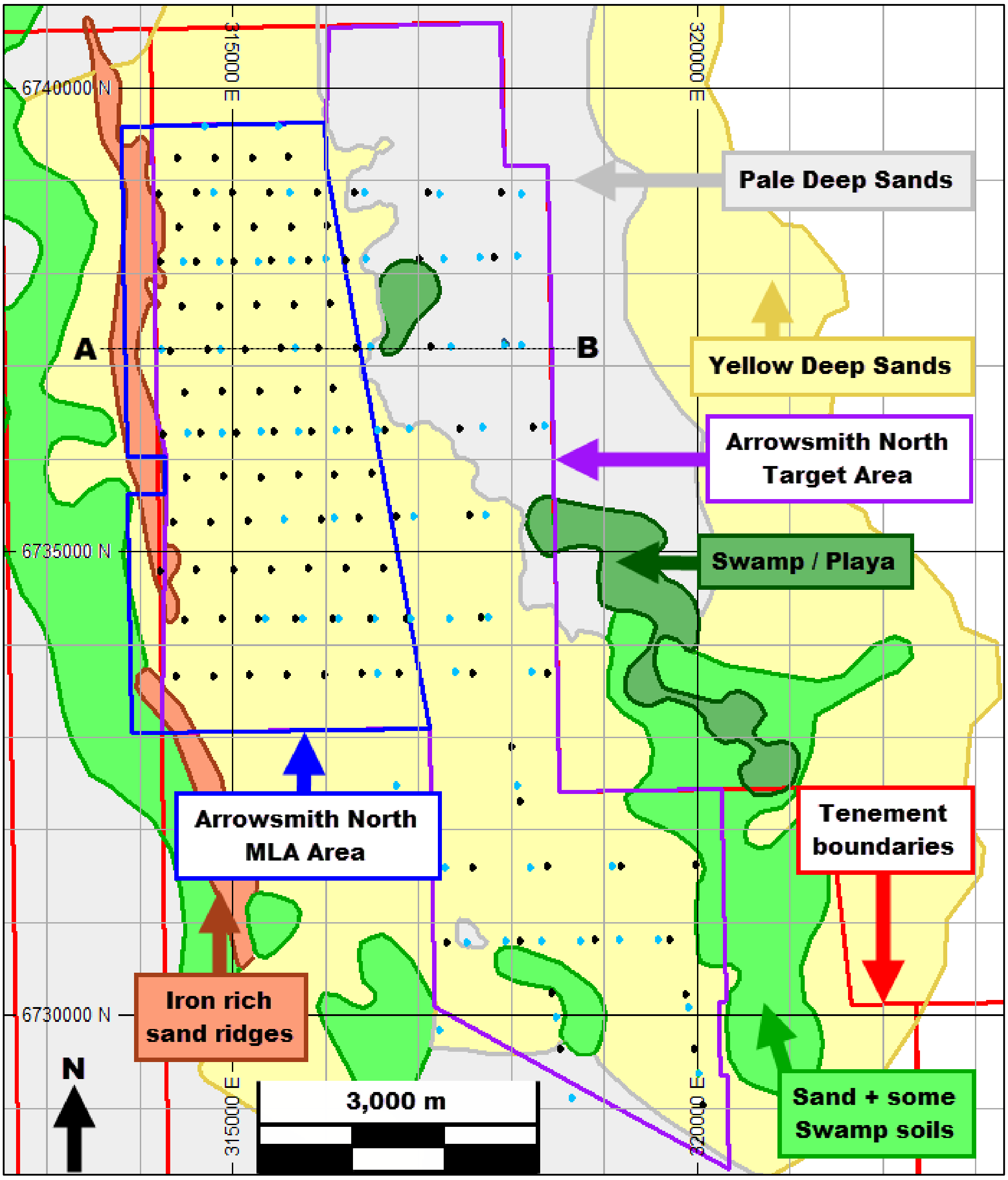


Figure 2: Simplified geology of the Arrowsmith North area. Section line A – B shown.

Black dots – Air Core collars, Blue Dots - Auger collars.

Tenements as in Figure 1.

***Source:** Outlines based on DOAG soil mapping data, refined based on drill data.*

5.2 Resources

5.2.1 Mineral Resource Estimate

The updated Mineral Resource estimate (**MRE**) for the Arrowsmith North deposit comprises 771 Mt @ 98% SiO_2 reported in accordance with the JORC Code[1].

The MRE is based on the results obtained from 62 hand auger drill holes for 234.6 m and 108 aircore (AC) drill holes for 1,176 m and defines two silica sand types, namely white and yellow sand, geologically logged and differentiated based on colour and through chemical analysis results.

Based on metallurgical testwork completed to-date, both sand types are readily amenable to upgrading by conventional washing and screening methods to produce a high-purity silica sand product with high mass recoveries. The high-purity silica sand product specifications are expected to be suitable for industries such as glass making and foundry sand.

The MRE results are shown in Table 2.

Classification	Domain	Million Tonnes	SiO_2%	Al_2O_3%	Fe_2O_3%	TiO_2%	LOI%
Indicated	**White Sand**	33	98.7	0.50	0.20	0.20	0.20
	Yellow Sand	215	97.5	1.10	0.40	0.20	0.50
	All Sand	248	97.7	1.00	0.40	0.20	0.50
Inferred	**White Sand**	280	98.7	0.50	0.10	0.20	0.20
	Yellow Sand	243	97.7	1.00	0.40	0.20	0.50
	All Sand	523	98.2	0.80	0.30	0.20	0.40
Indicated + Inferred	**White Sand**	**313**	**98.7**	**0.54**	**0.15**	**0.18**	**0.24**
	Yellow Sand	**458**	**97.6**	**1.08**	**0.40**	**0.17**	**0.52**
	All Sand	**771**	**98.0**	**0.86**	**0.30**	**0.17**	**0.41**
**Note: Interpreted silica sand mineralisation is domained above a basal surface wireframe defined based on drill logging data. The upper (Topsoil) layer within 0.5 m of surface is depleted from the modelled silica sand unit, being reserved for rehabilitation purposes. All classified silica sand blocks in the model are reported. Differences may occur due to rounding.*							

Table 2: Arrowsmith North Mineral Resource

The following summary presents a fair and balanced representation of the information contained within the MRE technical report prepared by CSA Global:

- Silica sand mineralisation at Arrowsmith North occurs within the coastal regions of the Perth Basin, and the targeted silica sand deposits are the aeolian sand dunes that overlie the Pleistocene limestones and paleo-coastline. (ASX LR 5.8.1 geology & geological interpretation).

- Samples were obtained from auger drilling and air core drilling. Quality of drilling/sampling and analysis, as assessed by the Competent Person, is of an acceptable standard for use in a Mineral Resource estimate publicly reported in accordance with the JORC Code. (ASX LR 5.8.1 Sampling & 5.8.1 Drilling).

- Major and trace elements apart from SiO_2 were analysed using a four-acid digest followed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry (ICP-OES) analysis at the Intertek Genalysis, Perth laboratory. Loss on Ignition at 1000°C (LOI) was analysed by Thermal Gravimetric Analyser. SiO_2 was back-calculated by subtracting all ICP major and trace elements plus LOI from 100%, as this is the most accurate way of determining SiO_2 content for samples with very high SiO_2. Certain of the ICP results were verified by X-Ray Fluorescence (XRF) analyses (ASX LR 5.8.1 Analysis).

- The Mineral Resource was estimated above 3-d wireframe basal surfaces for the white and yellow sands, with the surfaces being based on the geological boundaries defined by logged sand types and chemical analysis results from the drill data. The air core drilling demonstrated that the white sand layer extends to the west, past the interpreted contact, under the yellow sand in

[1] Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves, 2012 Edition (**JORC Code**).

approximately the northern half of the modelled area. The basal surface of the yellow sand is defined by this lithological contact, or is limited by interpretation of nominal average thickness of the sand layer based on the data from surrounding deeper drill holes as required. The white sand layer basal surface is similarly defined by the drilling data and or is limited by interpretation of nominal average thickness of the sand layer based on data from surrounding deeper drill holes as required. The horizontal extents of the interpreted sand layers are limited to within the VRX nominated Arrowsmith North target area and with reference to the publicly available soil mapping data. The surface humus layer is typically about 300 mm thick. In consultation with VRX, CSA Global considered that the upper 500 mm (overburden) is likely to be reserved for rehabilitation purposes. This overburden surface forms the upper boundary of the estimated Mineral Resource and is depleted from the reported Mineral Resource. Comparatively minor areas that are mapped as iron richer sand ridges, swamp or sandy swamp are also depleted from the Mineral Resource. (ASX LR 5.8.1 Estimation methodology).

- Grade estimation was completed using ordinary kriging with an inverse distance weighting to the power of two validation estimate also completed. (ASX LR 5.8.1 Estimation methodology).
- The Mineral Resource is quoted from all classified blocks within the defined layers for white and yellow sand and below the overburden surface layer. (ASX LR 5.8.1 cut-off grades).
- The Mineral Resource was classified as Indicated and Inferred based on drill hole logging, drill hole sample analytical results, drill spacing, geostatistical analysis, confidence in geological continuity, and metallurgical/process test results. (ASX LR 5.8.1 classification).
- Roughly 15% of the interpreted mineralisation is extrapolated.
- The JORC Code Clause 49 requires that industrial minerals must be reported “in terms of the mineral or minerals on which the project is to be based and must include the specification of those minerals” and that “[i]t may be necessary, prior to the reporting of a Mineral Resource or Ore Reserve, to take particular account of certain key characteristics or qualities such as likely product specifications, proximity to markets and general product marketability.” (ASX LR 5.8.1 Mining, metallurgy & economic modifying factors).
- Therefore, the likelihood of eventual economic extraction was considered in terms of possible open pit mining, likely product specifications, possible product marketability and potentially favourable logistics and it is concluded that Arrowsmith North is an industrial mineral Mineral Resource in terms of Clause 49. (ASX LR 5.8.1 Mining, metallurgy & economic modifying factors)

5.2.2 Drilling

Drilling over the Project area has been completed by means of aircore and hand auger (Figures 3 and 4). Auger drill hole depths range from 1.2 m to 7 m with an average depth of 3.8 m.

Aircore drilling hole depths range between 3 m and 21 m with an average depth of 10.9 m.

Auger drilling has been completed along existing tracks, that form a nominal 800 m section line spacing, with drill spacing of 400 m to 1,000 m apart along the section lines (Figure 5).

AC drilling was completed on these tracks as well as along new section lines forming an overall nominal 400 m section line spacing with drill holes nominally at 400 m spacing over the majority of the modelled area.

Figure 3: Hand auguring yellow sand at Arrowsmith

Figure 4: Landcruiser mounted Mantis 82 NQ sized aircore drill rig

Geological logging

Geological logging defining the aeolian dune sand types based on field observations of the colour tone has been completed on all drilling intervals. Geological logging of drill samples is done by the field geologist with samples retained in chip trays for later interpretation. Logging is captured in a Microsoft Excel spreadsheet, validated and uploaded into a Microsoft Access database.

Sampling

Aircore drilling samples are 1 m down hole intervals with sand collected from a cyclone mounted rotary cone splitter, ~2-3 kg (representing 50% of the drilled sand) was collected. Two sub-samples, A and B, of ~200 g were taken from the drill samples. The remainder was retained for metallurgical testwork purposes.

The 100 mm screw auger drilling samples are 1 m down hole intervals with sand collected from a plastic tub which received the full sample, ~8 kg, from the hole. All auger samples were weighed to determine if down hole collapse was occurring, if the samples weights increased significantly the hole was terminated to avoid up hole contamination. The sand was homogenised prior to sub sampling, two sub-samples, A and B, of ~200 g were taken from the drill samples. A bulk sample of ~5 kg was retained for each 1 m interval for metallurgical testwork. The "A" sample was submitted to the Intertek Laboratory in Maddington, Perth for drying, splitting (if required), pulverisation in a zircon bowl to a nominal -75 µm. The "B" sample was used for field duplicate samples inserted to the sample stream at a rate of 1 in 20.

The analysis for multi-elements are determined by an initial specialised four-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids in Teflon tubes on the pulverised samples. The digest is then analysed by means of Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry (ICP-OES) analysis, with silica reported by difference. Loss on Ignition at 1000°C (LOI) was analysed by Thermal Gravimetric Analyser (TGA).

Mineral Resource modelling

The Mineral Resource was estimated above 3-d wireframe basal surfaces for the white and yellow sands, with the surfaces being based on the geological boundaries defined by logged sand types and chemical analysis results from the drill data.

The air core drilling demonstrated that the white sand layer extends to the west, past the interpreted contact, under the yellow sand in approximately the northern half of the modelled area. The basal surface of the yellow sand is defined by this lithological contact or is limited by interpretation of nominal average thickness of the sand layer based on the data from surrounding deeper drill holes as required. The white sand layer basal surface is similarly defined by the drilling data and or is limited by interpretation of nominal average thickness of the sand layer based on data from surrounding deeper drill holes as required.

The horizontal extents of the interpreted sand layers are limited to within the VRX nominated Arrowsmith North target area and with reference to the publicly available soil mapping data (Figure 2).

The surface humus layer is typically about 300 mm thick. In consultation with VRX, CSA Global considered that the upper 500 mm (topsoil) is likely to be reserved for rehabilitation purposes (Figure 5). This overburden surface forms the upper boundary of the estimated Mineral Resource and is depleted from the reported Mineral Resources. Comparatively minor areas that are mapped as iron richer sand ridges, swamp or sandy swamp are also depleted from the Mineral Resource.

Despite both white and yellow sands being readily amenable to beneficiation, they have been separately interpreted, as they are separately estimated due to differences in grades of the various mineral components. Samples have been flagged based on being either yellow or white sand for further statistical analysis and grade estimation. The maximum extrapolation of grade estimated material beyond drill data points is up to 200 m, and the material types are additionally constrained within the VRX nominated target area and by the mapped material type boundaries.

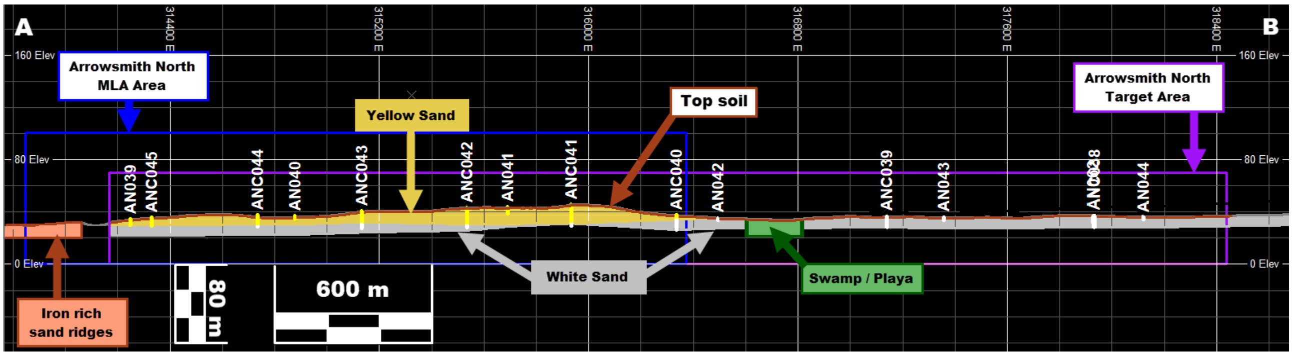


Figure 5: Cross section A – B at 6738150 mN (See Figure 2), Looking north; Five times Vertical exaggeration

Quality Assurance – Quality Control

VRX has provided CSA Global with an internal file note detailing procedures employed to ensure suitable levels of accuracy and precision are achieved by means of assay quality control work, and details provided in this section are largely derived from this note.

There is no certified, commercially available standard for high purity silica sand. VRX approached OREAS Pty Ltd to prepare a specialised run of 500 x 10 g packets, of their certified blank, OREAS 22e, without their usual 0.5% iron oxide pigment, this new standard has been denoted as VRX-22S. This material is generated from high purity silica sand as its base. As the sample does not include the pigment, and the exact composition of the pigment is unknown the certified values for OREAS 22e cannot be used. It should also be noted that the sample was prepared using a steel bowl pulveriser which will affect the total iron contained within the samples.

VRX has started a process of establishing values for VRX-22S, initially by doing a "Round Robin" to three laboratories in Perth. 20 sample packets were sent to Intertek, 10 to SGS and 10 to Nagrom. They all completed duplicated analysis on the packets with half of the packets using the two different analytical techniques:

- SiO_2 by difference through four acid digestion with ICP-OES finish (4A/ICP-OES), and LOI by TGA
- Fused bead X-ray fluorescence (XRF) analysis, direct reporting of SiO_2

The purpose of this exercise was twofold: first, to determine which analytical technique was most appropriate for high purity silica analysis and, second, to achieve a baseline set of values for the standard VRX-22s. When comparing the XRF results with the 4A/ICP-OES results, it becomes apparent that the XRF produces low variability results for all elements, including Si whereas 4A/ICP-OES has more variability. Generally, 4A/ICP-OES has lower detection limits, but these vary from laboratory to laboratory. When just comparing the SiO_2 value, it is believed that 4A/ICP-OES returns a better estimate of the true value, and further investigation has revealed that the "Industry Standard" for determining SiO_2 is the 4A/ICP-OES method tested here.

Overall CSA Global is of the opinion that the quality control work has demonstrated that the laboratory analyses and the sampling method has been appropriate, and the results of the chemical analysis are suitable for use in a reportable MRE.

Certified Reference Materials

CSA Global has completed a summary statistical analysis of the results from the round robin testing of the VRX-22S standard, with the results presented in Table 3. VRX geology staff expressed concern that the standard was not well enough understood using only the relatively few available analyses. Based on the fact that an additional 83 data points have been generated through the insertion of the standard to the sample stream, it was considered prudent to use the full available analysis result data set to establish a more robust statistical analysis of the values and variability that can be expected from the standard. The mean and standard deviation (SD) derived from this full data set analysis (Table 4) has been used as the basis for establishing the expected value and SD control lines in the control graph validating the laboratory analysis performance.

	Al_2O_3%	Fe_2O_3%	MgO%	TiO_2%	LOI%	SiO_2%
Number	40	40	40	40	40	40
Mean	0.126	0.038	0.005	0.040	0.082	99.699
Min	0.097	0.03	0.003	0.037	0.03	99.6369
Q1	0.122	0.036	0.004	0.039	0.050	99.677
Median	0.129	0.040	0.005	0.040	0.080	99.702
Q3	0.134	0.040	0.005	0.042	0.103	99.723
Max	0.141	0.05	0.0071	0.043	0.14	99.7503
Variance	0.0001	0.0000	0.0000	0.0000	0.0010	0.0008
Std Dev	0.0109	0.00438	0.0009	0.0018	0.0315	0.0279
Coeff Var	0.0869	0.1143	0.1933	0.0438	0.3839	0.0003

Table 3: Summary statistics for round robin testing of VRX-22s by 4A/ICP-OES

	Al_2O_3%	Fe_2O_3%	MgO%	TiO_2%	LOI%	SiO_2%
Number	123	123	123	123	123	123
Mean	0.140	0.040	0.005	0.041	0.087	99.675
Min	0.097	0.03	0	0.037	0.01	99.54195
Q1	0.131	0.039	0.004	0.040	0.060	99.647
Median	0.139	0.040	0.005	0.042	0.080	99.680
Q3	0.154	0.042	0.005	0.043	0.110	99.705
Max	0.1656	0.06	0.0074	0.0474	0.2	99.7841
Variance	0.0002	0.0000	0.0000	0.0000	0.0016	0.0019
Std Dev	0.0148	0.00575	0.0011	0.0020	0.0394	0.0438
Coeff Var	0.1055	0.1421	0.2246	0.0489	0.4531	0.0004

Table 4: Summary statistics for all testing of VRX-22s by 4A/ICP-OES

The VRX-22S standard was inserted to the drill sample submissions to the Intertek Laboratory in Maddington, in sequence, at a ratio of 1:20, with a total of 83 samples being analysed for the Arrowsmith North project samples submissions. Since most analytes are very close to the assay method detection limit, some inherent additional variability is expected to be seen in the results. Additionally, the preparation of the standard using a steel pulveriser is likely to introduce some variable low levels of iron to the sample. The statistical results of the standard analysis are shown in Table 5.

Grade variable	Fe_2O_3%	TiO_2%	Al_2O_3%	LOI%	SiO_2%	MgO%
Detection Limit	0.02	0.001	0.01	0.01	0.1	0.004
Number	83	83	83	83	83	83
Expected Value	0.038	0.040	0.126	0.082	99.699	0.0048
Mean	0.04	0.04	0.15	0.09	99.67	0.005
Min	0.030	0.039	0.122	0.010	99.551	0.0000
Median	0.041	0.042	0.148	0.080	99.676	0.0047
Max	0.060	0.047	0.166	0.200	99.784	0.0074
Variance	0.0000	0.000	0.0001	0.002	0.002	0.0000
Std Dev	0.006	0.002	0.011	0.042	0.044	0.0011
Expected Std Dev	0.004	0.002	0.011	0.032	0.028	0.0009
Coeff Var	0.145	0.043	0.072	0.476	0.000	0.2384

Table 5: Comparison of performance of VRX-22S Round Robin against sample stream submission

The control plot for SiO_2 is presented in Figure 6 and shows that overall the performance has been acceptable, with one value exceeding the -3SD failure limit. This sample had the highest LOI result from all data while all other analytes reported within acceptable bounds, hence the result has been discounted.

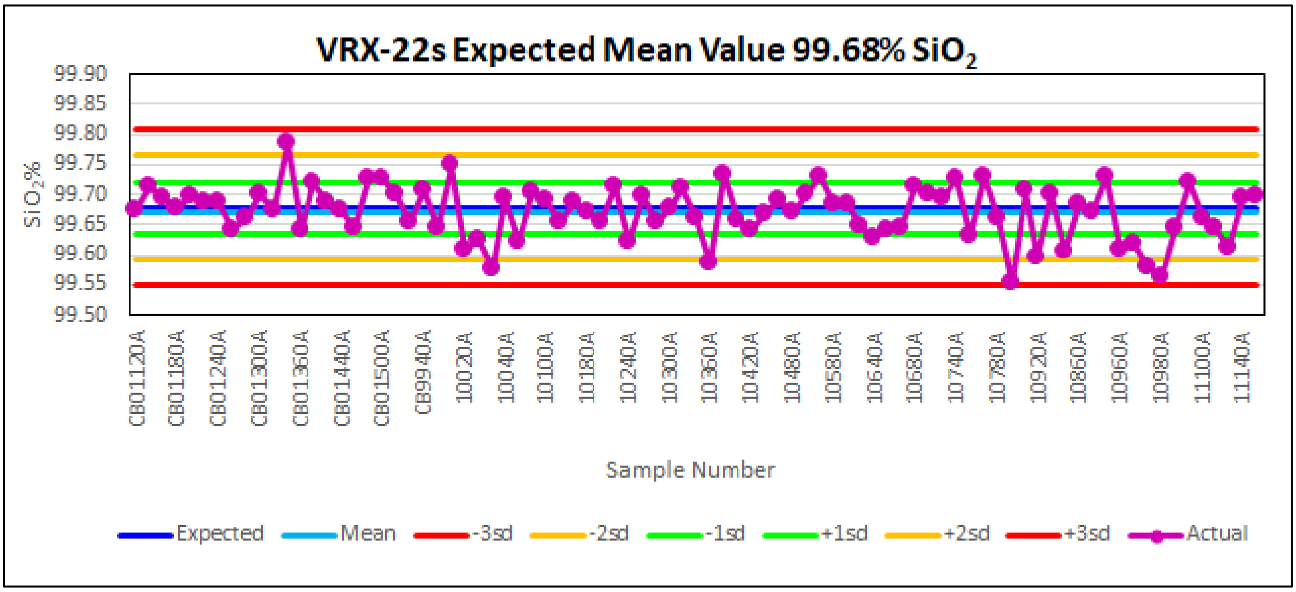


Figure 6: Control Chart for VRX-22S - SiO_2

Blanks

It was not considered necessary to insert blanks to the sample stream as the VRX-22S material is effectively also a blank

Field duplicates

Field duplicate samples were inserted in the sample stream at a rate of 1 in 20, resulting in 85 field duplicate samples. Analysis of the mean grades shown in Table 6 shows that the grade variables have reasonably similar mean grade results, similar population variability and generally strong correlation coefficients.

Grade Variable	SiO_2 Prim	SiO_2 Dup	Fe_2O_3 Prim	Fe_2O_3 Dup	TiO_2 Prim	TiO_2 Dup
Number	85	85	85	85	85	85
Mean	97.22	97.17	0.43	0.44	0.17	0.18
Variance	7.93	8.27	0.16	0.21	0.01	0.01
Std Deviation	2.82	2.88	0.41	0.45	0.07	0.09
Coeff.Var	0.03	0.03	0.95	1.02	0.07	0.09
Correl Coeff.	0.986		0.973		0.819	
Grade Variable	**Al_2O_3 Prim**	**Al_2O_3 Dup**	**MgO Prim**	**MgO Dup**	**LOI Prim**	**LOI Dup**
Number	85	85	85	85	85	85
Mean	1.22	1.24	0.02	0.02	0.17	0.66
Variance	1.68	1.80	0.00	0.00	0.01	0.83
Std Deviation	1.30	1.34	0.03	0.03	0.07	0.91
Coeff.Var	1.06	1.08	1.47	1.45	0.43	1.39
Correl Coeff.	0.983		0.976		0.993	

Table 6: Summary statistics Primary vs field duplicate samples

There is more scatter than is ideal seen in the analysis of the scatter plots, as shown in the example of Fe_2O_3 in Figure 7, with slight bias toward higher grade in the primary analysis, and a small number of outliers. However, the fact that the analytes are being assessed very close to their method detection limits, hence more variability should be expected, must be taken into account. Overall the resulting SiO_2 grade analysis results appear to be reasonable when looking at both the scatter and q-q plots in Figure 8.

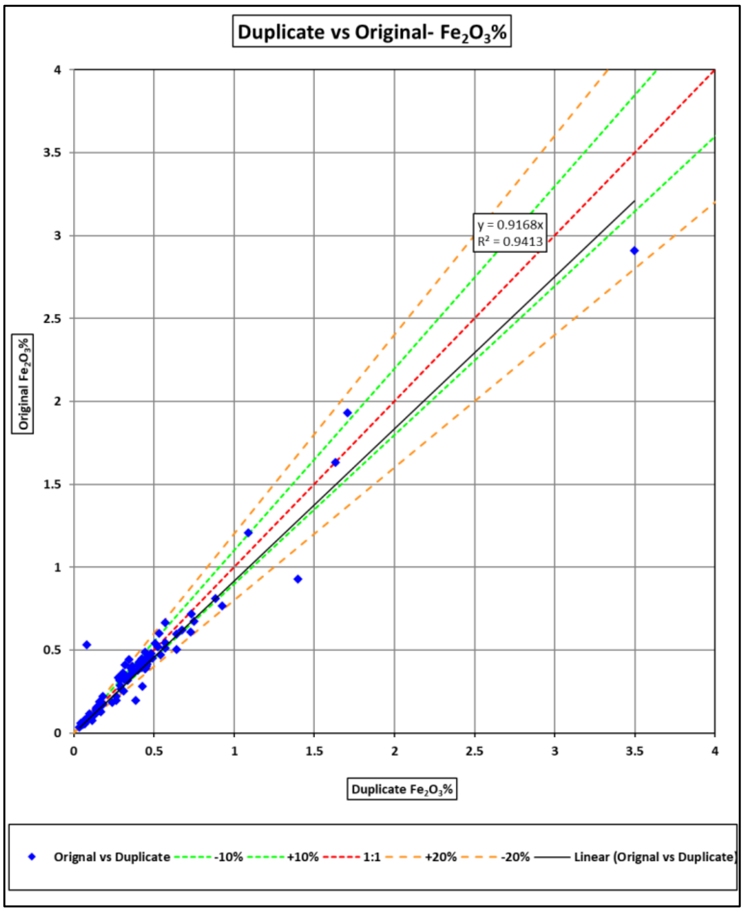


Figure 7: Scatter plot - Primary sample vs field duplicate for Fe_2O_3

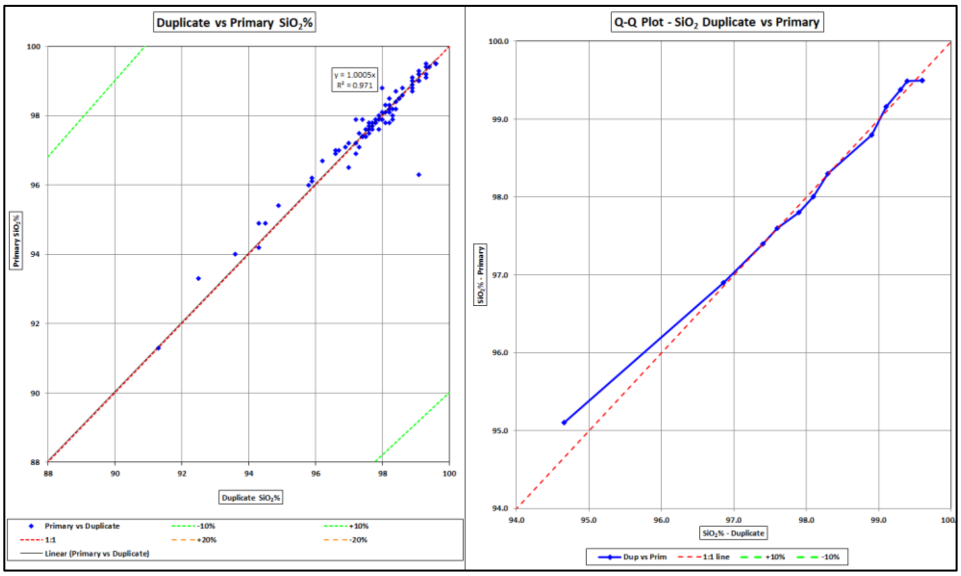


Figure 8: Scatter plot and Q-Q plot Primary vs field duplicate samples for SiO_2

Twin holes

Three AC drill holes were twinned in the Arrowsmith North project area. As can be seen from Table 7 mean values of all grade variables are very similar. The correlation matrix in Table 8 demonstrates a very strong correlation co-efficient for the relevant original and twin variables, except for TiO_2, which is analysed very close to detection limits and the result is considered acceptable with consideration of the very similar mean values. These results provide additional confidence that the AC drilling has provided samples that are representative of the in-situ materials and can be used in the MRE.

Grade Var	SiO_2_O	SiO_2_T	Al_2O_3_O	Al_2O_3_T	Fe_2O_3_O	Fe_2O_3_T	TiO_2_O	TiO_2_T	LOI_O	LOI_T
Number	40	40	40	40	40	40	40	40	40	40
Min	75.92	78.89	0.21	0.22	0.13	0.11	0.06	0.07	0.09	0.11
Max	99.34	99.34	1.74	1.79	0.55	0.57	0.27	0.26	9.73	8.46
Mean	97.57	97.60	0.84	0.81	0.33	0.32	0.15	0.14	0.64	0.63
Median	98.02	98.11	0.88	0.81	0.34	0.32	0.14	0.13	0.43	0.40
Std Dev	3.61	3.21	0.47	0.44	0.13	0.13	0.05	0.05	1.49	1.30
Variance	13.02	10.30	0.22	0.19	0.02	0.02	0.00	0.00	2.21	1.70
Coeff Var	0.04	0.03	0.55	0.54	0.40	0.42	0.30	0.33	2.34	2.06

Table 7: Summary Statistics for twin drilling

	Al_2O_3_O	Fe_2O_3_O	LOI_O	SiO_2_O	TiO_2_O	Al_2O_3_T	Fe_2O_3_T	LOI_T	SiO_2_T
Fe_2O_3_O	0.96								
LOI_O	0.17	0.1							
SiO_2_O	-0.3	-0.22	-0.99						
TiO_2_O	0.18	0.18	0.3	-0.35					
Al_2O_3_T	0.97	0.92	0.1	-0.23	0.11				
Fe_2O_3_T	0.94	0.96	-0.04	-0.08	0.09	0.95			
LOI_T	0.22	0.15	0.99	-0.98	0.28	0.15	0.01		
SiO_2_T	-0.34	-0.26	-0.97	0.99	-0.32	-0.29	-0.13	-0.99	
TiO_2_T	0.15	0.13	-0.05	-0.01	0.84	0.16	0.15	-0.06	-0.01

Table 8: Correlation Matrix for AC twin drilling

Density

Seven, certified, dry *in situ* bulk density measurements were completed by Construction Sciences Pty Ltd using a nuclear densometer. Table 9 shows the mean results from the seven measurements and the results of the moisture factor correction to a dry *in situ* density mean result of 1.66 t/m^3 which is used for all material in the MRE.

Mean Wet Density (t/m^3)	Mean Moisture %	Mean Dry Density (t/m^3)	Min. Dry (t/m^3)	Max. Dry (t/m^3)
1.71	2.9	1.66	1.60	1.72

Table 9: Density measurement results

5.2.3 Mineral Resource estimation

A block model was constructed using Datamine Studio software with a parent cell size of 200 m(E) x 200 m(N) x 4 m(RL). Sub-blocks down to 12.5 m(E) x 25 m(N) x 0.25 m(RL) were used for domain volume resolution. The model is flagged in the same way as the drillhole samples based on the interpreted white or yellow sand mineralisation domain zones, or for depletion based on being swamp, sandy swamp, or iron rich sand ridge material. The model is limited by the overburden and topographic surfaces above, to within a nominal maximum extension past known data points of up to 200 m and to within the VRX nominated Arrowsmith North target area.

The 1 m composited auger drillhole sample analysis results were subjected to detailed statistical analysis within each interpreted mineralisation domain zone. Both sand types display a minor negative skew in the SiO_2 grade population distribution (Figure 9) with the remaining grade variables showing a generally minor positive skew, with occasional outliers that required top cutting (Table 10). The summary statistics for the estimated grade variables are shown in Tables 15 and 16, and it can be seen that the mean grades for SiO_2 are about 1.2% higher in the interpreted white sand domain (98.8%) versus the yellow sand domain (97.6%).

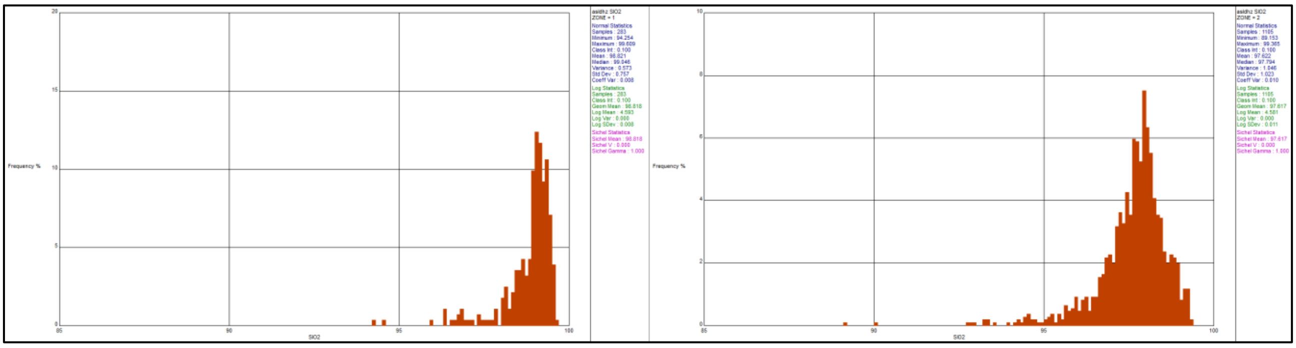


Figure 9: Histograms for SiO_2 – white sand left, yellow sand right

	Al_2O_3%	CaO%	Fe_2O_3%	K_2O%	LOI%	MgO%	SiO_2%	T_iO_2%
Number	283	283	283	283	283	283	283	283
Minimum	0.100	0.005	0.030	0.010	0.060	0.002	94.254	0.054
Maximum	2.003	0.506	3.486	1.227	2.110	0.684	99.609	0.504
Mean	0.462	0.011	0.148	0.129	0.225	0.010	98.821	0.164
Median	0.331	0.010	0.116	0.068	0.180	0.007	99.046	0.157
Std Dev	0.368	0.030	0.221	0.167	0.175	0.040	0.757	0.061
Coeff Var	0.797	2.671	1.492	1.297	0.778	3.871	0.008	0.373

Table 10: Summary statistics for white sand

	Al_2O_3%	CaO%	Fe_2O_3%	K_2O%	LOI%	MgO%	SiO_2%	T_iO_2%
Number	1105	1105	1105	1105	1105	1105	1105	1105
Minimum	0.144	0.005	0.043	0.004	0.13	0.004	89.153	0.015
Maximum	4.285	1.979	7.426	2.132	2.11	0.169	99.365	0.544
Mean	1.078	0.017	0.413	0.14	0.524	0.013	97.622	0.162
Median	1.016	0.01	0.387	0.078	0.5	0.012	97.794	0.15
Std Dev	0.473	0.086	0.276	0.208	0.216	0.009	1.023	0.065
Coeff Var	0.439	5.145	0.669	1.487	0.413	0.716	0.01	0.399

Table 11: Summary statistics for yellow sand

Domain	Al_2O_3%	CaO%	Fe_2O_3%	K_2O%	LOI%	MgO%	SiO_2%	T_iO_2%
White Sand	-	0.03	0.5	0.8	1	0.04	-	-
Yellow Sand	2.8	0.5	1.5	1.5	1.5	0.06	-	-

Table 12: Top cuts applied to grade variables

A spatial analysis of the data from the yellow sand material, which had more data, yielded reasonably robust variograms (Figure 10) so ordinary kriging (**OK**) was used as the primary grade estimation methodology. No clearly preferred mineralisation trend direction in the horizontal was recognised from the variogram modelling and primary continuity was modelled toward 000°, with both the major and semi-major axes having the same range of 700 m, and the minor axis vertical at 8.5 m. The modelled nugget from the downhole variogram was fairly low at 15%. The variogram parameters were fed into the OK grade estimate.

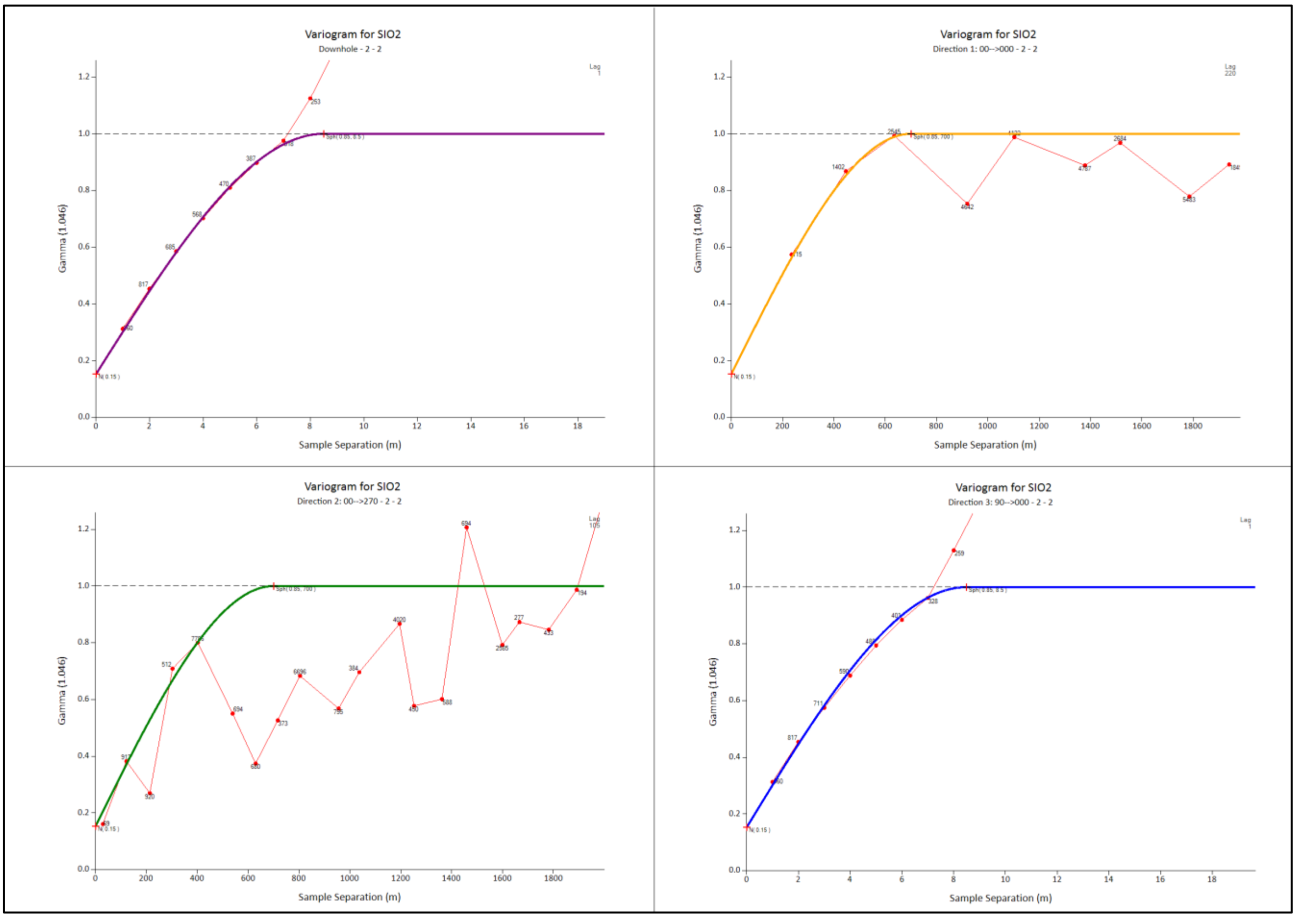


Figure 10: Variogram models

An inverse distance to the power of two weighting (IDS) was used as a check estimate for validation purposes. Hard boundaries have been used in the grade estimate between the yellow and white sand mineralisation domains.

The variogram ranges of 700 m for the major and semi-major axes were applied for the search ellipse with 10 m minor axis search. A maximum of 24 and a minimum of 16 samples were required for a valid block estimate from within the first search volume. The required sample numbers are reduced to 12 minimum and 20 maximum for the doubled size second search volume, and reduced again to 8 minimum and 16 maximum for the twenty-fold increased third search volume, which ensured all blocks were estimated. A maximum of four samples per drillhole are allowed per block estimate. Cell discretisation of 3(X) x 3(Y) x 4(Z) was applied and no octant-based searching was used in the grade estimate.

The measured, moisture factor corrected, mean density value of 1.66 t/m^3 has been assigned to all interpreted and modelled sand material in the model.

The model was validated visually, graphically, and statistically. The visual analysis and the trend plots, which compare model and drillhole composite grades by elevation, northing (Figure 11) and easting, showed that the grade trends in the model reflect the drillhole grade trends to a reasonable degree. Table 13 shows the similarity between OK and IDS grades and similarity between estimated and drillhole sample grades considering volume variance and expected grade estimation smoothing effects.

Yellow sand					
DENSITY	SiO_2%	Al_2O_3%	Fe_2O_3%	LOI%	TiO_2%
Model OK	97.6	1.08	0.40	0.53	0.16
Model IDS	97.6	1.10	0.41	0.53	0.17
Drill hole	97.6	1.08	0.41	0.52	0.16
White sand					
DENSITY	SiO_2%	Al_2O_3%	Fe_2O_3%	LOI%	TiO_2%
Model OK	98.6	0.55	0.15	0.25	0.18
Model IDS	98.7	0.52	0.15	0.24	0.17
Drill Hole	98.8	0.47	0.15	0.23	0.16

Table 13: Model validation comparing mean values for model IDS, model OK and drillhole sample data

The modelled extents of mineralisation at Arrowsmith North are extrapolated beyond the limits of the drillhole data. The limit of the modelling has been applied at a nominal 200 m past the drill information where the limiting boundary of the nominated target area is further than this distance away from the data points. Approximately 20% of the interpreted mineralisation is considered to be extrapolated.

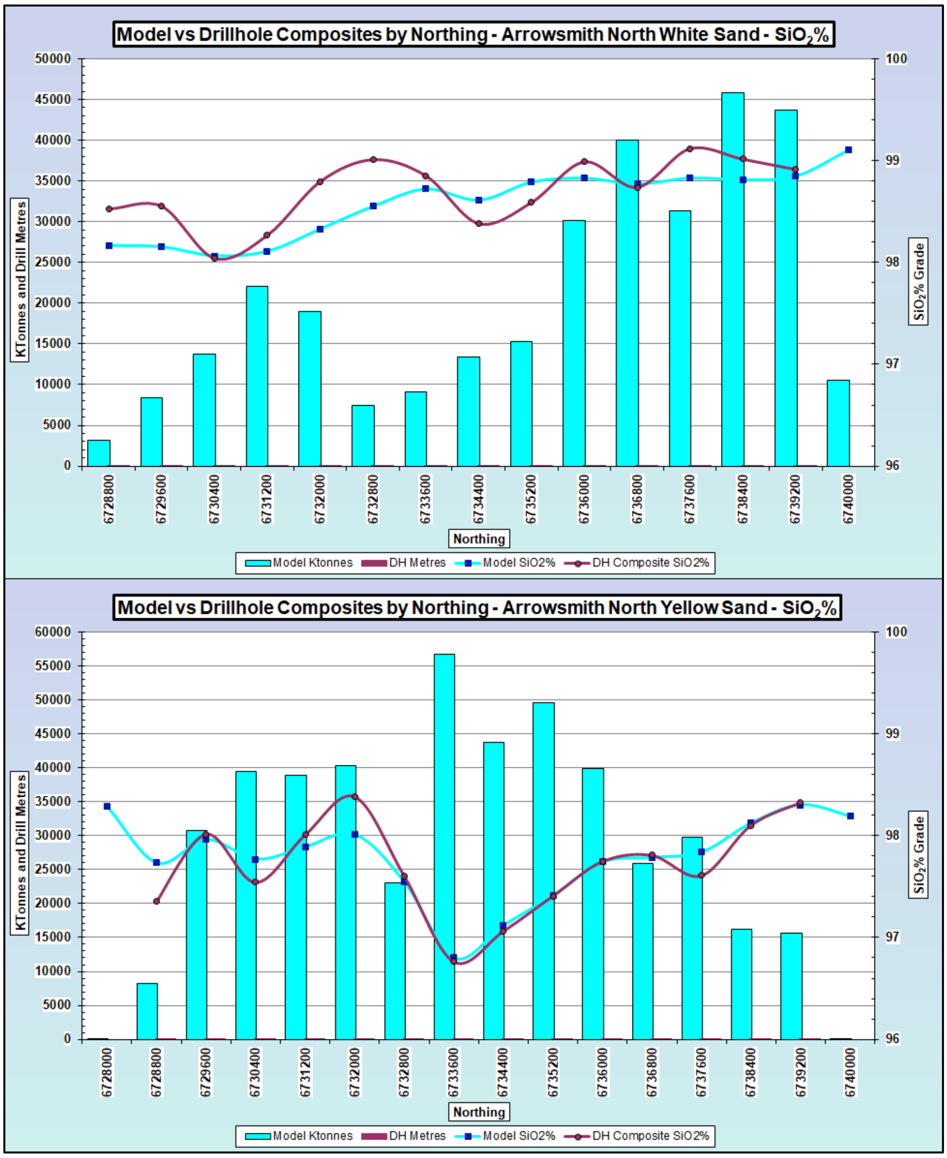


Figure 11: Swath plot by Northing for White sand above and Yellow sand below

5.2.4 Mineral Resource Classification

The Mineral Resource is classified as Inferred and Indicated according to the principles contained in the JORC Code.

Material that has been classified as Indicated was considered by the Competent Person to be sufficiently informed by geological and sampling data to assume geological and grade continuity between data points.

Material that has been classified as Inferred was considered by the Competent Person to be sufficiently informed by geological and sampling data to imply but not verify geological and grade continuity between data points.

The results of the MRE are presented in Table 14.

The MRE may also be presented in a grade-tonnage curve with the curve for all material reported shown in Figure 12.

Classification	Domain	Million Tonnes	SiO_2%	Al_2O_3%	Fe_2O_3%	LOI%	TiO_2%
Indicated	White Sand	33	98.7	0.5	0.2	0.2	0.2
	Yellow Sand	215	97.5	1.1	0.4	0.5	0.2
	All Sand	248	97.7	1	0.4	0.5	0.2
Inferred	White Sand	280	98.7	0.5	0.1	0.2	0.2
	Yellow Sand	243	97.7	1	0.4	0.5	0.2
	All Sand	523	98.2	0.8	0.3	0.4	0.2
Indicated and Inferred	All Sand	771	98.0	0.9	0.3	0.4	0.2

**Note: Interpreted mineralisation is domained into different sand types based on drill logging data and chemical analysis results. Depletion zones include the upper 0.5 m for rehabilitation purposes, iron richer sand ridges in the west and minor swamp zones in the east and south of the modelled area. Differences may occur due to rounding.*

Table 14: Arrowsmith North Mineral Resource

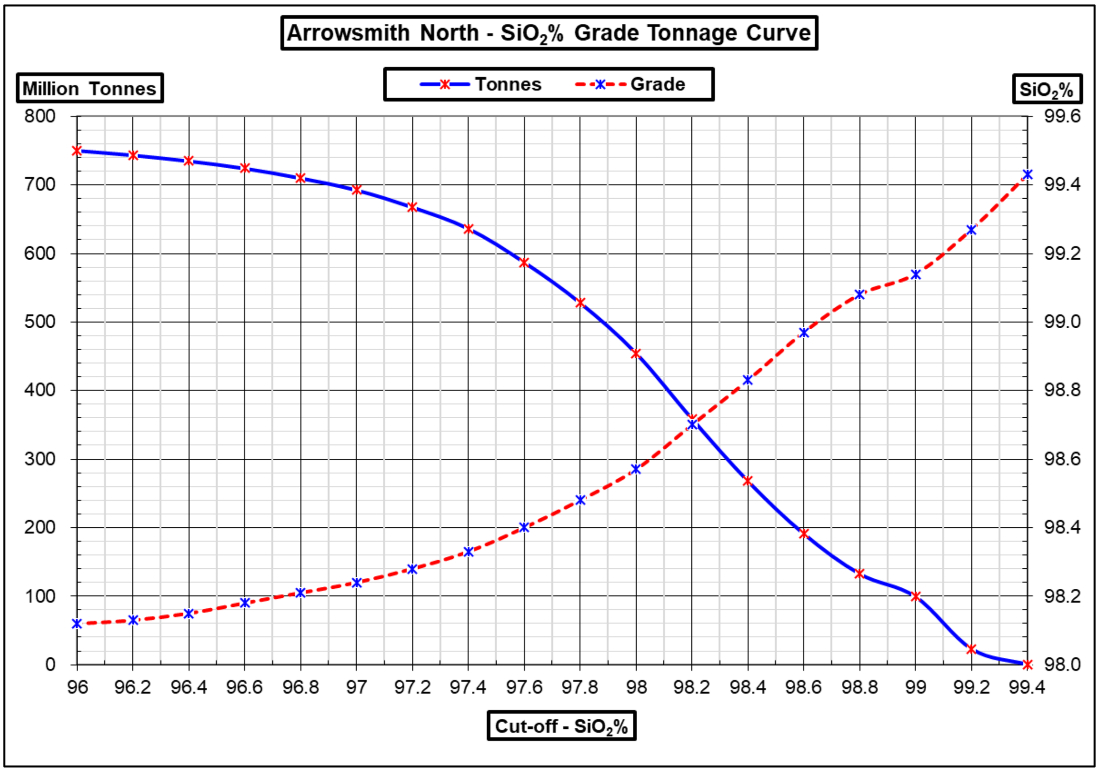


Figure 12: Arrowsmith North - all sand grade tonnage curve

5.2.5 Classification and JORC Code 2012, Clause 49

Mineral Resource tonnes and in situ SiO_2 content are key metrics for assessing silica sand projects, however these projects also require attributes such as final product size distribution, purity and particle shape to be evaluated to allow consideration of potential product specifications (e.g. Scogings, 2014). This is because these specifications are parameters that drive the value in a silica sand project.

Clause 49 of the JORC Code requires that industrial minerals such as silica sand that are produced and sold according to product specifications be reported "in terms of the mineral or minerals on which the project is to be based and must include the specification of those minerals".

Clause 49 also states that "It may be necessary, prior to the reporting of a Mineral Resource or Ore Reserve, to take particular account of certain key characteristics or qualities such as likely product specifications, proximity to markets and general product marketability".

Therefore, silica sand Mineral Resources must be reported at least in terms of purity and size distribution, in addition to SiO_2 and tonnes, and should also take account of logistics and proximity to markets.

Likely product specifications for the Arrowsmith North deposit are supported by the results of the composite sample process test work program undertaken by VRX in 2018 and 2019 at CDE Global in Northern Ireland.

Quartz (also known as silica) is produced commercially from a wide variety of deposits including unconsolidated sand, sandstone, quartzite, granite, aplite, and pegmatite. Silica sand and quartz are economical sources of SiO_2 used in glass and ceramics manufacture, for which key deleterious elements include iron and titanium. Silica sand is also used for foundry mould manufacture.

5.2.6 Glass and ceramics specifications

Though the production of glass requires a variety of different commodities, silica represents over 70% of its final weight. Its chemical purity is the primary determinant of colour, clarity and strength of the glass produced.

In the production of glass, there is both the need and requirement for silica to be chemically pure (composed of over 98% SiO_2), of the appropriate diameter (e.g. a grain size of between approximately 0.1 mm and 0.4 mm and with low iron content (less than approximately 0.04% Fe_2O_3). Refer to Tables 19, 20 and 21 for examples of chemical composition and size distribution for silica products for the glass and ceramics markets. Proposed VRX glass sand specifications are given in Tables 22 and 23; these are based on laboratory tests of drill sample composites in 2018 and 2019.

5.2.7 Foundry sand specifications

Silica sand is used in the production of sand moulds for casting of metals; this product is described generically as 'foundry sand'. Although other types of sand e.g. olivine, zircon, aluminosilicate or chromite sands can be used to make moulds, silica sand is used primarily because it is globally available and relatively inexpensive.

There are different size specifications depending on the foundry application and VRX has identified opportunities for a range of sand sizes. Foundry sands are commonly bonded using bentonite clay and water, or resin, depending on the application. Milled coal is commonly added to create a reducing environment and to improve the casting finish by depositing a lustrous carbon layer at the sand/casting interface.

It is preferable to have rounded to sub-rounded silica grains with medium to high sphericity, as this improves flowability of the mould during formation and allows for higher permeability after the metal has been poured. More angular sands don't pack as well and require higher binder additions.

Most foundry sands fall into the range of ~0.1mm to 0.5mm and they are produced to meet specific size distributions which are commonly described by a number known as the 'AFS number' (Table 25). The higher the AFS number, the finer the sand. Proposed VRX foundry sand specifications are given in Tables 24 and 25; these are based on laboratory tests of drill sample composites in 2018 and 2019.

5.2.8 Conclusion supporting economic extraction

CSA Global is of the opinion that available process testwork indicates that likely product qualities for glass, ceramics and foundry sand are considered appropriate for eventual economic extraction from Arrowsmith North. In addition, potentially favourable logistics and project location support the classification of the Arrowsmith North deposit as an industrial mineral Inferred/Indicated Mineral Resource in terms of Clause 49.

Market	SiO_2 %	Al_2O_3 %	Fe_2O_3 %
Flat glass	>99.5	<0.3	<0.04
Container flint glass	>98.5	<0.5	<0.035
Insulation fibre glass	>95.5	<2.2	<0.3
Porcelain	>97.5	<0.55	<0.2
Enamels	>97.5	<0.55	<0.02

Table 15: Silica chemical specifications for glass and ceramics markets
Source: Modified from Sinton (2006)

Specification	SiO_2 %	Other Elements %	Other Elements ppm
Clear glass-grade sand	>99.5	<0.5	<5,000
Semiconductor filler, LCD, and optical glass	>99.8	<0.2	<2,000
"Low Grade" HPQ	>99.95	<0.05	<500
"Medium Grade" HPQ	>99.99	<0.01	<100
"High Grade" HPQ	>99.997	<0.003	<30

Table 16: Silica sand and quartz chemical specifications by market
Source: Modified from Richard Flook (Hughes, E., Industrial Minerals Magazine, December 2013)

Sieve size	Mesh size	Flat glass	Flint container glass
mm	Openings per inch	Cumulative percent retained	Cumulative percent retained
1.18	14	0.0	0.0
0.85	18	<0.01	0.0
0.425	36	<0.1	<4
0.106	150	>92	>25
0.075	200	>99.5	>95

Table 17: Physical size specifications for glass sand
Source: Modified from Herron (2006)

Product	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	K_2O
				%			
Arrowsmith - NF500	99.7	0.20	0.050	0.035	0.010	0.002	0.030

Table 18: VRX Silica – provisional Arrowsmith North glass sand chemical specifications
Source: VRX Silica ASX announcement February 2019

	Sieve micron and % retained on sieve								
Product	850	600	425	300	212	150	106	75	53
Arrowsmith - NF500		0.5%	**40%**	**42%**	**17%**	1%	0%		

Table 19: VRX Silica – provisional Arrowsmith North glass sand PSD
Source: VRX Silica ASX announcement February 2019

Product	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	K_2O
Arrowsmith-N20 / N40	99.7	0.20	0.05	0.035	0.010	0.002	0.03

Table 20: VRX Silica – provisional Arrowsmith North foundry sand chemical specifications
Source: VRX Silica ASX announcement February 2019

Product		Mesh/mm % retained on sieve								AFS No
	10/2	20/0.85	30/0.6	40/0.425	50/0.3	70/0.212	100/0.15	140/0.196	200/75	
Arrowsmith-N20	0.1%	3%	**87%**	8%	1%	0.1%				**21**
Arrowsmith-N40		0%	**21%**	**36%**	**24%**	13%	5%	1%	0%	**36**

Table 21: VRX Silica – provisional Arrowsmith North foundry sand PSD and AFS specifications
Source: VRX Silica ASX announcement February 2019

5.3 Reserves

VRX has completed the necessary work to convert the Indicated Mineral Resource to Probable Ore Reserves. A summary of the work undertaken is included in this BFS.

Table 22 details the Probable Ore Reserve that will be produced from mining of the Indicated Mineral Resource and processing in a purpose built, wet sand processing plant. The plant will produce four saleable products for different markets with a **total Probable Ore Reserve of 223 million tonnes**, with 204 million tonnes contained within the Mining Lease application M70/1389.

Chemical Composition

Classification	Product	Recovery	Global Million Tonnes	Within MLA70/1398 Million Tonnes	SiO_2%	Al_2O_3%	Fe_2O_3%	TiO_2%	LOI%
Probable	Arrowsmith-N20	24%	60	54	99.7	0.2	0.05	0.035	0.1
	Arrowsmith-N40 / NF500	60%	149	136	99.7	0.2	0.05	0.035	0.1
	Local Market	6%	15	14					
		Total Reserve	**223**	**204**					

Particle Size — **Sieve Opening (Mesh/µm Retained)**

Product	10 / 2mm	20 / 850	30 / 600	40 / 425	50 / 300	70 / 212	100 / 150	140 / 106	200 / 75	AFS No
Arrowsmith-N20	0.10%	3%	87%	8%	1%	0.10%	-	-	-	21
Arrowsmith-N40	-	0%	21%	36%	24%	13%	5%	1%	0%	36
Arrowsmith-NF500	-	-	0.50%	40%	42%	17%	1%	0%	-	38
Local Market	-	-	-	-	-	-	64%	22%	14%	-

Table 22: Arrowsmith North Silica Sand Probable Ore Reserve as at July 2019

5.3.1 Metallurgical Factors

As a part of the upgraded MRE, CSA Global reviewed the metallurgical testwork to comply with Clause 49 of the JORC Code. CSA Global has concluded that the available process testwork indicates likely product qualities for glass, ceramics and foundry sand are considered appropriate for eventual economic extraction from Arrowsmith North. Favourable logistics and the location of the Project support the classification of Arrowsmith North in accordance with Clause 49 as an industrial mineral with an Inferred/Indicated Mineral Resource. The extensive metallurgical testwork which has been completed by CSA Global at their facility in Cookstown, Northern Ireland, and Nagrom in Kelmscott, Perth, allowed for the creation of a catalogue of silica sand products that could be produced from Arrowsmith North[2] (see Table 23).

Chemical Composition (%)

Product	Industry	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	K_2O
Arrowsmith-N20	Foundry	99.7	0.20	0.050	0.035	0.010	0.002	0.030
Arrowsmith-N40	Foundry	99.7	0.20	0.050	0.035	0.010	0.002	0.030
Arrowsmith-NF500	Glass	99.7	0.20	0.050	0.035	0.010	0.002	0.030

Particle Size — **Sieve Opening (Mesh/µm Retained)**

Product	10 / 2mm	20 / 850	30 / 600	40 / 425	50 / 300	70 / 212	100 / 150	140 / 106	200 / 75	AFS No
Arrowsmith-N20	0.1%	3%	87%	8%	1%	0.1%				21
Arrowsmith-N40		0%	21%	36%	24%	13%	5%	1%	0%	36
Arrowsmith-NF500			0.5%	40%	42%	17%	1%	0%		

Table 23: Arrowsmith North saleable Products from Catalogue

[2] ASX announcement of 26 February 2019, *"Testwork Update and product Catalogues"*.

These products become the recovered products which make up the Ore Reserve (see Table 22).

The mass balance of the particle sizes was analysed allowing for the recoveries of these products in a wet processing plant to be estimated.[3]

The recovery of each product is shown in Table 24.

Product	Industry	Recovery
Arrowsmith-N20	Foundry	24%
Arrowsmith-N40 / NF500	Foundry / Glass	60%
Local Market	Fine sand	6%
	Total Recovery	**90%**

Table 24: Arrowsmith North Product Recovery

5.3.2 Material Modifying Factors – Mining Factors

The mining method chosen for Arrowsmith North is a rubber wheeled front-end loader, feeding into a 3 mm trommel screen to remove oversize particles and organics. The undersize sand is slurried and pumped to a sand processing plant which is located proximal to the Eneabba-Geraldton Railway line. After processing, the silica sand is loaded into railway trucks for bulk export from the Geraldton Port.

Mining of the dune sand will extract to the base of the Indicated Resource/Probable Ore Reserve. This level is roughly the same as the freehold land boundary on the western side of the mining area and will leave a slightly undulating surface. On the eastern side of the mining area the sand will slope upward as a 10% gradient to the top of the adjacent dunes. The pre- and post-mining topography is shown in Figures 13 and 14.

100% of the material in the Mining Lease application rea is considered to be sand that can be beneficiated to a saleable silica sand project. The top 500mm has been excluded from the MRE as it will be reserved for rehabilitation purposes. As there is no waste material, the recovery factor is considered to be 100% and ore loss therefore is considered to be 0%.

[3]ASX announcement of 3 May 2019, *"High Recovery from Silica Sand Process Plant Design".*

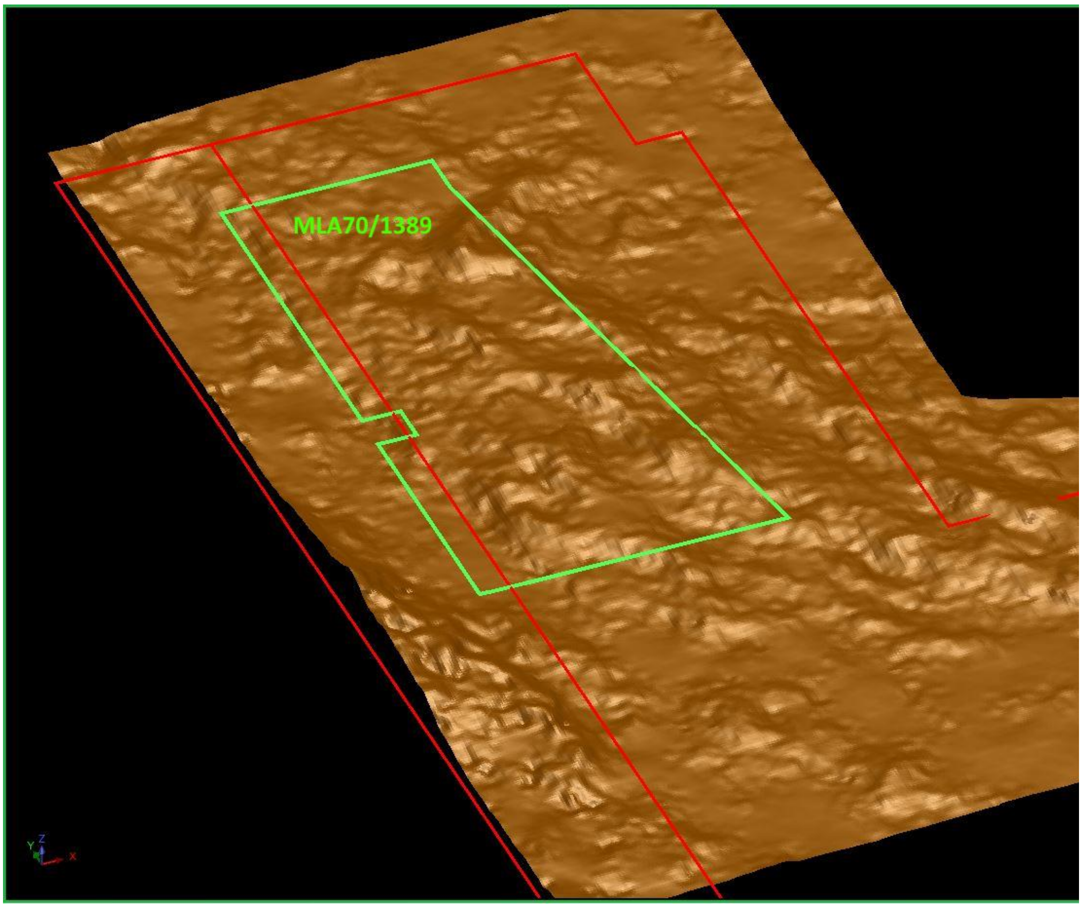


Figure 13: Arrowsmith North Pre-Mining Topography (10:1 vertical exaggeration)

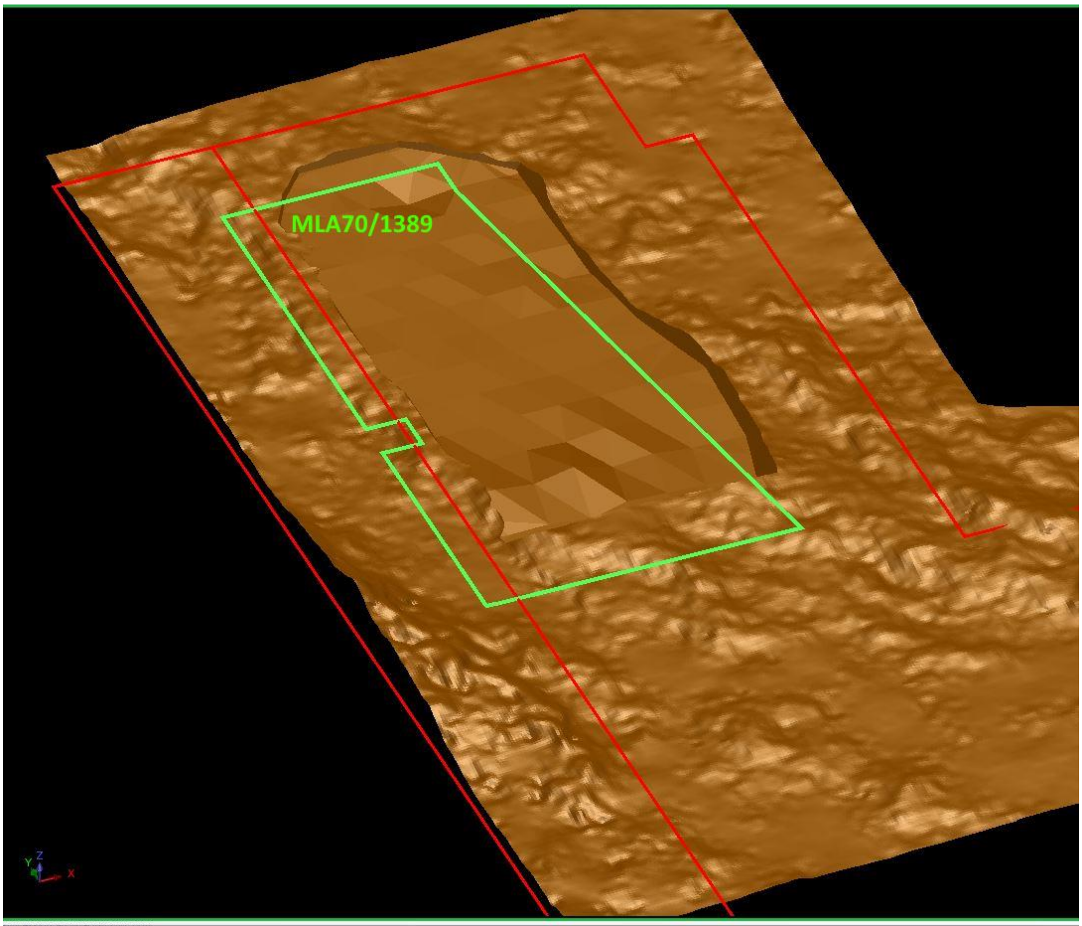


Figure 14: Arrowsmith North Post-Mining Topography (10:1 vertical exaggeration)

5.3.3 Material Modifying Factors – Environmental Studies

Development location

- South of the Yardongo Nature Reserve
- Approximately 10 km inland from the coast
- North of the Arrowsmith River (Registered Aboriginal Heritage Site)
- Outside of World Heritage Areas, National Heritage Places, Ramsar Wetlands, Conservation Reserves or Commonwealth Marine Reserves

The Probable Ore Reserve is located within an area of deep sands, leached of nutrients. The vegetation is coastal low scrub heath (known as Kwongan heath). There are relict dune structures which are represented as low rolling hills.

Assessment Process

- Referral submission to the Federal Department of the Environment and Energy (**DotEE**)
- Submission of Section 38 referral to State Environmental Protection Authority (**EPA**)
- Seek an Accredited *Environment Protection and Biodiversity Conservation* Act 1999 (Cth) Assessment under the State *Environmental Protection Act* 1986 (WA) via an Environmental Review Document with public comment
- Undertake any further studies required
- Submission of Environmental Review Document

Mitigation Strategies

- Proposed action lies within a large development envelope, allowing for the flexibility to target areas of lower significance to matters of national environmental significance (**MNES**)
- Disturbance will be kept to a minimum, up to 35 ha per year and 14 ha at any one time
- Progressive rehabilitation using topsoil re-location to ensure topsoil and plants are translocated intact to previously mined areas
- Conduct further surveys to identify MNES
- Use findings to steer the project and avoid MNES where possible

There are no mine tailings storage requirements.

There are no waste dumps.

Processing requires no chemicals.

5.3.4 Material Modifying Factors – Infrastructure

The Project is located on vacant, unallocated Crown land which is east of freehold land and bounded to the north by a Nature Reserve and south by a proposed Nature Reserve. The east boundary of the Project area is the limit of tenure. The Brand Highway is proximal to the area and access is via the Mount Adams Road from the north or Brand Highway to the south. The Eneabba-Geraldton Railway line lies to the south west of the Project and will be used to transport the processed silica sand to the Geraldton Port for bulk export.

The Project will require its own installed power and water infrastructure.

Labour will be sourced from the nearest towns, Dongara and Eneabba (approximately 30 km from the mine site) and there will be no accommodation installed at the mine site.

5.3.5 Costs

Operating costs

Operating costs have been determined from first principles and are estimated to include all costs to mine, process, transport and load product on to ships.

Royalties

The prevailing rate of royalty due to the State is used in VRX's economic assessments. The State Royalty rate is A$1.17 per dry metric tonne and reviewed every 5 years with the next review due in 2020.

There are no other royalties payable (including private), though a royalty may be negotiated with Native Title claimants.

5.3.6 Revenue

Product Quality

Multiple products will be differentiated during processing subject to required particle size distribution by screening. Recovery of products has been independently assessed by CDE Global, a world leading silica sand testing laboratory.

Commodity Prices

Commodity prices for silica sand products have been determined by independent industry source, Stratum Resources. The industry standard is that sales contracts are in US dollars. The exchange rate to convert to Australian dollars will be the prevailing rate at the time of payment.

Subject to final quality produced, the prices for the commodity will range from US$38 to US$58 per dry metric tonne Free on Board (**FOB**). There are no shipping cost estimates with all contracts to be based on FOB rates.

Revenue will be based on a negotiated per shipment basis per dry metric tonne FOB with payment by demand on an accredited bank letter of credit.

There will be no other treatment, smelting or refining charges.

5.3.7 Market Assessment

The Company has commissioned an independent assessment of the current market prices for proposed products by independent industry source, Stratum Resources. The assessment includes projections for future demand and supply of silica sand and concludes that there is a likely future tightening of supply of suitable glassmaking silica sand with a commensurate future increase in price.

Sales volumes have been estimated as a result of received letters of intent and expressions of interest to purchase products.

5.3.8 Economic Factors

The Company's economic analysis has calculated a 10% and 20% discounted ungeared post tax net present value (**NPV**). A 20% discounted NPV has also been calculated to demonstrate the strength of the economic analysis.

The analysis has not considered any escalated future product prices nor any inflation to operating costs. The analysis has used a US$/A$ exchange rate of US$0.70/A$1.00.

The analysis is based on a 25-year production profile, despite the Probable Ore Reserve far exceeding that project life.

Capital requirements are based on independent estimates.

The economic analysis is most sensitive to the exchange rate.

The analysis indicates the financials of the Project are very robust and there is a high confidence that a viable long-term mining operation can be justified.

5.3.9 Social Factors

The Company's Mining Lease application for Arrowsmith North lies within the Southern Yamatji Native Title claim boundaries (WC2017/002), which replaced a pre-combination claim (WC2004/002) by the Amangu People.

The Company is currently in negotiations with both the claimant group (Southern Yamatji) and the Government Party (Tenure and Native Title Branch of the Department of Mines, Industrial Regulation and Safety) with respect to the Mining Lease application. The Company expects that an agreement will be reached between the parties allowing for the mining lease to be granted.

The Project is wholly on vacant, unallocated Crown land and, therefore, there is negligible negative impact on local communities.

5.3.10 Project Funding

The financial model summarised in Section 18 sets out the project metrics and provides a basis for the potential capital structure of the Company for the development of the Project. Total capital expenditure at Arrowsmith North (for a 2 million tonnes per annum processing plant) is estimated at approximately A$28 million. Section 16 details capital cost estimates.

The Company anticipates that the source of funding for the capital investment at Arrowsmith North will be any one of, or a combination of, equity, debt and pre-paid offtake from the Project. Whilst no final decision has been made in that regard, the financial model assumes a maximum A$26 million in debt.

The Company has received a number of enquiries and expressions of interest from debt financiers for the Project. As noted above, the financial model provides for debt capacity and is designed to meet the expectations of any providers of potential debt funding for their due diligence and other internal requirements.

In addition, the Company has also received enquiries and expressions of interest from organisations across Asia for silica sand products from the Project, and holds signed letters of intent for substantial tonnages. A number of these organisations have expressed interest in becoming a funding partner of the Company for development of a mine by way of pre-paid offtake arrangements.

The balance of the Company's capital requirements will be funded from equity capital.

Whilst the envisaged project development requires a low capital intensity relative to a greenfields hard rock mining project, and any one of, or a combination of equity, debt and pre-paid offtake is planned, VRX has not as yet secured the required capital. The positive financial metrics of the BFS and feedback from potential funding partners provides encouragement as to the likelihood of meeting optimum project and corporate capital requirements.

6 Mining

The Project will utilise a unique and flexible mining and rehabilitation method to maximise production and the recovery of rehabilitated mined areas.

The proposed mining process is to sequentially mine 8-15 m of sand from below the base of the soil profile in 2.25 ha blocks (150 m x 150 m), with up to 8 blocks mined per year (18 ha).

High grade silica sand will be produced in line with the following sequential process:

1. An initial area of 150 m x 150 m will be cleared conventionally by dozing the topsoil to 400 mm into a topsoil stockpile to one side of the proposed mining area.

This windrow will be undisturbed for a significant time (up to 10 years). The windrow will be utilised as a seed bank and will be later reused as topsoil on the last area mined.

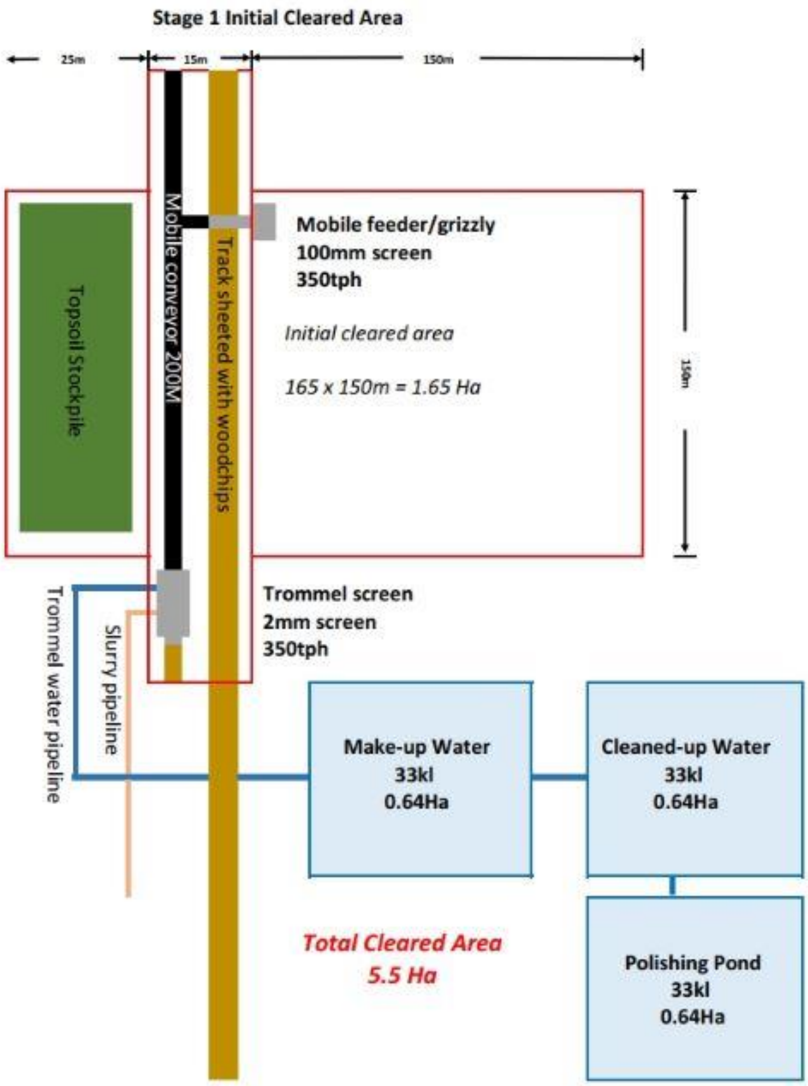


Figure 15: Mining process – initial cleared area

2. A conveyor route will be established

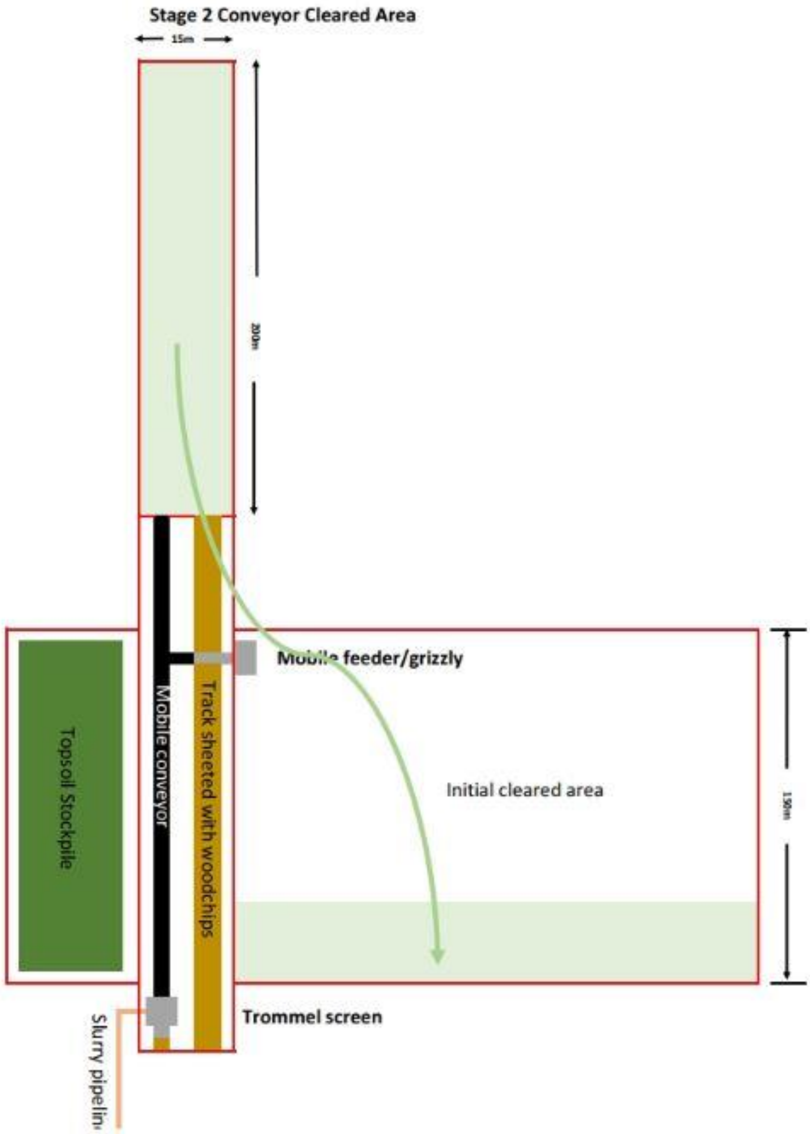


Figure 16: Mining process – conveyor cleared area

3. Vegetation is trimmed in preparation for translocation.

This will utilise a dozer front mounted mulcher which will trim the vegetation to approximately 800 – 1000 mm above ground. This will create vegetation material which will later breakdown as a humus but most important will reduce the foliage and aspiration rates to increase the survival rates after the Direct Vegetation Transfer (**DVT**) in a low rainfall area.

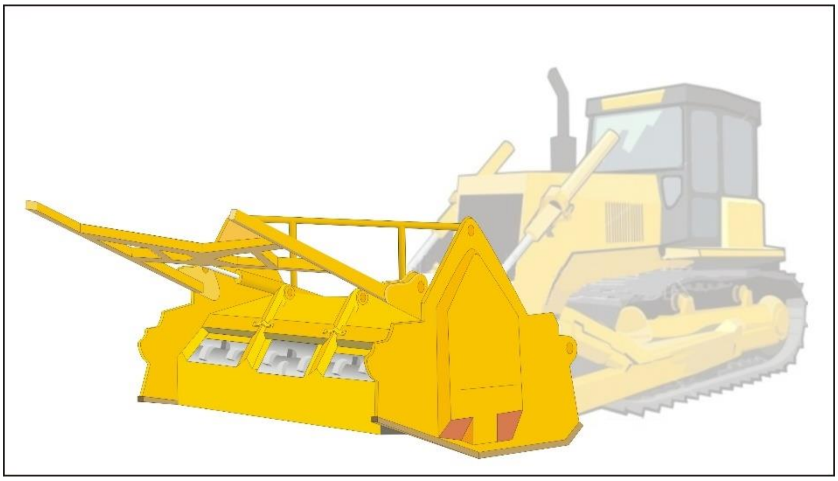


Figure 17: Mining process – vegetation trimmed

4. The ground will then be ripped using a dozer mounted scythe which will rip the shrub root systems at 400 mm below ground level.

This will reduce the root disturbance when later excavated by front end loader (**FEL**) during the DVT sequence.

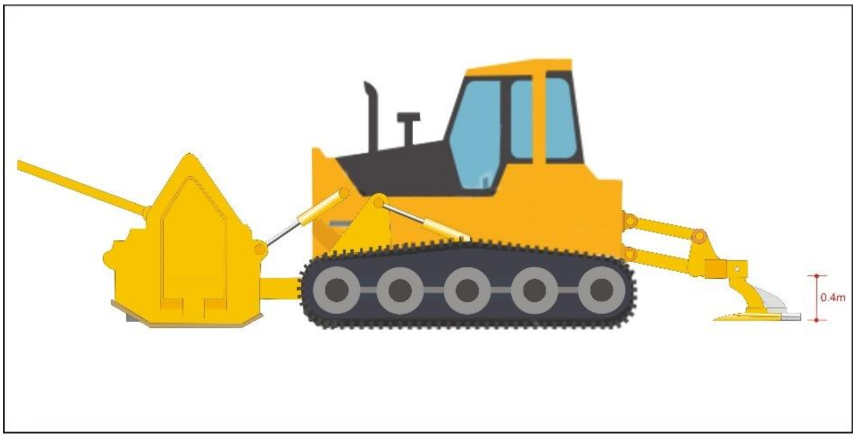


Figure 18: Mining process – ground ripped below shrub root systems

5. Intact vegetation and topsoil are translocated via DVT and silica sand mined in panels.

A modified FEL will be used to excavate a 3 m x 3 x 400 mm sod of topsoil which will include the relatively undisturbed microbial and invertebrate content. The sod including the topsoil and vegetation will be translocated to the previously mined area.

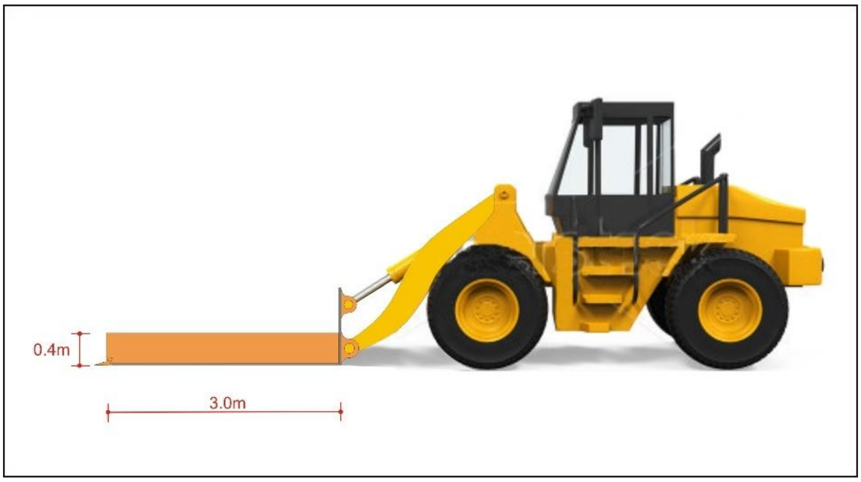


Figure 19: Mining process – vegetation and topsoil translocated

Silica sand is extracted in 2.25 ha panels following DVT.

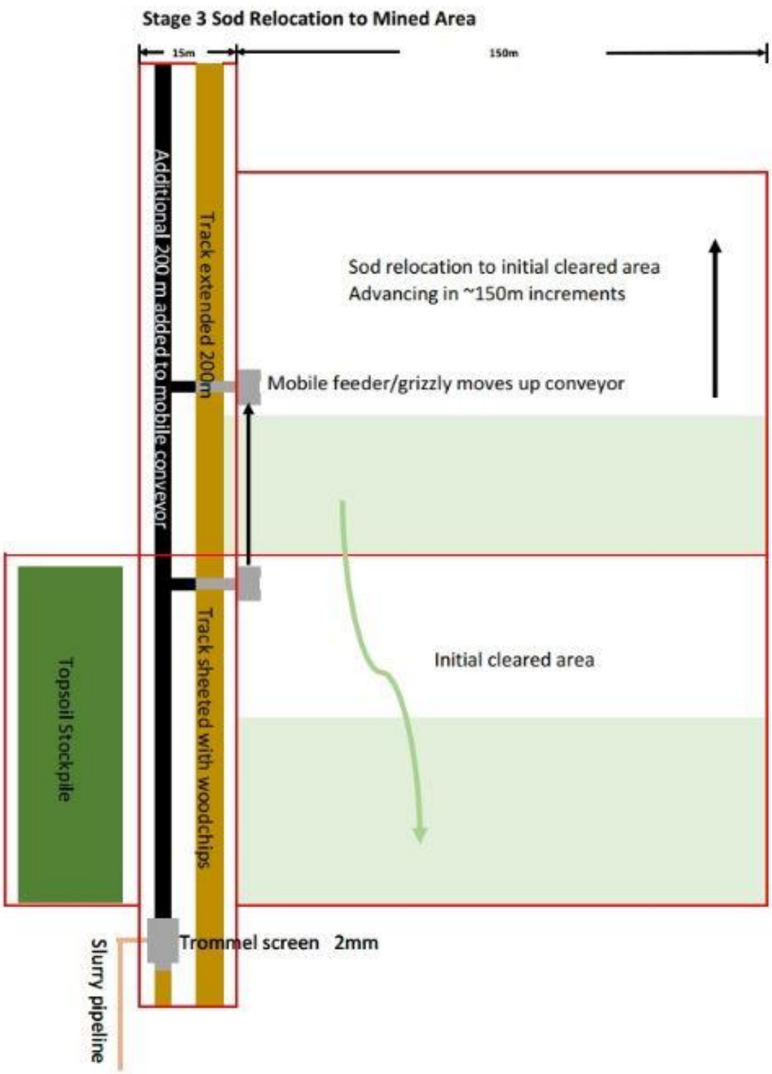


Figure 20: Mining process – silica sand mined in 2.25 ha panels

The process is continuous. Following extraction the mined 2.25 ha panel is rehabilitated with intact vegetation and topsoil translocated via DVT from the next 2.25 ha panel

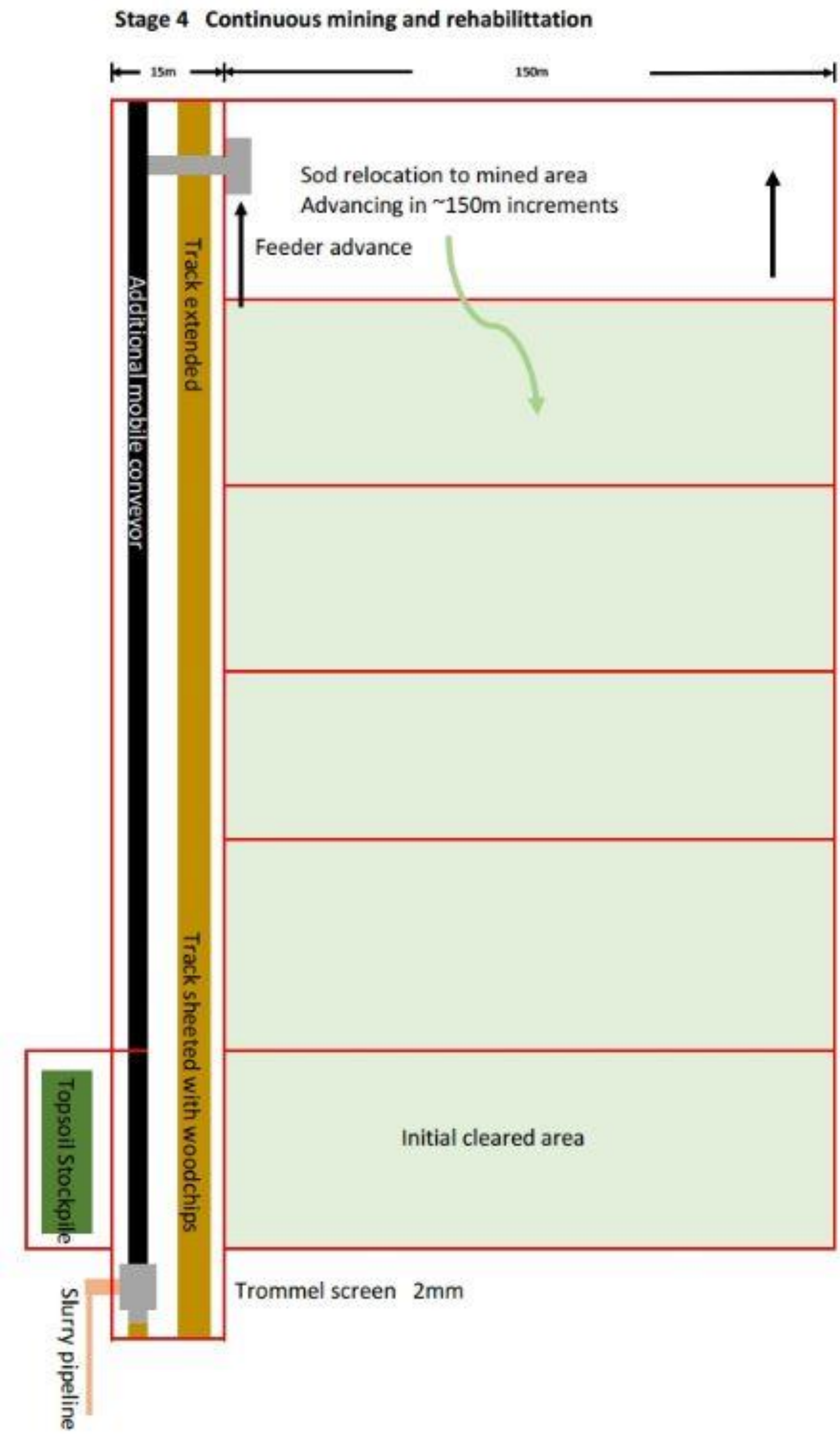


Figure 21: Mining process – continuous process of mining and rehabilitation

6. Silica sand is screened and conveyed to a rotating trommel

Mined silica sand is shifted via a conventional front end loader to a feeder bin for transfer on to a conveyer. This mobile feeder site is located at the mine face.

Figure 22: Mining process – silica sand loaded and screened

The trommel will have a water washed 3 mm screen that will remove any oversize and organic material. The silica sand will then be slurried (water sand mixture) and pumped to an off-site processing plant for beneficiation into a final saleable product.

7. Mining continues to the extent of the conveyor system

The mining and conveyor will advance in 150 m x 150 m panels with continuous DVT rehabilitation to the extent of the conveyor system, at which point the process will revert to the other side of the conveyor and retreat back to the initial mined area.

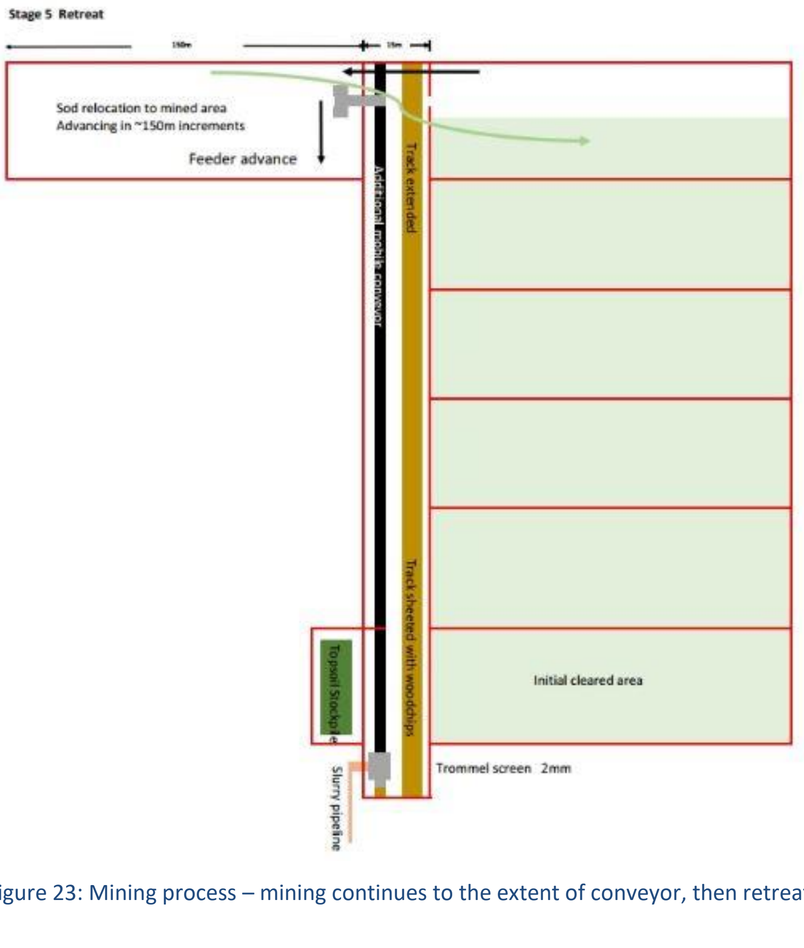


Figure 23: Mining process – mining continues to the extent of conveyor, then retreats

8. Mining continues in panels to the initial cleared area at which point the previously stockpiled topsoil will be spread across the final mined panel

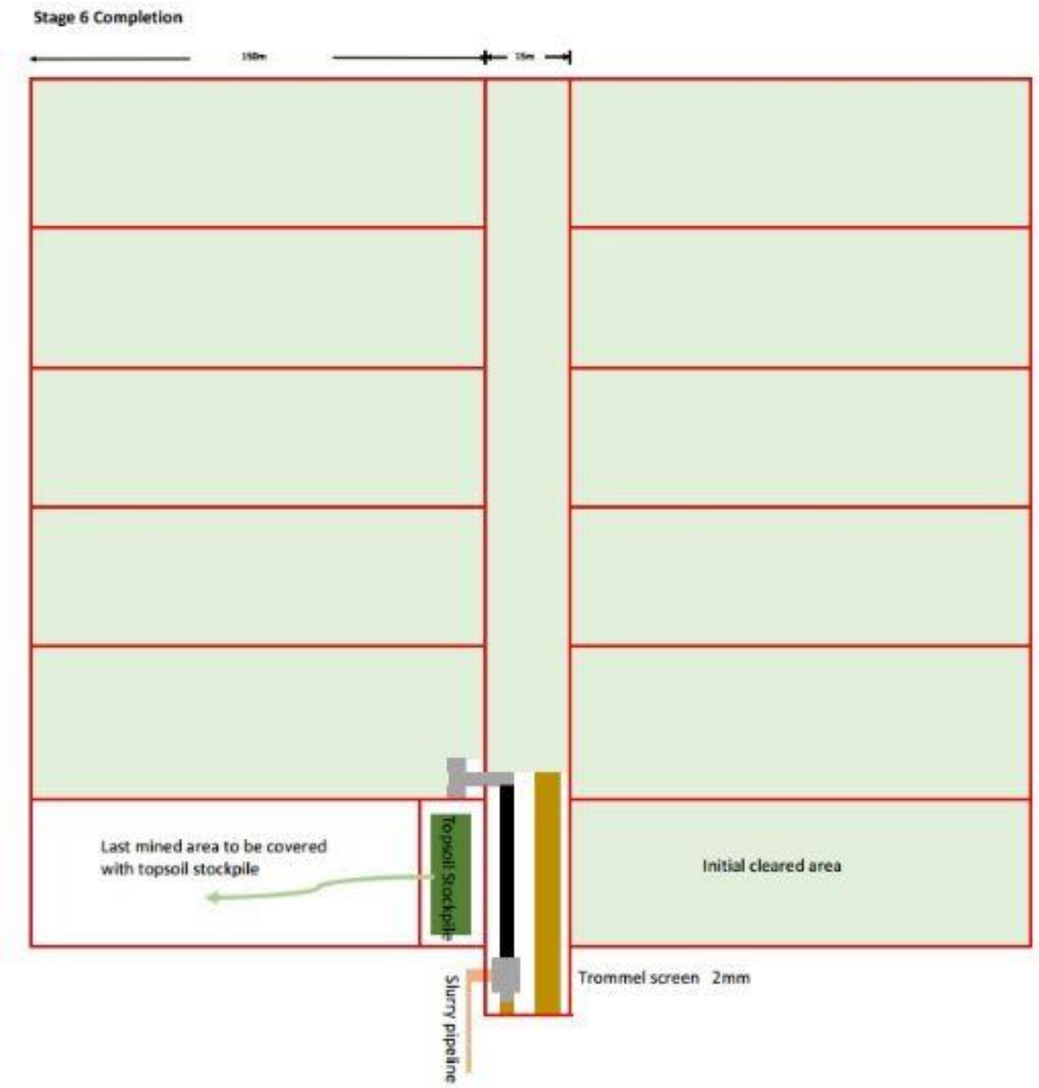


Figure 24: Mining process – mining continues in retreat to initial cleared area

9. ***The conveyor will then have a transverse added component and move the mining to a new area where the process will be repeated.***

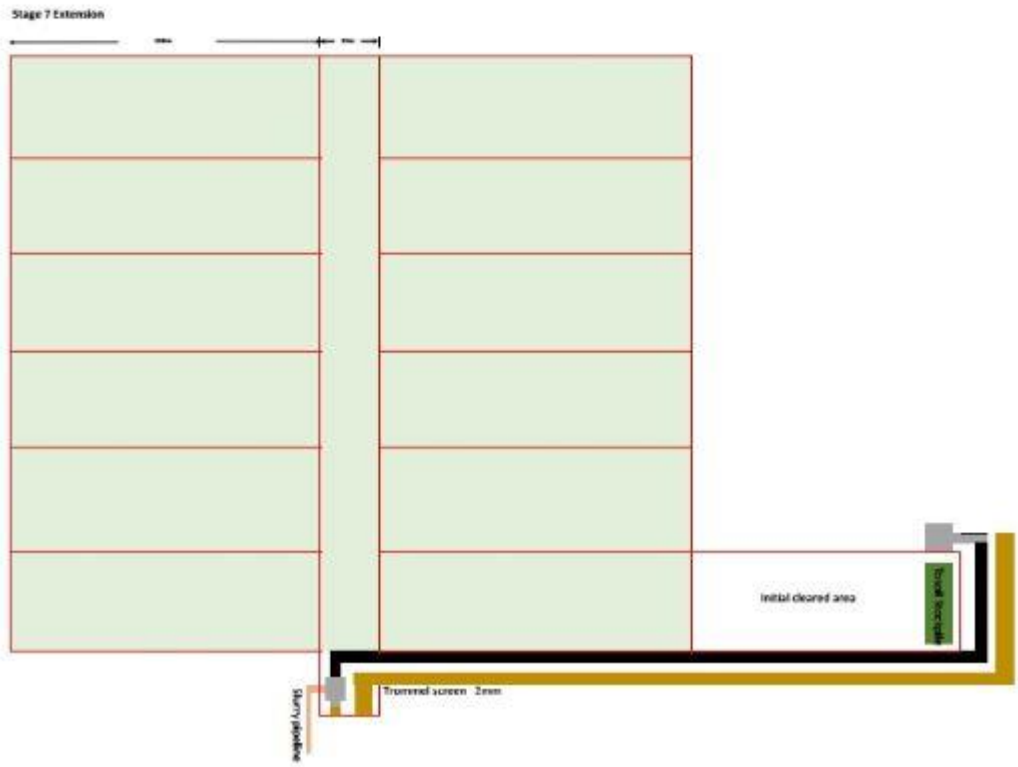


Figure 25: Mining process – process is repeated

7 Metallurgy

7.1 Sampling

A composite auger sand sample from Arrowsmith North was sent to CDE Global, in Cookstown, Northern Ireland for testing. The sample was screened at 4 mm to remove oversize particles. The remaining material was then subjected to an attrition process followed by spiral separations (Figure 26). The summary below was extracted from CDE Global's report (*Testing report, lab quotation number 0032; also refer to the Company's ASX announcement of 20 September 2018*).

7.1.1 Attrition and washing tests

Attrition testing was carried out at a retention period of 5 minutes, with the sample washed after attritioning to remove any liberated fine particles. Spiral testing was then carried out with approximately 80 kg of attritioned material. Attrition scrubbing is a process whereby minerals such as quartz can be cleaned, by the action of particles impacting one another and the removal of coating impurities such as clay. The attritioned sample was analysed for particle size distribution (Table 26) and a visual comparison is shown in Figure 27.

7.1.2 Spiral tests

Two different cut points were utilised in the spirals testing: an aggressive cut which produces high quality material but a lower yield and a conservative cut which produces material of a reduced quality but with a higher yield. The samples then underwent wet magnetic separation to explore the possibility of reducing the magnetic mineral content. The products from each stage of testing were chemically analysed to give an overview of the composition of each product (Table 27).

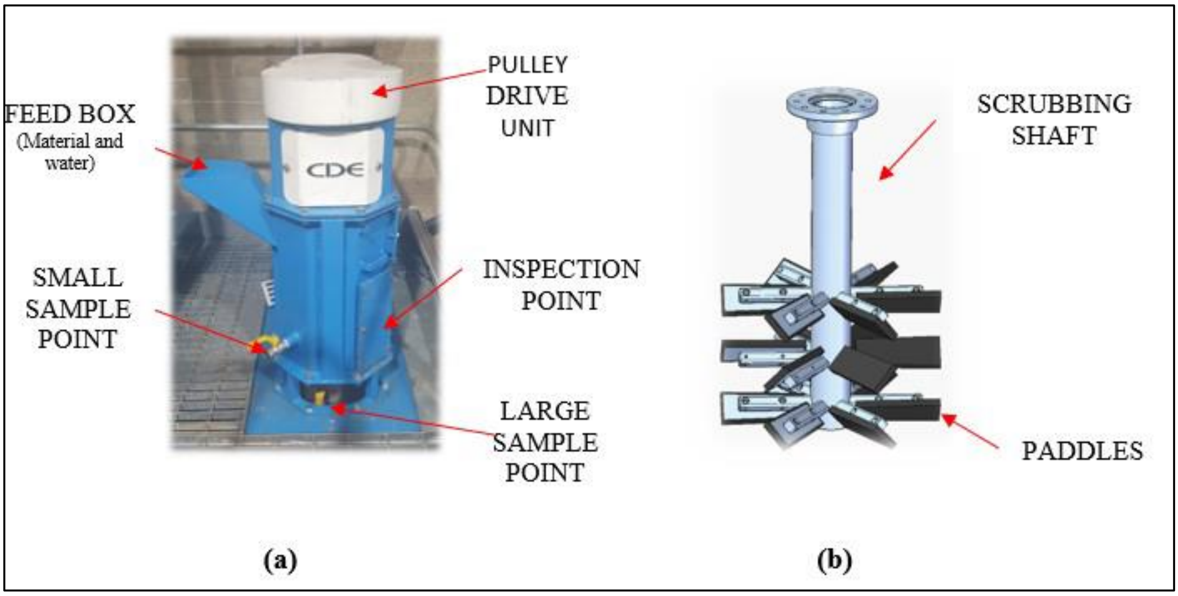


Figure 26: Lab scale attrition mill (left) and paddle shaft from lab scale attrition mill (right)

Figure 27: Arrowsmith North – visual comparison post attrition

Pre-washed material (bottom) with post attrition, washed material (top).

7.1.3 Chemical analyses

Chemical analysis showed a general decrease in Al_2O_3 with processing; attritioning and washing the material removed the largest fraction of Al_2O_3. The spiral separation process produced samples where the largest fraction of Al_2O_3 was found in the heavy mineral fraction. Magnetic separation resulted in the largest fraction of Al_2O_3 being in the magnetic fraction. The results for Fe_2O_3 follow the same general trend as for Al_2O_3.

The percentage fraction of SiO_2 in the samples increased during the test process. Attritioning and washing the material removed fines and silt, which increased the SiO_2 content. The spirals test produced samples where the largest fraction of SiO_2 was found in the light fraction. Magnetic separation indicated that the largest fraction of SiO_2 was in the middlings fraction.

7.1.4 Conclusions - glass and ceramic specifications

In the production of glass, there is both the need and requirement for silica to be chemically pure (composed of over 98% SiO_2), of the appropriate diameter (a grain size of between approximately 0.1 mm and 0.4 mm) and with low iron content (less than approximately 0.04% Fe_2O_3). Refer to Tables 19, 20 and 21 for examples of chemical and size distribution for silica products for the glass and ceramics markets. CSA Global is of the opinion that available process testwork indicates that likely product quality is considered appropriate for industrial mineral applications such as glass manufacture.

7.1.5 CDE Global testwork – 2019

Raw material remaining from first phase of testwork was removed from storage and was screened at 1 mm to remove oversize material and organics (Figures 28 and 29). These two fractions were screened to obtain particle size distributions (PSD) which are presented in Table 26 and Figure 30. Chemical analyses are presented in Table 27 and show that the +1 mm material contains less Al_2O_3, Fe_2O_3 and TiO_2 than the feed material, probably because there is less clay in the +1 mm fraction.

The sand was then wet screened through a 0.212 mm sieve and PSD test run which showed that the +0.212 mm material contains some fines (3.25% passing the 0.212 mm sieve) and in contrast the -0.212 mm sample contains a large amount of fines with 27.2% passing the 0.053 mm sieve. Chemical analysis showed that the -0.212 mm fraction contains more Al_2O_3 and Fe_2O_3 than the +0.212 mm fraction, due to higher clay fraction in the finer sample.

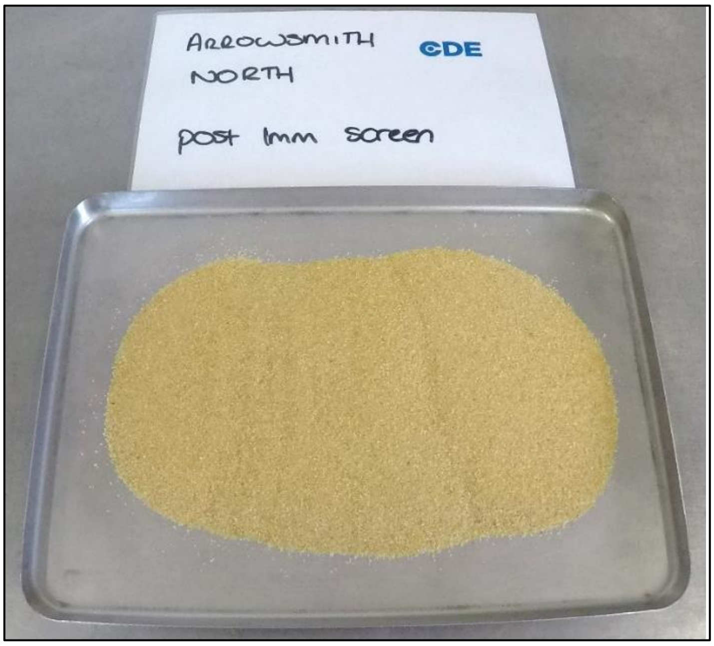


Figure 28: Arrowsmith North sand after screening to minus 1 mm

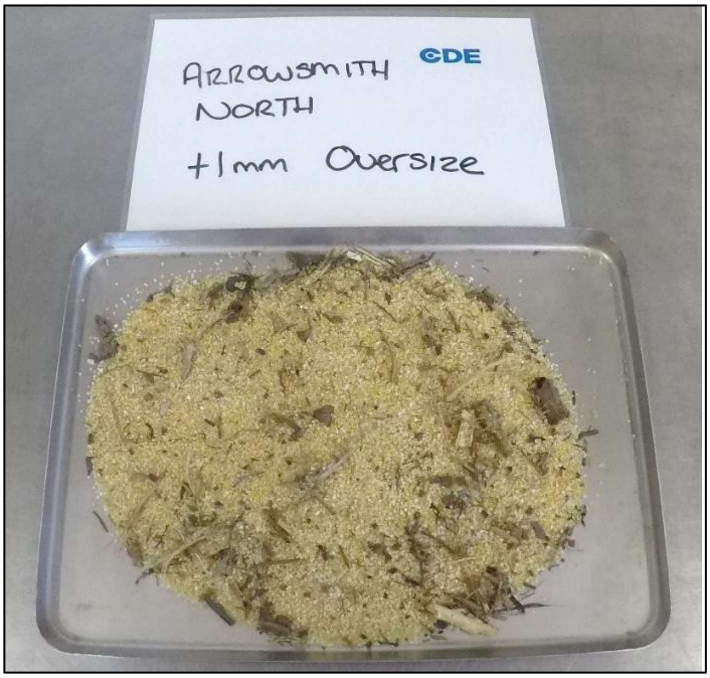


Figure 29: Arrowsmith North oversize sand and organic material after screening to plus 1 mm

7.1.6 Attrition and washing tests

The 0.212-1 mm fraction was then attritioned for 5 minutes and washed over a 0.063 mm sieve, highlighting that the attrition and washing process removed fine particles, and reduced Al_2O_3, Fe_2O_3 and TiO_2 contents (Tables 25 and 26).

7.1.7 Spiral tests

The 0.212 mm material was then processed in a spirals test unit and three fractions were produced, namely heavy, middling and light. Particle size distribution analysis showed that the heavies contain the highest amount of fines and that the lights contain the lowest amount of fines. This is probably because fine-grained dense minerals containing Fe and Ti are concentrated with the heavy fraction. This observation was borne out by chemical analysis which showed that Al_2O_3, Fe_2O_3 and TiO_2 are highest in the heavy fraction. These elements are lowest in the middling and light fractions, and lower than the feed material.

Sieve size (mm)	Mesh #	Raw material (% passing)	After attritioning For 5 minutes (% passing)
6.3	1/4 inch	100.0	100.0
4.75	3.5	100.0	100.0
2.36	7	100.0	100.0
1.18	14	100.0	99.9
0.6	25	82.5	80.6
0.355	44	33.3	30.0
0.212	72	10.7	18.8
0.106	150	4.0	1.0
0.075	200	3.0	0.2
0.038	400	2.7	0.0
Pan		0.0	0.0

Table 25: Arrowsmith North particle size distribution before and after attritioning

Process stage	Sample description	Mass	Fe_2O_3	MnO	TiO_2	Al_2O_3	SiO_2
		%	%	%	%	%	%
Feed	Raw Material		0.388	0.002	0.110	1.131	97.79
Attrition process and EvoWash Simulation	Attritioned & washed material		0.074	0.001	0.053	0.227	99.54
Spiral test 1. High grade, low yield	Heavies	10.27	0.086	0.002	0.074	0.215	99.52
	Middlings	79.90	0.043	0.000	0.021	0.166	99.67
	Lights	9.83	0.052	0.000	0.021	0.171	99.62
Spiral test 2. Low grade, high yield	Heavies	1.43	1.027	0.032	1.107	0.402	97.10
	Middlings	84.97	0.058	0.001	0.040	0.194	99.55
	Lights	13.60	0.048	0.000	0.025	0.207	99.46
Mag Sep Feed	Low grade, high yield - lights + middlings mixed		0.045	0.000	0.025	0.160	99.63
Magnetic separation of spiral test 2	Magnetics	0.63	1.546	0.043	2.267	0.507	95.25
	Middlings	9.33	0.045	0.000	0.025	0.176	99.65
	Non-magnetic	90.04	0.041	0.000	0.020	0.180	99.67

Table 26: Summary chemistry of samples processed at CDE Global, Northern Ireland.
(Analyses by ICP method)

7.1.8 Magnetic separation tests

The middling and light fractions from the spiral testwork were combined to form the feed for magnetic separation tests. The composite was then processed through a magnetic filter to generate magnetic, middling and non-magnetic fractions (Figure 21). Three magnetic strengths namely 0.5 Tesla, 0.65 Tesla and 1.0 Tesla were used.

The separation process works by passing sand and water slurry through a magnetised matrix in what is known as a 'HI Filter Unit'. Material which passes freely through the filter is described as non-magnetic, whereas the magnetic material adheres to the filter. At the end of the test, the HI Filter is de-energised and flushed using compressed air and water to discharge the magnetic particles which have collected in the magnetic matrix.

Magnetic separation results in an increase in SiO_2 and a decrease in Al_2O_3, Fe_2O_3 and TiO_2 in the non-magnetic fraction compared with the feed material (Tables 28 and 29).

7.1.9 Foundry products – comments on PSD

The composite sample tested by CDE Global in 2018 and 2019 indicates that a product with AFS ~45 should be achievable (Table 28 and Figure 30) and that some coarser AFS 20 product may also be achievable. Other foundry sand specifications include roundness and sphericity (Figure 30), clay content (generally <0.5%), moisture and SiO_2 content, which should be achievable with suitably processed Arrowsmith North silica sand.

7.2 Conclusions for products

Process testwork on a composite drill sample indicates that the Arrowsmith North deposit is suitable for the production of silica sand for glass, ceramics and foundry markets.

Sieve size (mm)	Sieve size (US mesh)	Raw material % passing	+1mm material % passing
1.7	12	100.0	98.0
1.18	16	99.9	93.8
0.85	20	98.5	18.2
0.600	30	84.1	3.3
0.425	40	54.5	2.6
0.300	50	28.3	1.8
0.212	70	12.4	1.2
0.150	100	6.1	0.9
0.106	140	3.7	0.8
0.075	200	2.7	0.8
0.053	270	2.2	0.7

Table 27: Arrowsmith North raw material and +1mm oversize material PSD results

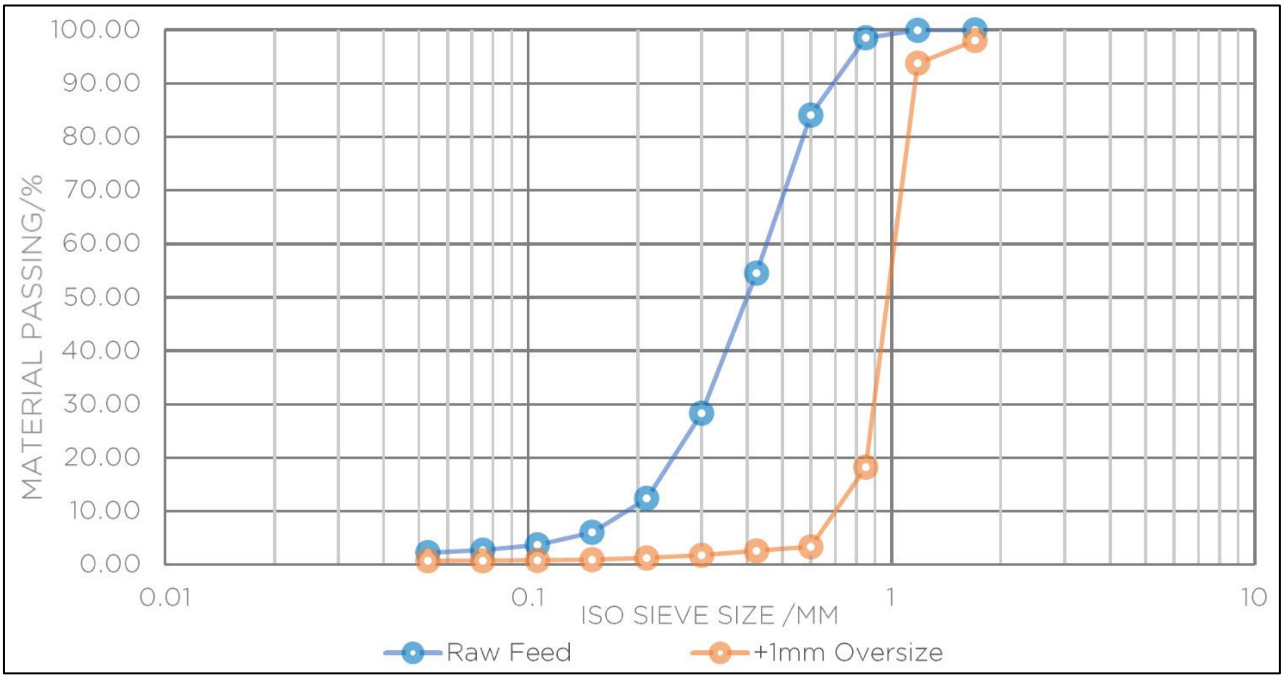


Figure 30: PSD curves for Arrowsmith North raw material and +1mm oversize material (CDE Global 2019)

Process Stage	Sample Name	Analysis method	Al_2O_3	CaO	Fe_2O_3	MgO	SiO_2	TiO_2
			%	%	%	%	%	%
Feed	Raw material	XRF	1.16	0.01	0.38	0.01	97.30	0.19
		ICP-MS	1.13	0.01	0.39	0.01	98.23*	0.11
1 mm screen	>1mm material	XRF	0.72	0.09	0.16	0.01	98.36	0.05
		ICP-MS	0.45	0.02	0.01	0.01	99.31*	0.03

** Calculated value*

Table 28: Chemical analysis of Arrowsmith North raw material and +1mm oversize

Sieve Sizes	Post attrition & wash 1	Post attrition & wash 2, post 0.212mm screen	-0.212mm material
	% passing	% passing	% passing
1.7	100.0	100.0	100.0
1.18	100.0	100.0	100.0
0.85	99.4	99.4	100.0
0.600	83.9	81.8	99.9
0.425	50.0	46.6	99.8
0.300	20.2	16.2	99.4
0.212	4.2	1.2	70.2
0.150	1.3	0.1	10.8
0.106	0.5	0.03	2.3
0.075	0.1	0.03	0.8
0.053	0.04	0.02	0.3

Table 29: Arrowsmith North post attrition wash

(Post attrition and wash 2 post 0.212 mm; -0.212 mm PSD results)

Process Stage	Sample Name	Analysis method	Al_2O_3	CaO	Fe_2O_3	MgO	SiO_2	TiO_2
			%	%	%	%	%	%
Attrition and EvoWash 1	Post wash	XRF	0.32	0.01	0.08	0.01	99.82	0.06
		ICP-MS	0.233	0.010	0.083	0.003	99.580*	0.039
Attrition and EvoWash 2. 0.212 mm screen	-0.212 mm	XRF	0.82	0.06	0.27	0.02	97.80	0.48
		ICP-MS	0.656	0.064	0.240	0.008	98.330*	0.237
	+ 0.212 mm	XRF	0.28	0.01	0.06	0.01	99.57	0.04
		ICP-MS	0.21	0.01	0.07	0.00	99.63*	0.03

** Calculated value*

Table 30: Chemical analysis of Arrowsmith North

(Post attrition and wash 2 post 0.212 mm; -0.212 mm)

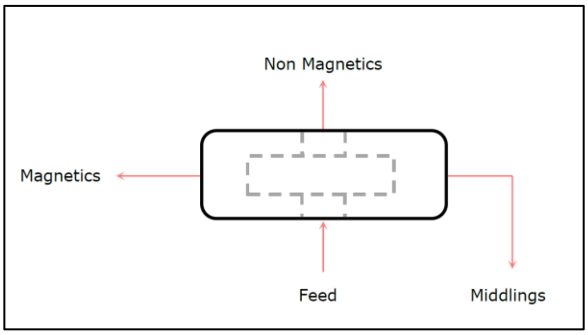


Figure 31: Schematic diagram of the magnetic filter separation process

Process Stage	Sample Identification	Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	SiO_2	TiO_2	Total	LOI 1000
		%	%	%	%	%	%	%	%	%
Magnetic Separation Feed Material	Feed	0.42	0.01	0.05	0.03	<0.01	99.11	0.03	99.94	0.28
0.5T Magnetic Separation	Magnetics	0.74	0.05	0.4	0.05	0.05	98.72	0.41	100.7	0.23
	Middlings	0.24	0.01	0.05	0.02	<0.01	99.03	0.03	99.6	0.2
	Non-magnetics	0.24	0.01	0.05	0.02	<0.01	99.51	0.04	100.05	0.18
0.65T Magnetic Separation	Magnetics	1.85	0.1	1.19	0.09	0.16	95.08	1.28	100.3	0.35
	Middlings	0.23	0.02	0.05	0.02	<0.01	99.24	0.04	99.9	0.27
	Non-magnetics	0.24	0.01	0.05	0.02	<0.01	99.61	0.03	100.2	0.2
1.0T Magnetic Separation	Magnetics	1.5	0.14	0.89	0.15	0.11	96.37	0.91	100.55	0.31
	Middlings	0.26	0.01	0.05	0.03	<0.01	99.18	0.03	99.74	0.17
	Non-magnetics	0.23	<0.01	0.04	0.02	<0.01	99.53	0.03	100.15	0.29

Table 31: XRF chemical analysis of Arrowsmith North magnetic separation tests 0.5T, 0.56T and 1.0T

Process Stage	Sample Identification	Na_2O	MgO	Al_2O_3	K_2O	CaO	TiO_2	Fe_2O_3	SiO_2
		%	%	%	%	%	%	%	%
Magnetic Separation Feed Material	Feed	0.005	0.003	0.207	0.028	0.008	0.021	0.059	99.65
0.5T Magnetic Separation	Magnetics	0.009	0.013	0.293	0.043	0.062	0.198	0.271	99.02
	Middlings	0.004	0.002	0.216	0.030	0.008	0.021	0.060	99.63
	Non-magnetics	0.004	0.002	0.209	0.026	0.007	0.019	0.056	99.65
0.65T Magnetic Separation	Magnetics	0.021	0.039	0.548	0.098	0.105	0.479	0.666	97.86
	Middlings	0.005	0.003	0.212	0.026	0.010	0.020	0.062	99.64
	Non-magnetics	0.004	0.002	0.210	0.027	0.007	0.019	0.058	99.66
1.0T Magnetic Separation	Magnetics	0.024	0.045	0.702	0.167	0.145	0.583	0.710	97.40
	Middlings	0.004	0.002	0.216	0.029	0.007	0.021	0.059	99.65
	Non-magnetics	0.003	0.002	0.209	0.028	0.006	0.020	0.053	99.66

Table 32: ICP-MS chemical analysis of Arrowsmith North magnetic separation tests 0.5T, 0.56T and 1.0T

Sieve mm	Sieve US mesh	Retained Sieve %	Multiplier	Product
3.35	6	0	3	0
1.7	12	0	5	0
0.85	20	1.5	10	15
0.6	30	14.4	20	288
0.425	40	29.6	30	888
0.3	50	26.2	40	1048
0.212	70	15.9	50	795
0.15	100	6.3	70	441
0.106	140	2.4	100	240
0.075	200	1	140	140
0.063	270	2.2	200	440
	PAN	0.5	300	150
	Total	100		4445
	AFS			**45**

Table 33: AFS calculation for Arrowsmith North raw material feed (sieve data from CDE Global 2019 report)

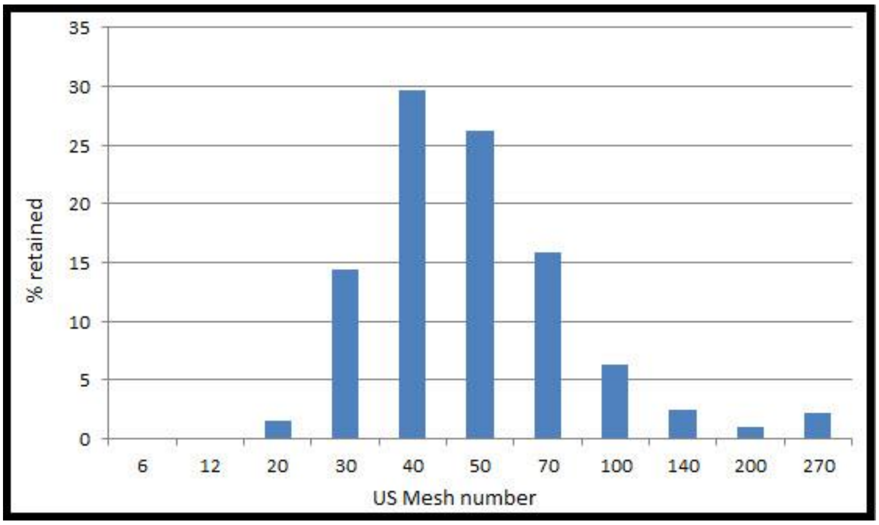


Figure 32: Size distribution (% retained) on sieves – raw material feed sample (CDE Global, 2019)

Figure 33: Arrowsmith North cream sand

(18_0002: 0.212-0.425 mm non-magnetic fraction Sphericity = 0.6 and roundness = 0.4)

The Project will utilise existing technology widely used in the mineral sands separation industry.

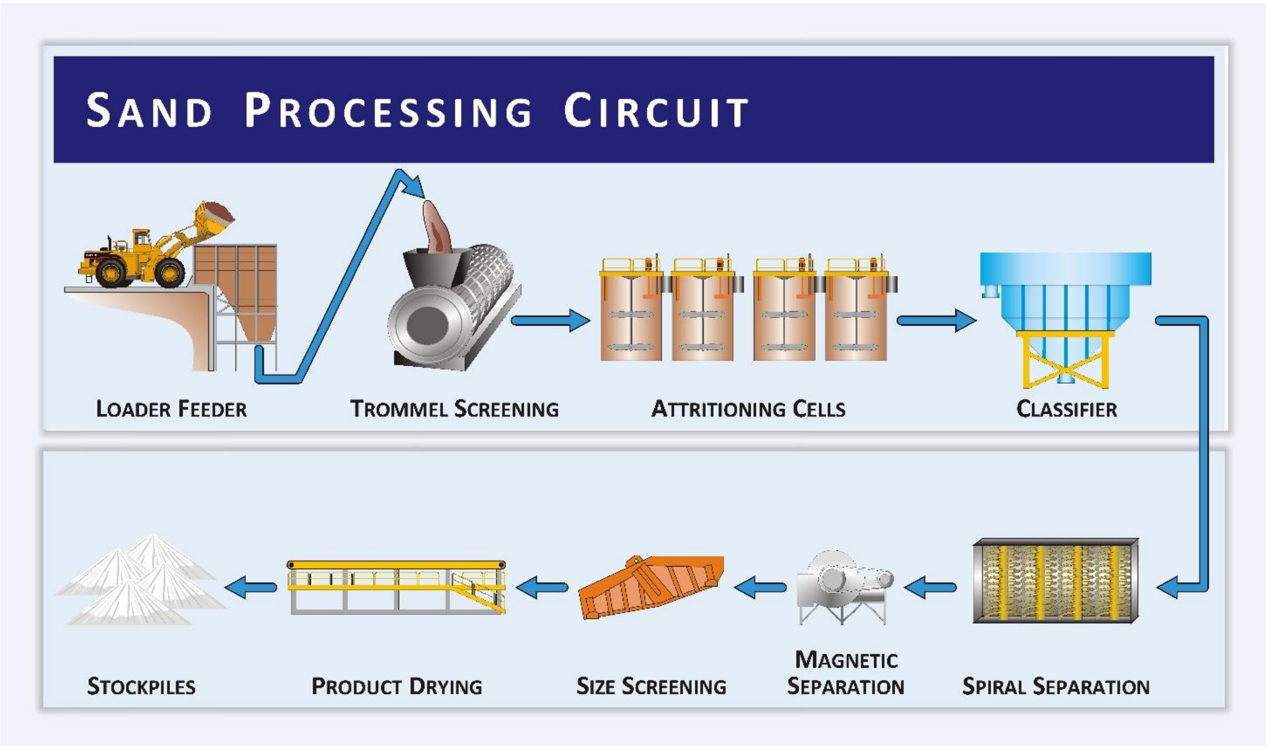


Figure 34: Processing circuit

8 Infrastructure

8.1 Roads

The project will be accessed by a 6 km dedicated road from a junction with the adjacent Brand Highway. The access road will be an upgraded existing cleared track.

8.2 Mine Services Area

The mine services area of 1 Ha will include demountable offices, workshop and ablutions.

8.3 Accommodation

No accommodation will be constructed or is required on the site

8.4 Fuel Storage

Fuel storage will require 1x55,000 litre bunded fuel storage facility for mining operations.

8.5 Water Supply and Distribution

8.5.1 Raw Water

Processing will recycle 95% of water and require 500 Megalitres per year as top up process water. Water will be stored in a 80 m x 80 m lined storage dam constructed in the vicinity of the feeder station. An additional two similar sized dams will be required to polish processing plant return water before being re-used.

Water supply will be from 2 bores sunk to the Yarragadee North deep acquifer and piped to the storage dam at the processing plant site. The Company has a pending application for a Miscellaneous License for the Search for Water over the Mining Lease area.

8.5.2 Potable Water

Potable water requirements will be from off site and trucked to a day storage tank.

8.6 Waste Disposal

The site will generate very little waste products which will be disposed of offsite. Waste hydrocarbon products will be disposed of offsite at licensed disposal sites.

8.7 Power Supply

The Project will have a dedicated diesel fired power supply adjacent to the off-site processing plant facility. Power requirements for the feeder and mining area will be reticulated by aerial power lines.

Total power requirements will be 4 Megawatts with 5 Megawatts installed with redundant capacity.

8.8 Communications

The site has mobile phone coverage and will utilise VHF channels for site communications.

9 Mill Residue Dry Stacking

9.1 Water Management

The processing plant will utilise a thickener and polishing ponds to recycle 95% of the processing water.

9.2 Residue Management

The processing plant will produce a tailings residue of up to 40,000 tonnes per year of fine-grained clay. The clay will be predominately aluminium and titanium with some iron. The clay contains no heavy metals or significant deleterious elements. A series of high-pressure cyclones will be utilised to produce a near dry (2-3% moisture) tail as clay and recover the water for re-use. The clay can be returned to the mined area and spread over the remaining sand after mining and before the VDT procedure. There is also a local market for tailings residue as a soil conditioner in the local sandy agricultural areas.

10 Product Logistics

10.1 Rail

There is a rail connection from the project area to the Geraldton Port via Narngulu, which is the route previously used by the Eneabba mineral sands operations. The rail is rated at 19 tonnes per axle and is a Tier 1 railway line. The mineral sands operations have depleted reserves and are no longer operating. The rail turnaround is at Eneabba and there is also a passing bay near Dongara. Rail operations for Arrowsmith North would most likely use the Dongara passing bay to avoid the Brand Highway crossing at Eneabba. There is very little rail traffic on the route.

The owner of the line is Arc Resources Pty Ltd, a subsidiary of Brookfield Limited.

While Arc Resources owns and maintains the railway line, it does not operate rolling stock.

The main operators in Western Australia are Watco Group, Pacific National and Aurizon. Carriages will be the same as for grain cartage; namely, covered wagons and bottom dumping. All operators have available carriages but locomotives are in short supply. Each operator will require six months' notice to begin haulage operations. All operators have submitted haulage proposals.

The rail capacity can haul up to 2 million tonnes per year with one train set. The rail operators have estimated that up to 4 million tonnes per year and two train sets is the maximum capacity without significant upgrades to the rail operations.

10.2 Port

Geraldton port operations are operated by Mid West Ports, which owns the rail unloading and ship loading equipment and leases storage areas.

The Company has engaged with the Mid West Ports Authority for unloading, storage and shiploading and has received indicative operating costs, barrier limits and capacity.

11 Environment, Water and Social Factors

The Company has undertaken detailed surveys and investigations regarding flora and vegetation, fauna, inland waters and social surroundings for the Project area.

Table 34 sets out a summary of the surveys undertaken, potential impacts and impact management plans.

EPA Factor*	Surveys and investigations undertaken	Potential impact(s) – based on the surveys	Management of impacts
Flora and Vegetation	Desktop and Field study of Flora and Vegetation, Spring 2018 (Mattiske). Key notes: • Survey covers part of the DE • No Threatened Flora found in DE to date • No Threatened Flora with high likelihood of occurrence • Priority Flora recorded in DE • No TECs or PECs	Vegetation Clearing: • Mining will occur in 2.25 ha blocks (150 m x 150 m), up to 16 blocks will be mined each year (35 ha) • 12 ha of vegetation will be cleared for long term infrastructure, this will last the life of the mine • A total of 15 ha will be 'open' at any one time (inclusive of long term clearing) • This strategy will result in 353 ha of vegetation being cleared and rehabilitated over the life of the Proposal. No clearing of Threatened Flora (will be avoided if new specimens found during surveys) Clearing of Priority Flora could occur and their survival after VDT cannot be guaranteed at this stage. The health of 353 ha of vegetation will be affected by the VDT method.	• Detailed flora and vegetation survey over DE to identify areas of significance (i.e. significant flora and vegetation) • Any Threatened Flora records will be avoided • Long-term clearing restricted to 12 ha for mining and processing infrastructure. • Mining will be carried out in panels, with only 2.25 ha of active mining area at any one time. • Direct rehabilitation will happen in parallel with mining, using VDT • Vegetation will be removed in situ and transferred directly to already mined and landformed areas to retain vegetation and rootstock • Flexibility is provided by a 1,572 ha development envelope, with the Proposal encompassing 365 ha of this area • By utilising a larger development envelope it is possible to select areas to mine which will not have an impact on significant flora and vegetation • Implementing VDT results in a greater likelihood of retaining the complete vegetation assemblage. This method retains hard to rehab flora such as recalcitrant species
Terrestrial Fauna	Level 1 Fauna Survey, Summer 2019 (Bamford Consulting Ecologists) Key notes: • Survey covers part of the DE	• Habitat clearing (refer above for size and method). • All habitat predicted to be potential Carnaby's Black Cockatoo foraging habitat	• Detailed fauna survey over DE to identify areas of significant habitat • Refer above for clearing method • If roosting trees are recorded they will be avoided • If active Malleefowl mounds are recorded they will be avoided

EPA Factor*	Surveys and investigations undertaken	Potential impact(s) – based on the surveys	Management of impacts
	• No Threatened Fauna found in DE to date • Vegetation represents Carnaby's Black Cockatoo foraging habitat • No roosting trees recorded or expected • No Malleefowl mounds recorded • High pest numbers (wild cats, foxes and dogs)	• No impacts to active Malleefowl mounds (will be avoided if found) • Direct impacts (mortality, injury) to conservation significant fauna from clearing and mining operations could occur • Impacts to fauna habitat health are expected to be minimal due to VDT method	
Inland Waters	Hydrogeological Feasibility Assessment, January 2019 (HydroConcept). Key notes: • All mining to occur above water table • Water supply to target deeper Yarragadee Aquifer • No defined surface drainage due to sandy soils • No contamination risk – process plant simply washes clays (2%) out of sand	• Changes to surface water infiltration and flows due to removal of 3 – 8 m of silica sand and deposition of clays • Potential impact on other groundwater users of the Yarragadee Aquifer	• Abstraction will be from the Yaragadee aquifer which will minimise the impact on groundwater dependent ecosystems (if present) or users of the surficial aquifer. • Abstraction managed under RIWI Act • No other groundwater users were identified in close proximity to the Proposal. • Landforming of the mined areas to maintain a natural water regime.
Social Surroundings	None to date. No registered Aboriginal or European heritage sites in DE	• Noise and dust impacts unlikely given small scale of operations and distance to residents (buffer distance can be maintained) • Impacts to Aboriginal heritage sites expected to be able to be avoided if recorded	• Buffer distance between operations and residential properties • Use of existing rail – no transport on public roads • Aboriginal heritage surveys to be completed • Heritage sites to be avoided if recorded, or S18 approval if it cannot be avoided (unlikely)

Table 34: Summary of flora and vegetation, fauna, inland waters and social surroundings

11.1 Environment

The Project site falls into the Lesueur Sandplain subregion – Figure 35 (Thackway & Cresswell 1995).

The climate is warm Mediterranean with a hot, dry summer and a cool, wet winter.

Median and mean annual rainfall in this region are 481 mm and 489 mm respectively. The Lesueur Sandplain is dominated by proteaceous heath on sandy over lateritic soil; the dominant land uses are dryland agriculture, conservation and crown reserves.

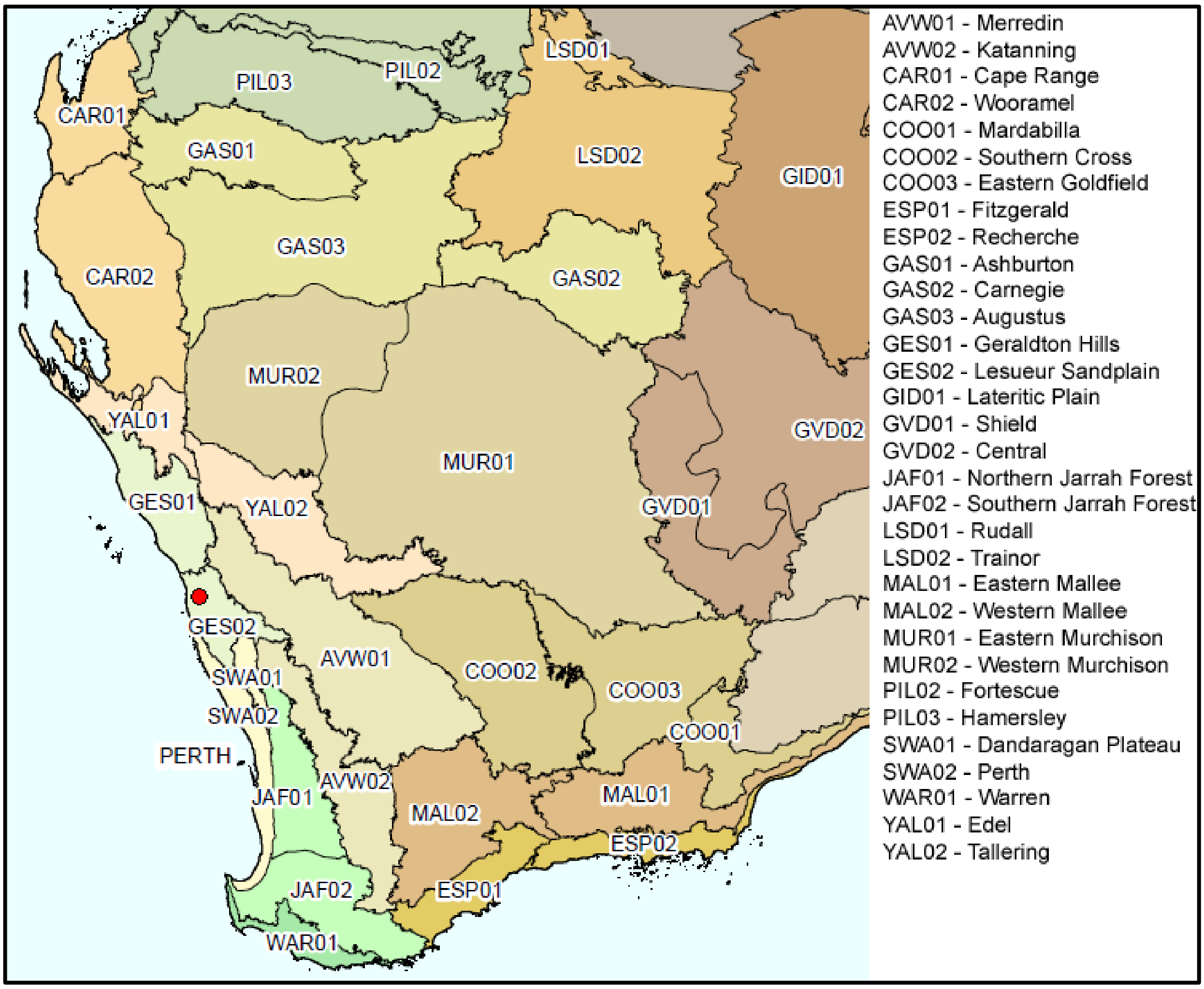


Figure 35: Bioregions across Western Australia (Project area in the Lesueur Sandplain subregion)

11.1.1 Vegetation and Flora

Vegetation in the Project area primarily consists of scattered eucalypts over mixed kwongan shrubland on sand. There is a seasonal drainage line running through the southern part of the Project area.

Mattiske Consulting was commissioned in October 2018 by Preston Consulting Pty Ltd on behalf of VRX to undertake a flora and vegetation survey of the entire Arrowsmith survey area (including the Company's other project areas adjacent to Arrowmsith North). The survey area occupies an area of approximately 2520 ha, and is located between the towns of Eneabba and Dongara, Western Australia. A total of 139 vegetation survey quadrats were established to sample all the apparent vegetation community types which were located within the survey area. A total of 16 of these vegetation survey quadrats were located with a current revised development envelope.

Rainfall in the three months preceding the October/November 2018 survey was above the long-term average rainfall for the area, based on Bureau of Meteorology data for Green Grove. Overall, and based on a range of factors including the proportion of potential flora recorded (estimated at 85%), proportion of annual taxa recorded (14.35 %), and vegetation quadrat distribution within the survey area the survey has not been constrained by factors which would adversely affect the survey outcomes nor the conclusions derived from the data used to support vegetation analysis. It is acknowledged the development envelope had been altered between completing fieldwork and reporting, however top up field surveys will be completed in spring 2019 to infill remaining unsurveyed areas.

A total of 263 vascular plant taxa, representative of 126 genera and 48 families, were recorded within the Arrowsmith Project survey area. The majority of taxa recorded were representative of the *Proteaceae* (36 taxa), *Myrtaceae* (33 taxa), and *Fabaceae* (22 taxa) families. Within the current development envelope, a total of 154 vascular plant taxa, representative of 88 genera and 38 families were recorded. The majority of the taxa recorded were widespread both locally and more broadly within the associated biogeographical subregion.

No threatened flora pursuant to Subdivision 2, Section 19 of the Biodiversity Conservation Act 2016 were recorded in the survey area. Ten priority taxa, as listed by the WAH (1998-) were recorded in the survey area. These were *Comesperma rhadinocarpum* (P3), *Hemiandra* sp. *Eneabba* (H. Demarz 3687) (P3), *Hopkinsia anoectocolea* (P3), *Hypocalymma gardneri* (P3), *Leschenaultia juncea* (P3), *Persoonia rudis* (P3), *Banksia elegans* (P4), *Calytrix chrysantha* (P4), *Schoenus griffinianus* (P4) and *Stawellia dimorphantha* (P4). Two of these species, *Hemiandra* sp. *Eneabba* (H. Demarz 3687) (P3) and *Persoonia rudis* (P3), are present in the current development envelope.

Vegetation mapping based upon the quadrat-based species data resulted in four vegetation communities comprising three *Eucalyptus todtiana* shrublands and one mixed heathland community. The most dominant vegetation type was the S2 vegetation community which was present throughout the central and northern portion of the development envelope. This community accounted for 41.7 % of the total area surveyed. The second most commonly represented vegetation was the H1 vegetation community which was a common feature in the central and southern portion of the development envelope. The most restricted vegetation community defined was the Woodland of *Xylomelum angustifolium* and *Eucalyptus todtiana* community (W1, 2.3 % of the area surveyed).

Overall, the vegetation communities mapped and species recorded in the Arrowsmith survey area were consistent with the historical mapping of Beard (1976, 1990). The majority of the survey area is situated on sand plains supporting *Eucalyptus todtiana* over mixed heath. The vegetation communities they hosted were not locally or regionally unique as they are well represented in the wider area. It is recommended to infill areas in the current development envelope that were not assessed in the current survey - spring is the optimal time. Given two priority flora species were recorded in the current development envelope, *Hemiandra* sp. *Eneabba* (H. Demarz 3687) (P3) and *Persoonia rudis* (P3), it is recommended that the development envelope be further refined so a more detailed and targeted search can be carried out to obtain an accurate idea of population numbers to be impacted.

Environmental Legislation and Guidelines

The following key Commonwealth (federal) legislation relevant to this survey is the:

- *Environment Protection and Biodiversity Conservation Act 1999.*

The following key Western Australian (state) legislation relevant to this survey include the:

- *Biodiversity Conservation Act 2016 (**BC Act**);*
- *Biosecurity and Agriculture Management Act 2007 (**BAM Act**); and*
- *Environmental Protection Act 1986 (**EP Act**); and Wildlife Conservation Act 19 50 (**WC Act**).*

Furthermore, key Western Australian guidelines relevant to the survey are the:

- *Environmental Factor Guideline: Flora and Vegetation (**Environmental Protection Authority [EPA] 2016a**); and*
- *Technical Guidance – Flora and vegetation surveys for environmental impact assessment (**EPA 2016b**).*

Desktop Assessment

A desktop assessment was conducted using FloraBase (WAH 1998-), NatureMap (DPaW 2007-) and Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) Protected Matters Search Tool (DoTEE 2013) databases, to identify the possible occurrence of threatened and priority flora and threatened and priority ecological communities within the Arrowsmith Project survey area.

The NatureMap search was conducted separately for the three main Arrowsmith exploration licences: North (E70/5027), Central (E70/4987) and South (E70/4986). Search parameters were ‘by rectangle’ and encompassed each Arrowsmith Project Tenement

Field Survey

A detailed field assessment of the flora and vegetation of the Arrowsmith survey area within tenements E70/4987 and E70/5027 was undertaken by four experienced botanists from MCPL, between 29 October and 9 November 2018, in accordance with methods outlined in Technical Guidance – Flora and vegetation surveys for environmental impact assessment (EPA 2016b) (**Technical Guidance**). All botanists held valid collection licences to collect flora for scientific purposes, issued under the WC Act.

The geographic co-ordinates defining the Arrowsmith survey area were supplied by the Company. Aerial photographic maps of the proposed Arrowsmith survey area were prepared and supplied by CAD Resources. Survey sites for the Arrowsmith survey area were selected using aerial photographic maps and field observations. A total of 139 survey sites (41 in Central survey area and 98 in North survey area) were selected to sample all vegetation types, with replication, within the survey area.

Survey sites consisted of pegged 10 m x 10 m quadrats. Flora and vegetation were described and sampled systematically at each survey site, and additional opportunistic collections were undertaken wherever previously unrecorded plants were observed. At each quadrat the following floristic and environmental parameters were recorded:

- GPS location (GDA94 datum, zone 50J);
- Local site topography;
- Soil type and colour;
- Outcropping rocks and their type;
- Percentage litter cover and percentage bare ground;
- Approximate time since fire;
- Vegetation condition (based on [Keighery 1994); and
- Flora & Vegetation – Arrowsmith Project.

For each vascular plant species, the average height and the percentage cover (of both alive and dead material) over the survey site.

For assessing threatened and priority flora, methodology consisted of extensive foot traverses within the Arrowsmith Project survey area. Botanists used handheld Garmin GPS units loaded with the survey polygons and a 400 m wide grid overlayed. Botanists walked in a zig-zag fashion recording conservation significant species. If suspected or known conservation significant flora species were encountered, a specimen was collected and plant numbers were recorded for the population.

All plant specimens collected during the field surveys were dried and processed in accordance with the requirements of the WAH. The plant species were identified based on taxonomic literature and through comparison with pressed specimens housed at the WAH. Where appropriate, plant taxonomists with specialist skills were consulted. Nomenclature of the species recorded is in accordance with the WAH (1998)

Survey Timing

According to Table 3 in the Technical Guidance, the primary survey timing for the Irwin Botanical Province is spring (September/November). As the current survey was conducted in October and November, it falls within this period. The survey was timed, where possible, to align with peak flowering periods of conservation significant flora with the potential to occur in the Arrowsmith survey area. Rainfall in the three months preceding the survey (July to September 2018) was slightly above average.

Analysis of Site Data

A species accumulation curve, based on accumulated species versus sites surveyed was prepared to provide an indication of the level of adequacy of the survey effort (Estimates – Colwell 2006). As the number of survey sites increases, and correspondingly the size of the area surveyed increases, there should be a diminishing number of new species recorded. At some point, the number of new species recorded becomes essentially asymptotic. The asymptotic value was determined using Michaelis-Menten modelling and provided an incidence based coverage estimator of species richness (Chao 2004). When the number of new species being recorded for survey effort expended approaches this asymptotic value, the survey effort can be considered to be adequate.

Plymouth Routines in Multivariate Ecological Research v7 (PRIMER) statistical analysis software was used to analyse species-by-site data and discriminate survey sites on the basis of their species composition

(Clarke and Gorley 2006). To down-weight the relative contributions of quantitatively dominant species, a fourth root transformation was applied to the data set. Introduced species, annual species, specimens not identified to species level and singletons (species recorded at a single quadrat and not forming a dominant structural component) were excluded from the data set prior to analysis. Computation of similarity matrices was based on the Bray-Curtis similarity measure. Data were analysed using a series of multivariate analysis routines including Similarity Profile (SIMPROF), Hierarchical Clustering (CLUSTER), Analysis of Similarity (ANOSIM) and Similarity Percentages (SIMPER). Results were used to inform and support interpretation of aerial photography and delineation of individual plant communities.

Vegetation Descriptions

Vegetation descriptions were based on Alpin's (1979) modification of the vegetation classification system of Specht (1970), to align with the National Vegetation Information System (**NVIS**) (see Appendix A5). Vegetation communities were described at the association level of the NVIS classification framework, as defined by the Executive Steering Committee for Australian Vegetation Information (2003). Vegetation condition of each of the mapping sites was assessed as per the criteria developed by Keighery (1994).

Survey Limitations

A general assessment was made of the current survey against a range of factors that may have limited the outcomes and conclusions of the report (Table 3, Technical Guidance). Based on this assessment, the present survey has not been subject to constraints which would affect the thoroughness of the survey, and the conclusions which have been formed.

Potential Survey Limitation	Impact on Current Survey
Availability of contextual information at a regional and local scale	**Not a limitation:** Reference resources such as Beard's mapping, together with online flora and vegetation information, has provided an appropriate level of information for the current survey.
Competency/experience of team carrying out survey; experience in the bioregion surveyed	**Not a limitation:** All botanists had extensive experience working in a range of botanical districts across the state. Majority of the plants observed in the field were collected for formal identification and were compared with specimens at the Western Australian State Herbarium where required.
Proportion of flora collected and identification issues	**Potential limitation:** While many plants were in flower during the survey, a proportion of plants encountered during the survey were sterile and may impact the chance of identification of some specimens to species level. Orchid species may not emerge each year if conditions are not favourable. Although this may affect the completeness of the species list, it is not expected to have a significant effect on mapping reliability, nor on the identification of threatened and priority species in the area as the majority were perennial species.
Effort and extent of survey (Was the appropriate area surveyed for the type of survey?) (reconnaissance/targeted/detailed)?	**Potential limitation:** The survey area was thoroughly covered. Survey quadrats were initially selected from high resolution aerial maps, with additional quadrats selected in situ based on in field observations. Low replication of some vegetation communities was unavoidable given their low occurrences within the survey area. It is acknowledged the development envelope had been altered between completing fieldwork and reporting, however top up field surveys will be completed in spring 2019 to infill remaining unsurveyed areas.
Access restrictions within survey area	**Not a limitation:** Vehicle access to the Arrowsmith Project survey area and foot traverses were sufficient to allow access to the entirety of the survey area.

Potential Survey Limitation	Impact on Current Survey
Survey timing, rainfall, season of survey	**Not a limitation:** The EPA (2016a) recommends that flora and vegetation surveys in the South – West Botanical Province be conducted in Spring (September-November). The current survey was conducted in October and November which falls within this period. Rainfall in the three months preceding the survey (July to September 2018) was slightly above average.
Disturbances (fire/flood/clearing)	**Not a limitation:** The Arrowsmith Project survey area exhibits minimal levels of disturbance, mainly from past fire events.
Data and statistical analysis	**Not a limitation:** Introduced species, annual species and singletons were excluded from the data set prior to analysis. Data collected was sufficient for delineation of vegetation communities based on statistical analysis.

Table 35: Potential limitations affecting the conclusions

Field Survey Results

A total of 139 survey quadrats were used to assess the flora and vegetation of the Arrowsmith Project survey area. A total of 16 quadrats were surveyed within the current development envelope. Refer to Appendix D for a list of the geographic locations for each of the survey quadrats. The taxa recorded during the survey are set out in Appendix E. A list of plant taxa recorded at each survey quadrat within the Arrowsmith Project survey area

Flora

A total of 263 vascular plant taxa, representative of 126 genera and 48 families, were recorded within survey quadrats within the Arrowsmith Project survey area. The majority of taxa recorded were representative of the *Proteaceae* (36 taxa), *Myrtaceae* (33 taxa) and *Fabaceae* (22 taxa) families (see Appendix E for a complete species list). From within the current development envelope, total of 154 vascular plant taxa, representative of 88 genera and 38 families were recorded. Thirty-three annual plant species were recorded during the survey of the Arrowsmith Project survey area, representing 14.35 % of all taxa recorded, five of these represent introduced annual species. A number of plant species collected could not be identified accurately to species level due to the absence of sufficient taxonomic characters to enable accurate identification. The principle reasons for not being able to fully identify some of the collected specimens to species level were:

- plant material was sterile or lacked sufficient taxonomic feature to permit accurate identification to species level. In these cases the species is identified as, for example, *Thysanotus* sp. or *Drosera* sp.; and
- the plant material collected could not be determined to a known taxon. For example, *Lepidosperma* species are currently undergoing taxonomic revision.

A species accumulation curve was used to evaluate the sampling adequacy (Figure 36). The incidence based coverage estimator (ICE) of species richness was 309.41. Based on this value and the total of 263 species recorded (in vegetation mapping sites only), approximately 85% of the flora species potentially present within the Arrowsmith survey area were recorded.

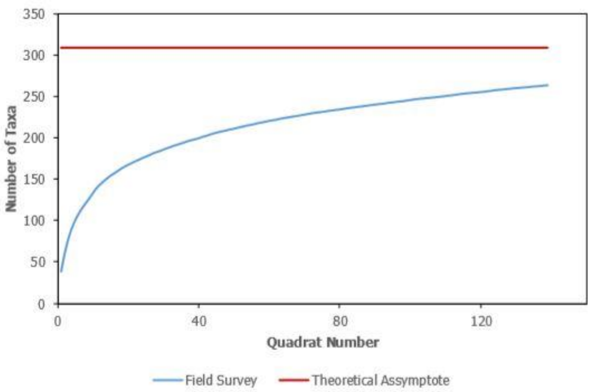


Figure 36: Average randomised species accumulation graph

Threatened and Priority Flora

No threatened flora species pursuant to subsection (2) of section 23F of the WC Act and as listed by the DBCA (2018a), or pursuant to section 179 of the EPBC Act or listed by the DotEE (2019b), were recorded within the Arrowsmith Project survey area.

Ten priority flora species, *Comesperma rhadinocarpum* (P3), *Hemiandra sp. Eneabba* (H. Demarz 3687) (P3), *Hopkinsia anoectocolea* (P3), *Hypocalymma gardneri* (P3), *Leschenaultia juncea* (P3), *Persoonia rudis* (P3), *Banksia elegans* (P4), *Calytrixchrysantha* (P4), *Schoenus griffinianus* (P4) and *Stawellia dimorphantha* (P4), as listed by the WAH (1998-), was recorded within the Arrowsmith Project survey area (Table 6). Two of these species are present in the current development envelope, *Hemiandra sp. Eneabba* (H. Demarz 3687) (P3) and *Persoonia rudis* (P3). *Hemiandra sp. Eneabba* (H. Demarz 3687) (P3) was recorded from 23 locations totalling 26 plants and *Persoonia rudis* (P3) was recorded from 6 locations totalling 8 plants.

Flora Range Extensions

Two species recorded at the Arrowsmith Project survey area represented extensions to their current known distributions, these species being *Tricoryne* sp. *Mullewa* (G.J. Keighery 12080) and *Synaphea spinulosa* subsp. *borealis*. *Tricoryn* e sp. *Mullewa* (G.J. Keighery 12080) represents a range extension of approximately 110 km to the south of its current known distribution (WAH 1998-). While, *Synaphea spinulosa* subsp. *borealis* represents a range extension of approximately 130 km to the south of its current known distribution (WAH 1998-). In this report, 100 km has been used as a basis to determine an extension to the currently known range for a species.

Introduced (Weed) Species

A total of five introduced (weed) species were recorded within the Arrowsmith survey area. None of these species, **Aira caryophyllea* , **Hypochaeris glabra* , **Lysimachia arvensis*, **Ursinia anthemoides* and **Wahlenbergia capensis* are declared pest organisms pursuant to section 22 of the BAM Act. None are listed as Weeds of National Significance (DotEE 2019c). All species recorded are listed in the Midwest region impact and invasiveness ratings (DPaW 2013). Two were listed as having high ecological impact and two were listed as being of low ecological impact, the remaining species **Wahlenbergia capensis* is listed as having unknown ecological impacts (DPaW 2013). All weed species recorded were described as having rapid invasiveness (DPaW 2013).

Statistical Analysis

SIMPROF analysis identified four significantly associated groups of quadrats. Four significantly dissimilar vegetation communities were delineated within the Arrowsmith survey area. A dendrogram representing the results of the cluster analysis, and the corresponding four vegetation communities was produced.

Vegetation Communities

Based on statistical analysis, four vegetation communities were defined and mapped across the Arrowsmith Project survey area. In addition to the statistical analysis, survey quadrat physical data and aerial photographic maps were used to delineate the boundaries of the vegetation communities in the Arrowsmith Project survey area. A summary of the vegetation communities is presented below.

S1: Isolated trees of *Eucalyptus todtiana*, over shrubland of *Banksia leptophylla* var. *melletica, Acacia blakelyi* over mixed understorey of *Proteaceae* and *Myrtaceae* species on grey/white sand plains.

S2: Isolated trees of *Eucalyptus todtiana*, over shrubland of *Melaleuca leuropoma*, *Calothamnus quadrifidus subsp. quadrifidus* and *Xanthorrhoea drummondii*, over isolated *Ecdeiocolea monostachya* and *Mesomelaena pseudostygia* on cream/grey sand plains

W1: Woodland of *Xylomelum angustifolium* and *Eucalyptus todtiana*, over open shrubland of *Melaleuca leuropoma* and *Hakea polyanthema* over isolated *Mesomelaena pseudostygia* on cream sand plains.

H1: Heathland of *Banksia attenuata*, *Hakea polyanthema* and *Melaleuca leuropoma* over isolated *Verticordia grandis* and *Banksia nivea* on white sand plains.

Threatened and priority Ecological Communities

No TECs, pursuant to Schedule 1 of the WC Act and as listed by the DBCA (2018b) or DoTEE (2019d) were recorded within the Arrowsmith Project survey area. No PECs as listed by the DBCA (2019b) were recorded within the Arrowsmith Project survey area

Vegetation Condition

The condition of the vegetation within the Arrowsmith Project survey area ranged from Pristine to Completely Degraded, with majority of the area was considered Pristine according to the Keighery (1994; Appendix A5) scale.

Within the Arrowsmith North survey area these areas can be delineated as follows:

Pristine: Majority of the current development envelope, away from edge effects on western side and recently burnt area in south. No tracks or disturbances present.

Excellent: Areas in the southern section of the development envelope, very little disturbance from fire and associated fire breaks.

Completely Degraded: Road, dam next to railway line on western side.

Conclusion and recommendations

Overall, the vegetation communities mapped and species recorded in the Arrowsmith Project survey area were consistent with the historical mapping of Beard (1976, 1990). The majority of the survey area is situated on sand plains supporting *Eucalyptus todtiana* over mixed heath. The vegetation communities they hosted were not locally or regionally unique as they are well represented in the wider area. It is recommended to infill areas in the current development envelope that were not assessed in the current survey - spring is the optimal time.

Given two priority flora species were recorded in the current development envelope, *Hemiandra sp*. Eneabba (H. Demarz 3687) (P3) and *Persoonia rudis* (P3), it is recommended that the development envelope be further refined so a more detailed and targeted search can be carried out to obtain an accurate idea of population numbers to be impacted.

11.1.2 Fauna

The objectives of investigations to date are to: identify fauna values; review impacting processes with respect to these values and the proposed activity; and provide recommendations to mitigate these impacts.

The methods used for this assessment are based upon the general approach to fauna investigations for impact assessment. The impact assessment process involves the identification of fauna values, review of impacting processes and, where possible, preparation of mitigation recommendations.

This approach to fauna impact assessment has been developed with reference to guidelines and recommendations set out by the Western Australian Environmental Protection Authority (**EPA**) on fauna surveys and environmental protection, and Commonwealth biodiversity legislation (EPA 2002; EPA 2004). The EPA proposes two levels of investigation that differ in the approach to field investigations, Level 1 being a review of data and a site reconnaissance to place data into the perspective of the site, and Level 2 being a literature review and intensive field investigations (e.g. trapping and other intensive sampling). The level of assessment recommended by the EPA is determined by the size and location of the proposed disturbance, the sensitivity of the surrounding environment in which the disturbance is planned, and the availability of pre-existing data.

The following approach and methods are divided into three groupings that relate to the stages and the objectives of impact assessment:

Desktop assessment. The purpose of the desktop review is to produce a species list that can be considered to represent the vertebrate fauna assemblage of the project area based on unpublished and published data using a precautionary approach.

Field investigations. The purpose of the field investigations is to gather information on this assemblage: confirm the presence of as many species as possible (with an emphasis on species of conservation significance), place the list generated by the desktop review into the context of the environment of the project area, collect information on the distribution and abundance of this assemblage, and develop an understanding of the project area's ecological processes that maintain the fauna. Note that field investigations cannot confirm the presence of an entire assemblage, or confirm the absence of a species. This requires far more work than is possible in the EIA process. For example, in an intensive trapping survey, How and Dell (1990) recorded in any one year only about 70% of the vertebrate species found over three years. In a study spanning over two decades, Bamford et al. (2010) has found that the vertebrate assemblage varies over time and space, meaning that even complete sampling at a set of sites only defines the assemblage of those sites at the time of sampling.

Impact assessment. Determine how the fauna assemblage may be affected by the proposed development based on the interaction of the project with a suite of ecological and threatening processes.

Desktop Assessment

Information on the fauna assemblage of the survey area was drawn from a wide range of sources. These included state and federal government databases and results of regional studies. Databases accessed were the Atlas of Living Australia (ALA), the WA Department of Biodiversity, Conservation and Attractions (DBCA) NatureMap (incorporating the Western Australian Museum's FaunaBase and the DBCA Threatened and Priority Fauna Database), BirdLife Australia's Birdata (Atlas) Database (BA), the EPBC Protected Matters Search Tool and the Bamford Consulting Ecologists (BCE) Database (Table 1). Information from the above sources was supplemented with species expected in the area based on general patterns of distribution. Sources of information used for these general patterns were:

- Frogs: Tyler et al. (2000) and Anstis (2013);
- Reptiles: Storr et al. (1983, 1990, 1999 and 2002) and Wilson and Swan (2013);
- Birds: Blakers et al. (1984); Johnstone and Storr (1998, 2004), Barrett et al. (2003) and Menkhorst et al. (2017);
- Mammals: Menkhorst & Knight (2004); Churchill (2008); and Van Dyck and Strahan (2008).

Sources of information used for the desktop assessment:

- Atlas of Living Australia (ALA 2019) Records provided by collecting institutions, individual collectors and community groups 29° 40' 10''S, 115° 10' 41''E – plus 20 km buffer.
- NatureMap (DBCA 2019) Records in the WAM and DPaW databases. Includes historical data and records on Threatened and Priority species in WA. 29° 40' 10''S, 115° 10' 41''E – plus 20 km buffer.
- BirdLife Australia Birdata (Atlas Database) Records of bird observations in Australia, 1998-2018. 29° 40' 10''S, 115° 10' 41''E – plus 20 km buffer.
- EPBC Protected Matters Records on matters of national environmental significance protected under the EPBC Act. 29° 40' 10''S, 115° 10' 41''E – plus 20 km buffer.

Previous fauna surveys

BCE has conducted multiple fauna surveys at Arrowsmith and nearby areas. These surveys have included monitoring, targeted fauna assessments and a level 2 fauna assessment. Other surveys conducted by BCE further afield will be used as background information only to inform potential species lists compiled during desktop studies. There have also been studies by other consultants in the region, particularly for the Eneabba mineral sands mine. Species records from these studies are contained in the Naturemap database which was consulted as part of the desktop study. In addition, BCE maintains a detailed database and annotated species lists that were available for reference as part of the desktop study. Some of the BCE records pre-date Naturemap. Previous reports consulted for background information include Harris et al. (2008), Metcalf and Bamford (2008), Bamford (2009), Bamford (2012), Everard and Bamford (2014), Bamford et al. (2015) and Bamford and Chuk (2015-17). Some of these studies were undertaken within 1km of the project area; others within about 10km.

Nomenclature and taxonomy

As per the recommendations of EPA (2004), the nomenclature and taxonomic order presented in this report are based on the Western Australian Museum's (WAM) Checklist of the Fauna of Western Australia 2016.

The authorities used for each vertebrate group were: amphibians (Doughty et al. 2016a), reptiles (Doughty et al. 2016b), birds (Johnstone and Darnell 2016), and mammals (Travouillon 2016). In some cases, more widely-recognised names and naming conventions will be followed, particularly for birds where there are national and international naming conventions in place (e.g. the BirdLife Australia working list of names for Australian Birds). English names of species where available are used throughout the text; Latin species names are presented with corresponding English names in tables in the appendices.

Interpretation of species lists

Species lists generated from the review of sources of information are generous as they include records drawn from a large region and possibly from environments not represented in the survey area. Therefore, some species that were returned by one or more of the data searches will be excluded because their ecology, or the environment within the survey area, meant that it is highly unlikely that these species will be present. Such species can include, for example, seabirds that might occur as extremely rare vagrants at a terrestrial, inland site, but for which the site is of no importance.

Species returned from the databases and not excluded on the basis of ecology or environment are therefore considered potentially present or expected to be present in the survey area at least occasionally, whether or not they were recorded during field surveys, and whether or not the survey area is likely to be important for them. This list of expected species is therefore subject to interpretation by assigning each a predicted status in the survey area.

The status categories used are:

- **Resident:** species with a population permanently present in the survey area;
- **Migrant or regular visitor:** species that occur within the survey area regularly in at least moderate numbers, such as part of annual cycle;
- **Irregular Visitor:** species that occur within the survey area irregularly such as nomadic and irruptive species. The length of time between visitations could be decades but when the species is present, it uses the survey area in at least moderate numbers and for some time;
- **Vagrant:** species that occur within the survey area unpredictably, in small numbers and/or for very brief periods. Therefore, the survey area is unlikely to be of importance for the species; and
- **Locally extinct:** species that would still be present but has not been recently recorded in the local area and therefore is almost certainly no longer present in the survey area.

These status categories make it possible to distinguish between vagrant species, which may be recorded at any time but for which the site is not important in a conservation sense, and species which use the site in other ways but for which the site is important at least occasionally. This is particularly useful for birds that may naturally be migratory or nomadic, and for some mammals that can also be mobile or irruptive, and further recognises that even the most detailed field survey can fail to record species which will be present at times, or may be previously confirmed as present. The status categories are assigned conservatively. For example, a lizard known from the general area is assumed to be a resident unless there is very good evidence that the site will not support it, and even then it may be classed as a vagrant rather than assumed to be absent if the site might support dispersing individuals.

Field Investigation Methodology and Personnel

The survey area was visited on 18 November 2018 by Dr Mike Bamford (BSc Hons. Ph.D. (Biol.)), Dr Wes Bancroft (BSc Hons. Ph.D. (Zool.), Sarah Smith (Bsc. (Biol.) and Peter Smith (Dip. Ag. Sc.). Mike Bamford and Katherine Chuk - B. Sc. (Zool.) Hons. prepared a report.

During the site inspection as much as possible of the site was visited, habitat observations were made in order to develop descriptions of Vegetation and Substrate Associations (VSAs), and opportunistic fauna observations were recorded when relevant to the survey. Access to the site was good due to the rail alignment from Eneabba to Geraldton passing along the western side.

Survey Limitations

The EPA Guidance Statement 56 (EPA 2004, now EPA 2016) outlines a number of limitations that may arise during surveying. These survey limitations are discussed in the context of the BCE investigation of the survey area in Table 36.

Potential Survey Limitation	BCE Comment
Level of survey.	Level 1 (desktop study and site inspection). Survey intensity was deemed adequate due to the scale of the project and the amount of data available in the region.
Competency/experience of the consultant(s) carrying out the survey.	The ecologists have had extensive experience in conducting fauna surveys and have conducted several fauna studies within the immediate region.
Scope. (What faunal groups were sampled and were some sampling methods not able to be employed because of constraints?)	The survey focussed on vertebrate fauna and fauna values.
Proportion of fauna identified, recorded and/or collected.	All vertebrate fauna observed were identified. Extensive desktop information allowed for a robust predicted species list to be developed.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	Abundant information from databases and previous studies.
The proportion of the task achieved and further work which might be needed.	The survey was completed and the report provides fauna values for the project area.
Timing/weather/season/cycle.	Timing is not of great importance for level 1 investigations.
Disturbances (e.g. fire, flood, accidental human intervention etc.) that affected results of survey.	None
Intensity. (In retrospect, was the intensity adequate?)	All major VSAs were visited and significant species habitat and traces were identified.
Completeness (e.g. was relevant area fully surveyed).	Site was fully surveyed to the level appropriate for a level 1 assessment and for the proposed impact. Fauna database searches covered a 20 km radius beyond the survey area boundary. Detailed field investigations covered the VSAs present.
Resources (e.g. degree of expertise available in animal identification to taxon level).	Field personnel have extensive experience with fauna and habitat in the region.
Remoteness and/or access problems.	There were no remoteness/access problems encountered.
Availability of contextual (e.g. biogeographic) information on the region.	Regional information was available and was consulted.

Table 36: Survey Limitations

Fauna values within the survey area can be summarised as follows:

Fauna assemblage. Moderately rich but incomplete with some species locally extinct. Assemblage is typical of the Lesueur Sandplains subregion. Notable for a rich reptile assemblage and high proportion of non-resident birds, many of which are nectarivorous and exploit seasonal abundance of nectar and pollen from the species-rich flora.

Species of conservation significance. Few species of high conservation significance are present or expected, but the Carnaby's Black-Cockatoo is important, with known roost sites nearby and the species very likely to be a regular foraging visitor to the project area. The locally significant Rufous Fieldwren and Rainbow Bee-eater are almost certainly present, with the bee-eater a breeding visitor. The Western Ground Parrot may be locally extinct but because of its very high conservation significance (with the only known wild population estimated as <150 birds; A. Burbidge pers. comm.), the slight possibility of the species being extant in the general area is important.

Vegetation and Substrate Associations (VSAs). The survey area supports few but distinct VSAs, all of which are mostly intact. All are very extensive regionally.

Patterns of biodiversity. Within the survey area all VSAs, aside from a small disturbed area in the north-west, are intact and likely to support a high level of species richness. VSA3 may support some aquatic and wetland-associated species not found in VSAs 1 and 2 due to the seasonal presence of water. VSAs 1 and 2 are likely to support a high diversity of terrestrial species, with VSA1 notably important for conservation significant species such as Carnaby's Black-Cockatoo.

Key ecological processes. The main processes which may affect the fauna assemblage are likely to be local hydrology, the fire regime and the presence of feral predators.

Conclusion and recommendation

Because of the fairly continuous and undisturbed habitat surrounding the survey area, potential impacts are mostly considered to be minor or negligible. Potential impacts of greatest concern to fauna include:

- Loss of habitat
- mortality during clearing
- habitat fragmentation (drainage line)
- roadkill due to increased traffic
- impacts of feral species
- hydrological change
- altered fire regimes
- light

Recommendations to manage potential impacts include:

- Referral to the Department of Energy and the Environment under the EPBC Act for impact on >1ha of moderate to high forging value vegetation for Carnaby's Black-Cockatoo.
- Undertake baseline surveys (bird censusing and systematic sampling of small, terrestrial vertebrates) to provide data for the assessment of the effectiveness of post-mining rehabilitation. Rehabilitation is assumed as a standard part of the mining process.
- Conduct aural surveys for the Western Ground Parrot to see if the species persists in the broader area. In the unlikely event that it is confirmed to be present, even within 5-10km, discussions will need to be held with DBCA regarding management actions for this species.
- Conduct survey for Mallee fowl mounds before clearing.
- During clearing operations, investigate options for fauna rescue to reduce direct mortality.
- Clearing is likely to increase feral species activity (particularly Fox, Cat and Goat). Waste management to reduce increase in feral species and control of pre-existing feral species (particularly Fox and Cat) would provide further benefit. Survey lines and access tracks should be rehabilitated as soon as they are no longer needed as these re utilised by feral fauna.
- Minimising clearing where possible and progressively rehabilitate where practical after mining.
- Minimise impact on the drainage line, and manage ground water if the project may impact groundwater levels.
- Minimise disturbance. Night time operations and lighting are of particular concern and lighting should be directed away from bushland areas.
- Fire management measures should be implemented to prevent extensive fires affecting the project area or surrounding landscapes. Ideally this would protect infrastructure and contribute to a regional approach to fire management.

11.2 Groundwater

Water is required for processing at Arrowsmith North with groundwater resources being considered the most likely and reliable source. The water demand is approximately 500 ML/yr at the Arrowsmith North site. In order to meet these water requirements, there will be need for a groundwater licence from the Department of Water and Environmental Regulation (**DWER**).

This document provides a scoping level of hydrogeological assessment that reviews the regional hydrogeology, development constraints, potential borefield layout and design considerations, and the likely approval process within the DWER.

11.2.1 Potential development of groundwater

The most viable option for developing a groundwater supply would be the construction of bores into the Yarragadee aquifer. The production bores would need to be constructed to a minimum depth of 200 m; however, about 300 m is recommended with screens in the lower 60 m. A single bore for each operation should be sufficient and capable of providing 5000 kL/day. At Arrowsmith North, the suggested bore design should place the screen interval in Unit C of the Yarragadee Formation with a groundwater salinity of 1 200 to 1 500 mg/L. Whereas at Arrowsmith Central, the screen interval is likely to be within Unit A and have a groundwater salinity of around 1 000 mg/L. An advantage of screening the bores deeper below Unit D or Unit B is that the siltstone and shale beds should impede the upward propagation of water level drawdown resulting from the abstraction. This would minimise the local decline of the watertable and reduce the impact on any groundwater dependent ecosystems.

11.2.2 Hydrogeology

The Project is situated upon the Swan Coastal Plain, which is up to about 30 km wide comprising several geomorphic units parallel to the coast. Specifically, the Project is located upon the Eneabba Plain, which is made up of shoreline, lagoonal and dune deposits possibly reworked from late Tertiary alluvial fans.

The area lies within the northern end of the Perth Basin, containing a succession of Quaternary to Permian age deposits up to a total of 12,000 m thick, but thinning to around 1,000 m over the Beagle Ridge southwest of the tenements. A detailed description of the geology and hydrogeology in the northern Perth Basin is given by 'Northern Perth Basin: Geology, hydrogeology and groundwater resources' (Department of Water, 2017).

Two aquifers are present beneath the tenements, one within the relatively thin Superficial Formations, which is underlain by a major regional aquifer within the Yarragadee Formation.

Period	Epoch	Stratigraphy	Max Thickness (m)	Lithology
Quaternary	Holocene	Alluvium, estuarine and swamp deposits	5	Clay, sand and peat
		Safety Bay Sand	100	Sand
	Pleistocene	Bassendean Sand	40	Sand, minor silt and clay
		Tamala Limestone	150	Calcareous arenite, limestone, sand and clay
		Guildford Clay	30	Clay, sandy clay and clayey sand
Neogene	Pliocene	Ascot Formation	31	Sand, clay and limestone
		Yoganup Formation	21	Sand

Table 37: Stratigraphy of the Superficial Formations in the Arrowsmith Project area.

11.2.3 Superficial geology and aquifer

The Swan Coastal Plain is underlain by a sequence of Quaternary and Pliocene sedimentary deposits summarised by Table 37, which unconformably overlie Mesozoic deposits upon a gentle, westward sloping erosional surface (Figure 38).

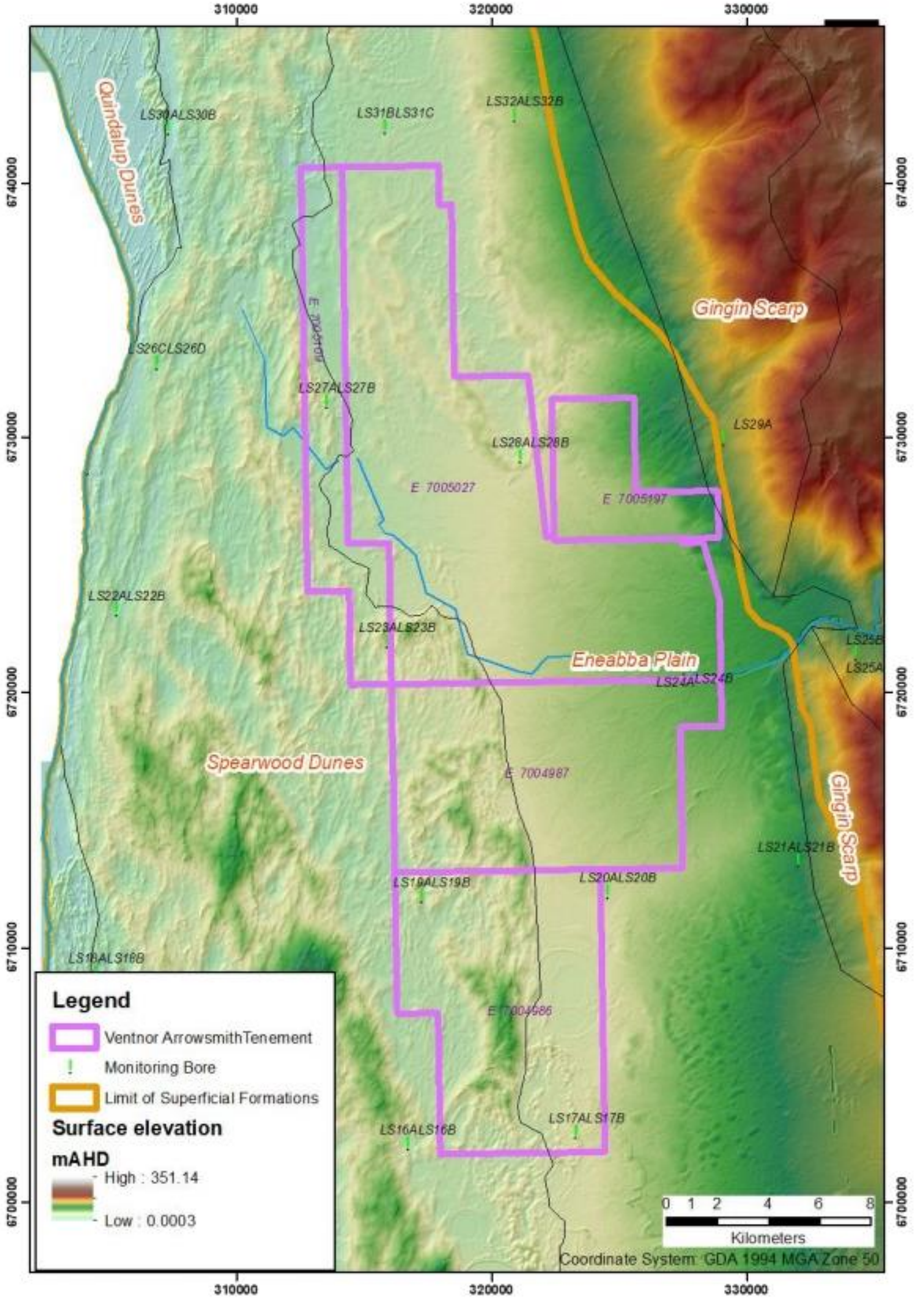


Figure 37: Physiography

The Superficial Formations form an unconfined aquifer referred to as the Superficial aquifer. The Project area is underlain by a relatively thin cover of sand belonging to the Bassendean Sand upon a thicker section of predominantly clayey sand forming the Guildford Clay, which are approximately coincident with the Eneabba Plain. Calcarenite limestone of the Tamala Limestone is located west of the project areas beneath the Spearwood Dunes, and frequently contain karstic cavities.

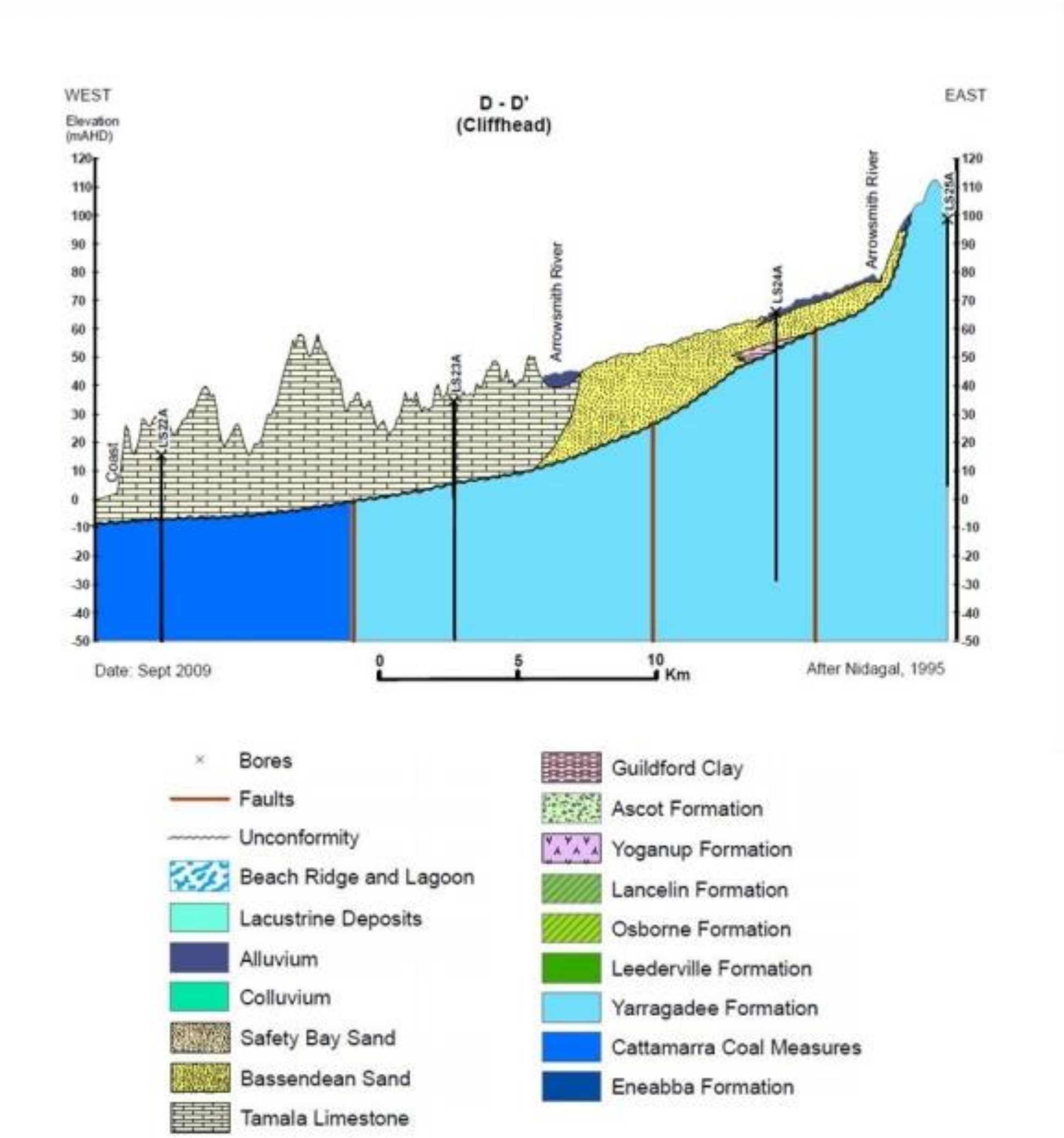


Figure 38: Geological east-west section through the Superficial Formations (after Nidigal, 199)

Detailed geological logs from Leeman Shallow (LS) monitoring bores are available near the Project area (Nidagal, 1991a, b; Kern, 1994). A summary of the Superficial Formation units intersected by these bores near the Project area is given in Table 38.

Monitoring Bore	Location from project area	Superficial Formations	Bassendean Sand	Guildford Clay	Tamala Limestone
LS27	southwest	30			30
LS28	southeast	33	5	28	
LS31	north	24	10	14	

Table 38: Superficial Formation units intersected in Leeman Shallow monitoring bores

The water table within the Superficial aquifer, shown by Figure 39, falls from around 50 to 60 m AHD about the eastern margin of the coastal plain to sea-level at the coast. About the inland margin of the coastal plain, the water table is typically within the Mesozoic formation (Yarragadee Formation) underlying the Superficial Formations, so that the Superficial aquifer is unsaturated.

Groundwater is recharged mainly by the infiltration of rainfall, but there is also a component of recharge by upward leakage from underlying aquifers, mostly about the central portion of the coastal plain, and by the infiltration from streams and rivers flowing out onto the coastal plain, including the Arrowsmith River that discharges over the coastal plain. Groundwater flows down the hydraulic gradient toward the coast, where most of the groundwater is discharged to the ocean. A component of groundwater is lost via evaporation from lakes and evapotranspiration.

The saturated thickness of the Superficial aquifer is shown by the interpretive isopach in Figure 40. The inland margin of the Superficial aquifer is unsaturated. At Arrowsmith North, the saturated thickness is mostly 10 to 15 m, with a saturated profile in the nearby monitoring bores of 11.2 m, 26.1 m and 19 m at LS27, LS28 and LS31 respectively. To the south of the Project area, the Superficial aquifer has a saturated thickness ranging from less than 10 m to about 20 m, becoming unsaturated east of the project area. And the nearby monitoring bores contain 26.3 m and 12.3 m of saturated Superficial aquifer in LS19 and LS20 respectively, while it is unsaturated in LS24.

Groundwater salinity within the Superficial aquifer is generally fresh at less than 1 000 mg/L about its eastern margin, increasing toward the coast where it becomes saline. Groundwater salinity distribution within the Superficial aquifer is shown by Figure 41. Beneath the Arrowsmith North project area, the groundwater salinity is approximately 1 000 mg/L to 1 700 mg/L.

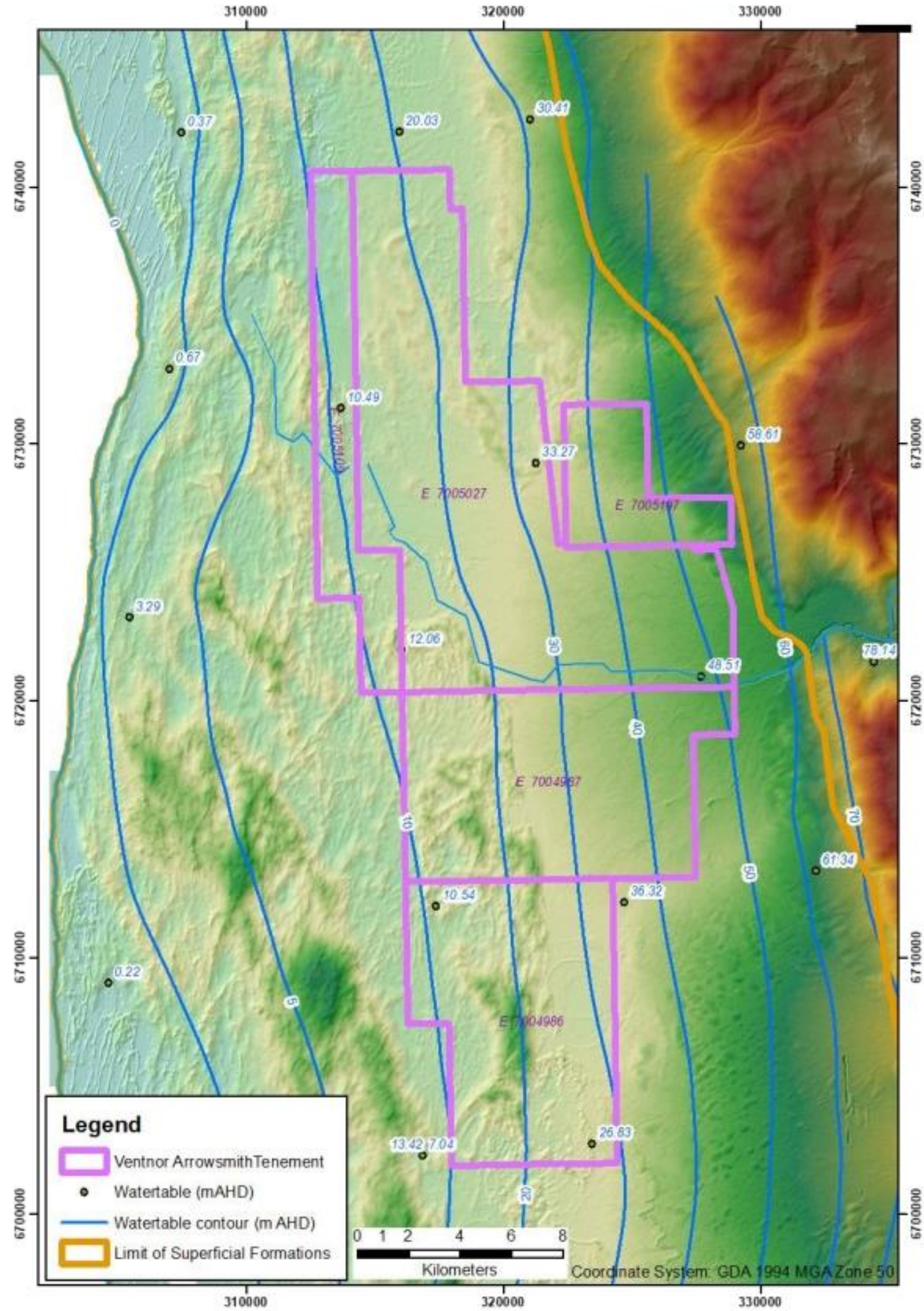


Figure 39: Watertable across the coastal plain

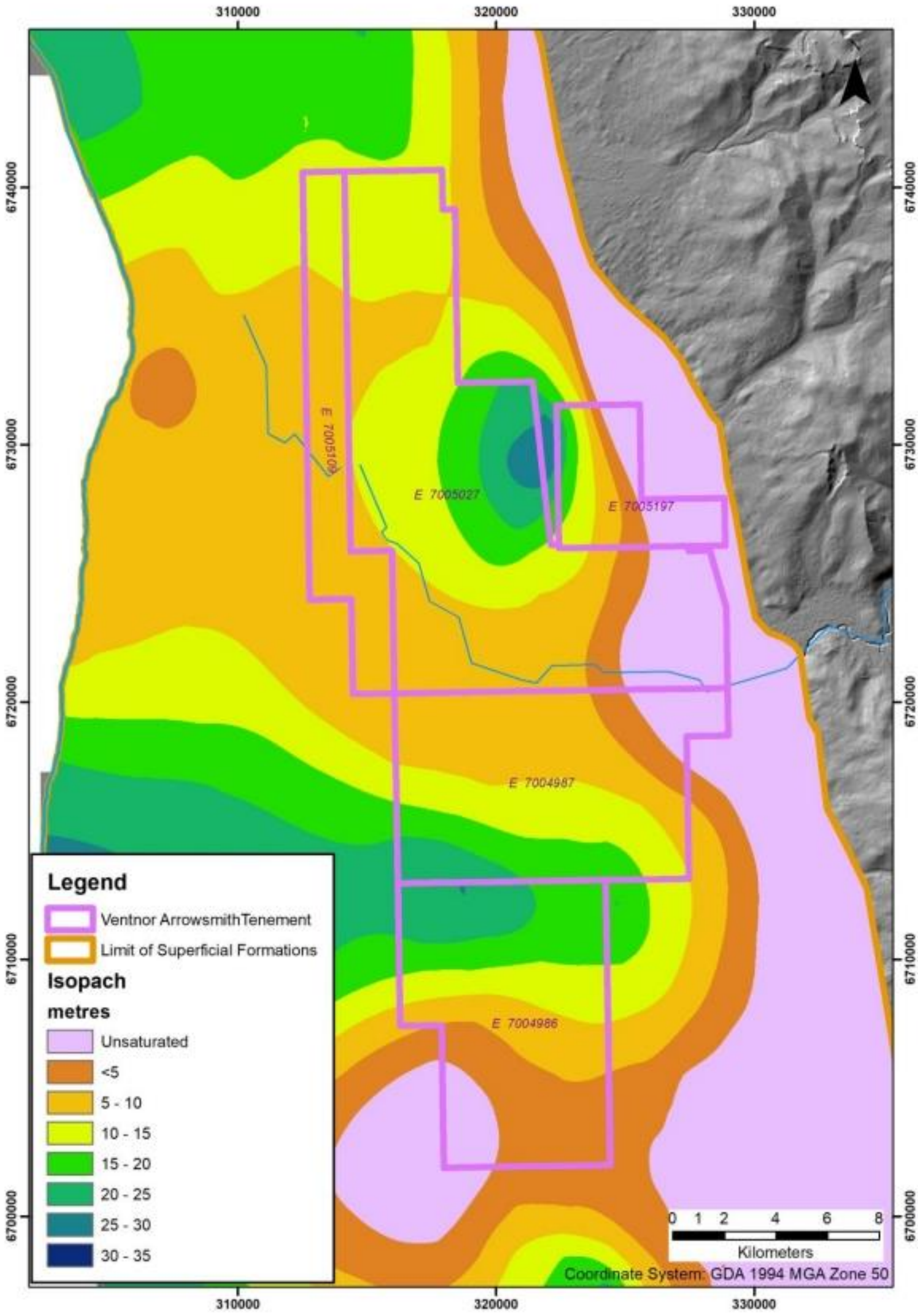


Figure 40: Interpretive isopachof the Superficial aquifer

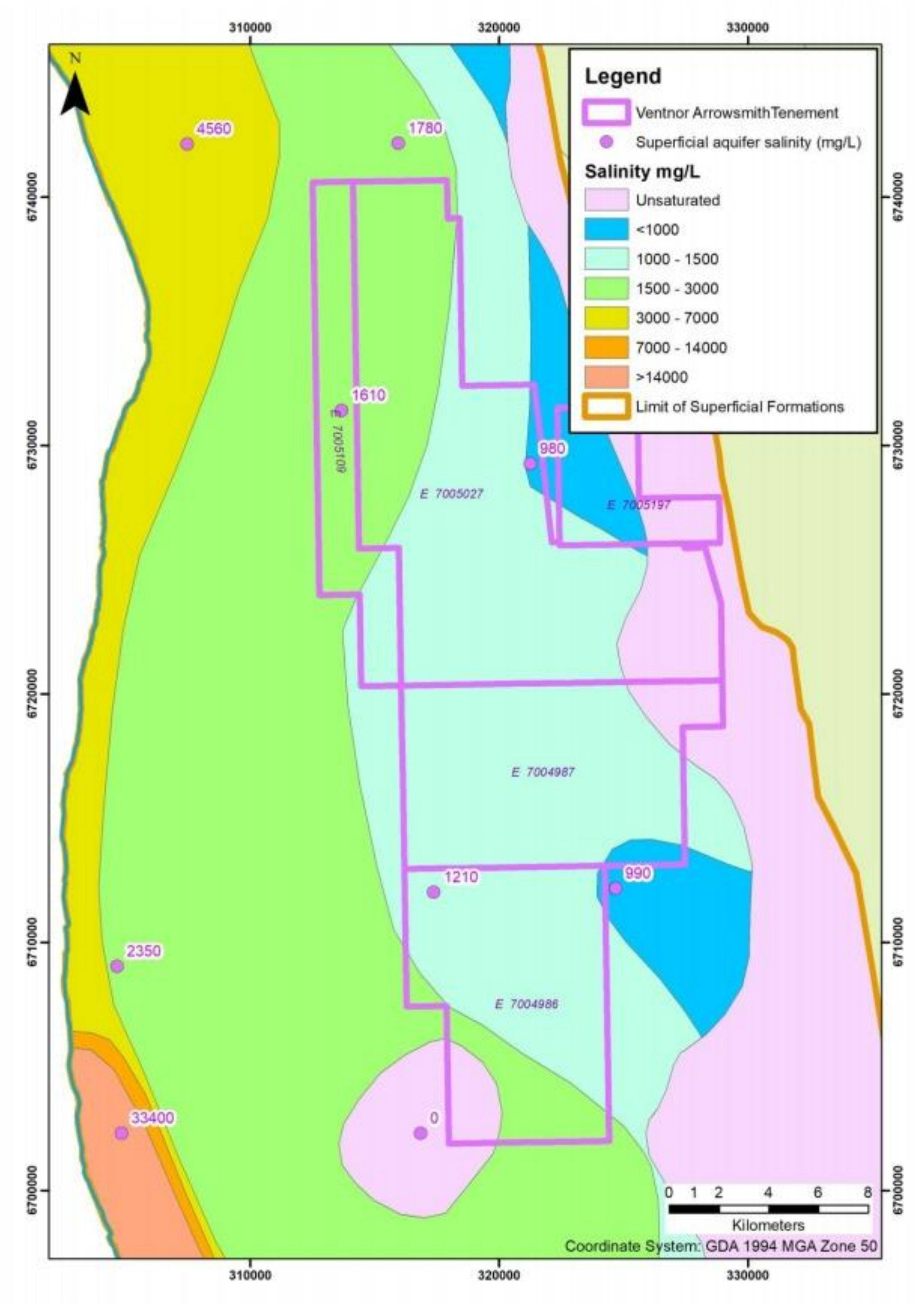


Figure 41: Groundwater salinity distribution within the Superficial aquifer

Transmissivity of the Superficial aquifer typically increases toward the coast, mostly because of more permeable strata present toward the coast. Tamala Limestone forms the most permeable portion of the aquifer due to the presence of karst features, from which relatively large bore yields can be obtained, such as around 1,000 to 2,000 kL/day from bores of the Jurien Bay town water supply borefield south of Arrowsmith. Hydraulic conductivity will be highly variable depending on the development of karst features below the watertable but is mostly between 50 and 1 000 m/day (Department of Water, 2017).

Bassendean Sand within the eastern portion of the Superficial Formations is largely unsaturated, with the aquifer mostly comprising the Guildford Clay. As the Guildford Clay lithology is principally a clayey sand, it is anticipated to have a relatively low permeability, possibly in the range of 0.4 to 1 m/day, similar to that reported for comparable lithologies of the Guildford Clay in the Perth area (Davidson, 1995).

11.2.4 Yarragadee geology and aquifer

Beneath the Superficial Formations, both tenements are mostly underlain by the Yarragadee Formation (shown by Figure 42), which is Middle to Late Jurassic in age. Numerous deep wells have been drilled as part of petroleum exploration and development in the Arrowsmith area, which has facilitated geological mapping.

The Yarragadee Formation is a major, regionally extensive formation within the Perth Basin that can exceed 3 600 m thick. It consists of predominantly weakly to moderately cemented sandstone, with interbedded siltstone, shale and claystone (Department of Water, 2017).

Several sub-units are identified within the Yarragadee Formation based on palynological ages and the lithological portions of sand compared with finer-grained sand, silt and clay, and are informally referred to as units A, B, C and D in ascending order. Units A and C are predominantly sand, while unit B contains approximately 50% siltstone and shale, and Unit D can comprise more than 80% fine-grained sediments. The Yarragadee Formation is conformably underlain by the Cadda Formation, comprising sandstone, siltstone and claystone.

Petroleum exploration wells North Yardanogo 1 (Barrack Energy, 1990) is drilled to the north of Arrowsmith North and South Yardanogo 1 (Arrow Petroleum, 1991) is in the central part, while Beekeeper 1 is located just to the south of Arrowsmith Central. Figure 43 shows the Yarragadee Formation sub-divisions present within North Yardanogo 1 and Beekeeper 1, together with the downhole groundwater salinity derived from regional mapping.

Arrowsmith North is situated upon a down-faulted block just east of the Mountain Bridge Fault. The Superficial Formations are underlain by the Yarragadee Formation which extends to between about 1,000 m and 1,200 m depth. North Yardanogo 1 drilled through the Yarragadee Formation intersecting 1,055 m of the formation (below about 30 m of Superficial Formations), including Unit D extending to 94 m depth. Lithology of Unit D is not logged within the well, although monitoring bore LS31 located to the north intersected coarse-grained sand with a large component of interbedded grey-black siltstone, black clay and shale over the comparable interval.

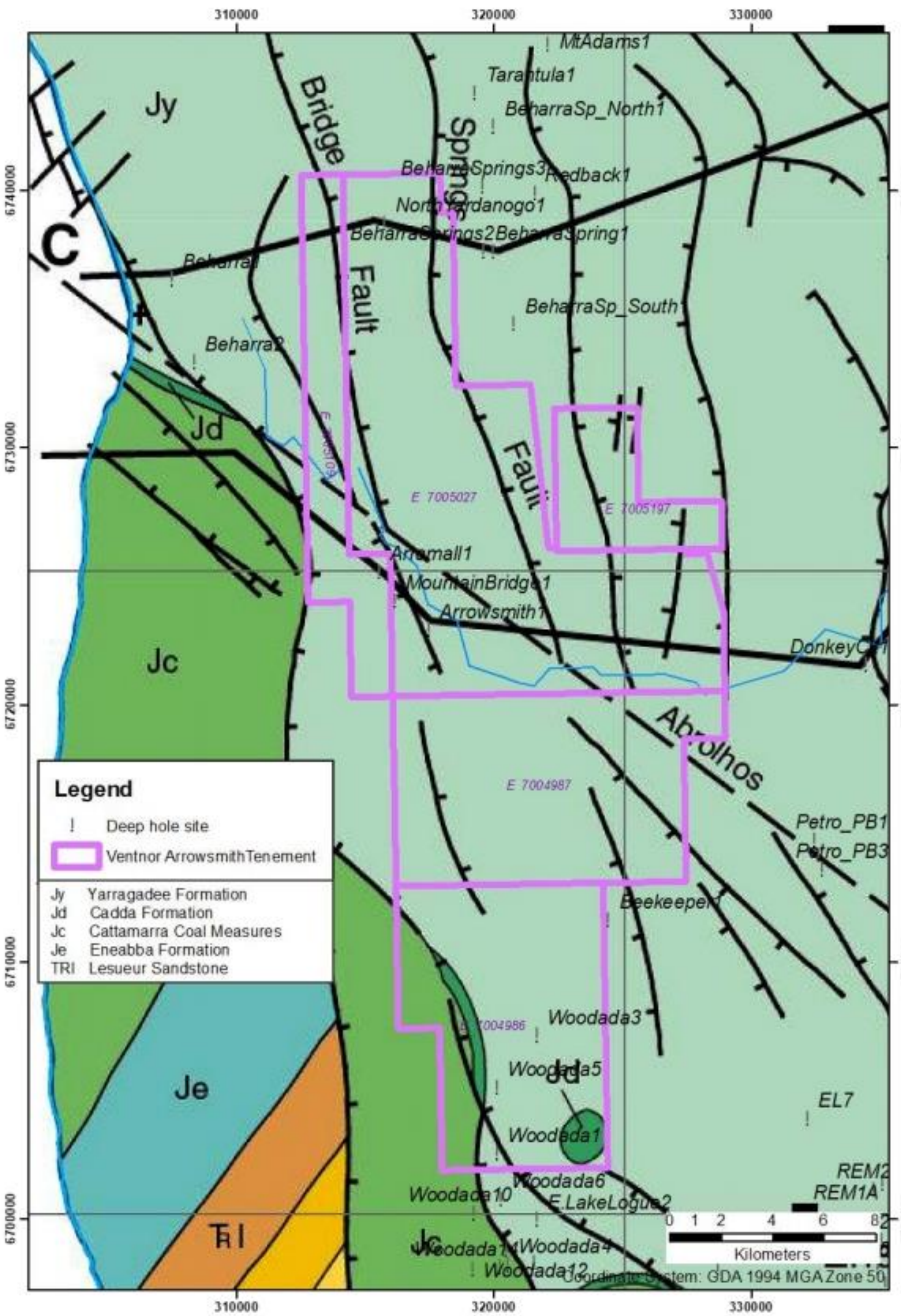


Figure 42: Mesozoic geology in the Arrowsmith area

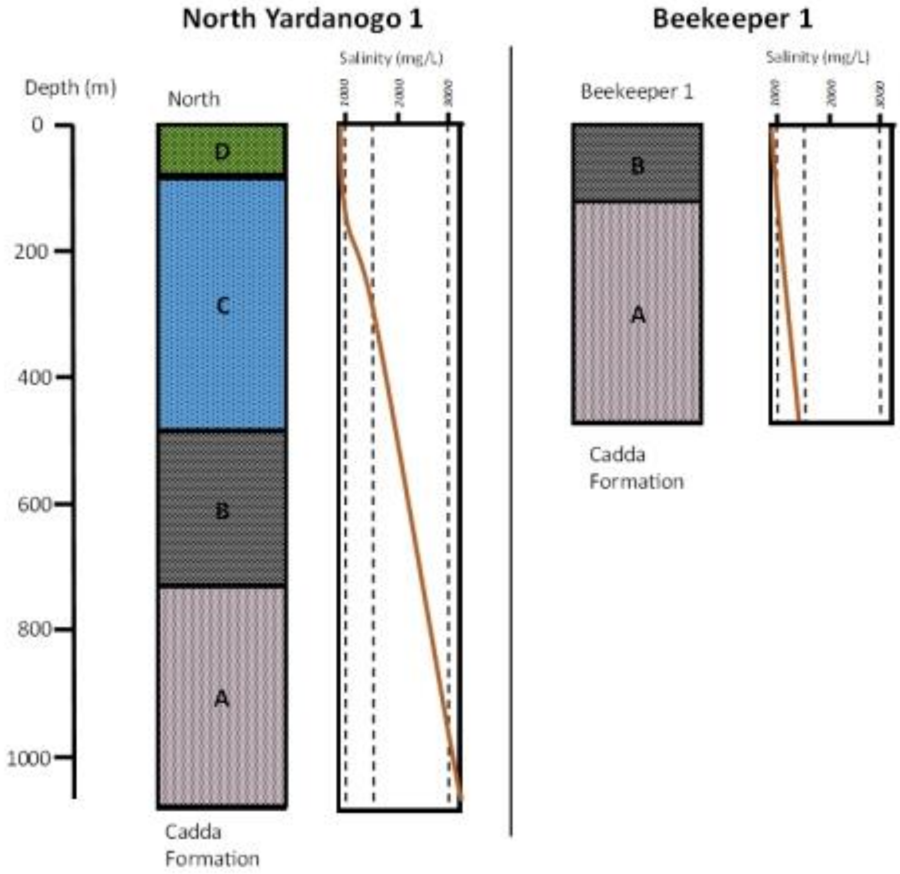


Figure 43: Geological profile: sub-division units (A-D) and interpretive groundwater salinity (Through the Yarragadee Formation within North Yardanogo 1 and Beekeeper 1)

Unit C is the sandiest portion in the Yarragadee Formation with only minor interbedded siltstone and shale is present over about 94 to 486 m depth. Downhole gamma-ray logging shows around 50% of clayey strata through Unit B over 486 m to 733 m depth. Unit A was intersected over 733 m to 1085 m depth where the profile is dominantly sand with approximately 20% clayey intervals. Exploratory petroleum well South Yardanogo 1 located in the central portion of Arrowsmith North intersected 1,020 m of the Yarragadee Formation (below about 40 m of Superficial Formations). The base of Unit C is at about 373 m depth, while Unit D appears to be absent.

Extending south from the Project area, located south of the Abrolhos Transfer Fault, there is a thinner interval of the Yarragadee Formation present, which is projected to thicken beneath that area from around 400 m in the western portion to 800 m in the east. Only Units A and B of the Yarragadee Formation are present. Unit B extends to about 250 m deep around the eastern portion of the area but pinches out toward the western margin where only the lower-most Unit A is present.

Beekeeper 1 (Australian Aquitaine Petroleum, 1982) drilled just south of the area intersected the Yarragadee Formation to 477 m depth. Unit B extends to 113 m depth in the well, and while the lithology over this unit was not logged the equivalent section in the adjacent monitoring bore LS20 (Nidagal, 1991a) comprises dominantly coarse-grained sandstone with abundant intervals of fine-grained sandstone, siltstone and shale. The underlying Unit A extends to 470 m depth, with a gamma-ray log showing that it is dominantly sandstone with some finer-grained intervals making no more than about 20% of the unit.

The Yarragadee Formation contains the Yarragadee aquifer which is the largest regional aquifer within the northern and central Perth Basin, forming a thick, permeable aquifer. Hydraulic properties are dependent on the portions of sand versus silt and clay, and the degree of cementation. Overall, the transmissivity of Unit C and A would be greater, however, good sand intervals within Units D and B can also be of high permeability. Siltstone and shale layers within Units D and B can form local aquitards.

Evaluation of many pumping tests have found average and median values for hydraulic conductivity of 12 m/day and 5.6 m/day respectively (Department of Water, 2017), although generally lower values are associated with Units D and B. Bore yields are generally large, with pumping rates up to 6000 kL/day obtained from production bores at Eneabba (Johnson and Commander, 2006).

Groundwater within the Yarragadee aquifer is recharged by downward rainfall infiltration over the dissected plateau region inland of the coastal plain referred to as the Arrowsmith Region. From the Arrowsmith Region groundwater flow is westward, discharging about the western margin of the Yarragadee Formation approximately coincident with the central portion of the coastal plain by upward leakage into the Superficial aquifer.

There is no direct measure of groundwater salinity from deeper portions of the Yarragadee aquifer in the Arrowsmith project area, but the salinity has been recorded from the upper portion of the aquifer in nearby Leeman Shallow monitoring bores. The salinity in deeper sections will be estimated from regional mapping.

At Arrowsmith North, LS31B (94 to 100 m) obtained groundwater from the upper portion of Yarragadee aquifer with a salinity of 860 mg/L (Nidagal, 1994). Regional groundwater salinity mapping suggests that the salinity rises to 1 500 mg/L by around 300 m depth, and 3 000 mg/L toward the base of the Yarragadee aquifer.

LS20A (97 to 100 m), located south-southwest of the Project area, yielded groundwater with a salinity from the upper portion of the Yarragadee aquifer of 520 mg/L (Nidagal, 1991a), and at LS24A (96 – 99 m) northeast of the area the salinity was 600 mg/L. Groundwater of salinity less than 1 000 mg/L is projected to extend to about 150 m depth beneath Arrowsmith Central, remaining below 1 500 mg/L to the base of the aquifer.

11.2.5 Development constraints

The most significant constraint to groundwater abstraction in the Arrowsmith Project area is the potential impact on groundwater dependent ecosystems due to a decline in water levels, particularly in areas of shallow watertable including wetlands and damplands. Figure 44 shows the depth of watertable below the land surface over the coastal plain in the Arrowsmith tenements area.

Areas of shallow watertable are found about (east, north and west) and within Arrowsmith North, where a series of wetlands are present along the eastern margin that may have some dependency on groundwater within the Bassendean Sand. Another group of wetlands/damplands is located west of the area where the watertable is within the Tamala Limestone.

Potential wetlands or groundwater dependent ecosystems are present within several kilometres south of the Project area. However, this area does not appear to be associated with a shallow watertable within the Superficial aquifer, where the watertable is projected to be at least 10 m depth. These wetlands may represent areas of perched groundwater developed upon clay in the Guildford Clay. At LS20, several metres of clay (6.9 to 9.0m) is present within the Guildford Clay (Nidagal, 1991a) which could potentially support a local overlying perched groundwater system. A significant wetland situated from about 3 km south of the project area has a white lake floor, possibly due to salt deposits, which is characteristic of perched groundwater discharging upon a claypan.

The Arrowsmith River will not be impacted by groundwater abstraction from either projectarea as the river bed is well above the potentiometric head of the Yarragadee aquifer and watertable in the Superficial aquifer, and there is no groundwater discharge to the river.

Over the Arrowsmith Region plateau area further east, there may potentially be some seepage to the river from perched groundwater higher within the Yarragadee Formation, most likely associated with Unit D, but this would not be influenced by groundwater abstraction from the Arrowsmith tenements area.

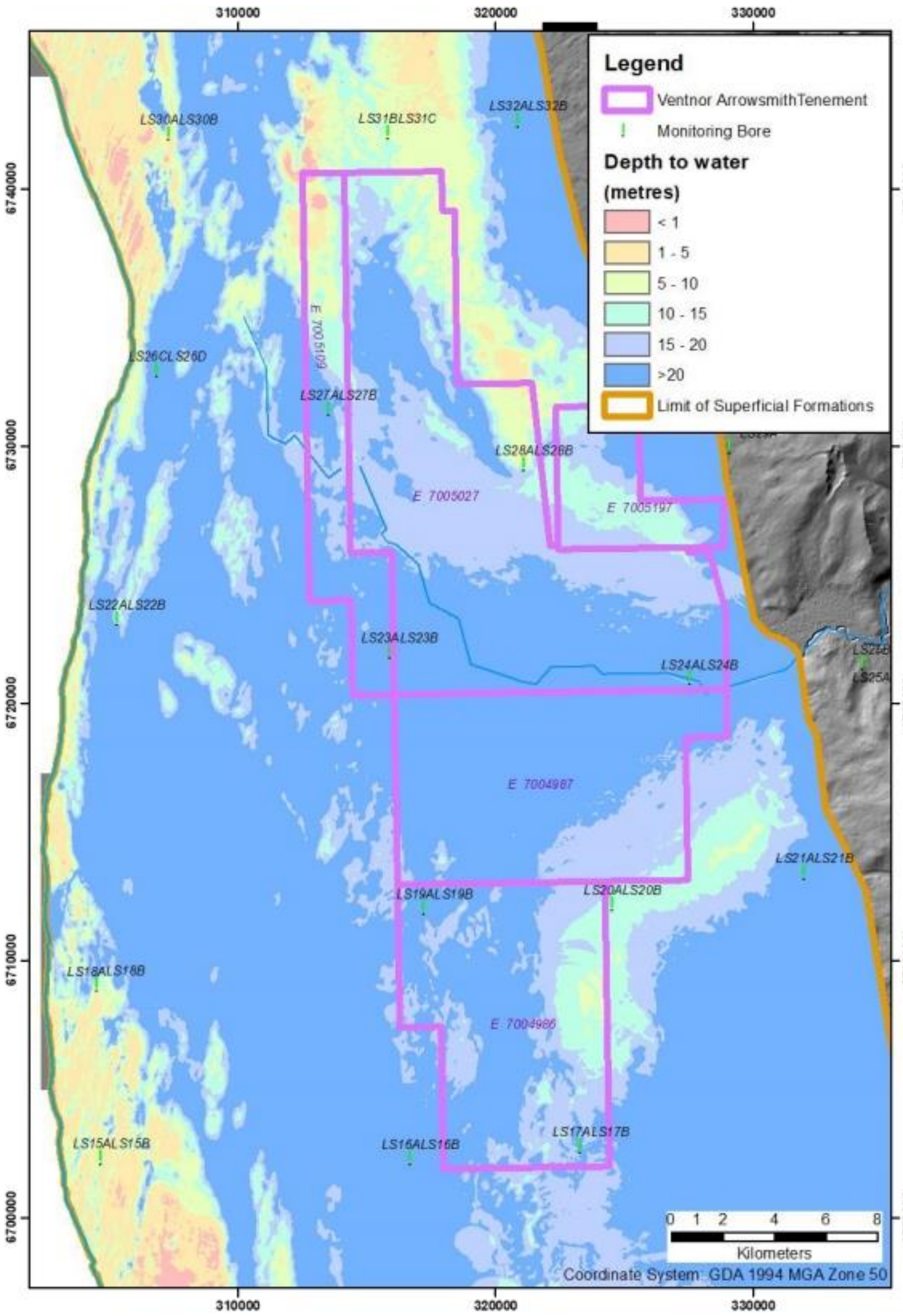


Figure 44: Depth to the water table over the coastal plain in the Arrowsmith area

11.3 Social factors

11.3.1 Population Centres

The nearest population centres are Dongara and Eneabba, which are equidistant from the Project via Brand Highway at 30 km. The nearest farmhouse is more than 5 km from the Project area.

The Company will source labour requirements from these two population centres.

11.3.2 Land Ownership and Use

The entire project is located on vacant, unallocated Crown Land.

The Company has a Mining Lease application (MLA70/1389) which is predominately within granted Exploration License E70/5027 and encroaching on E70/5109. The Mining Lease application and Exploration Licenses are held by Ventnor Mining Pty Ltd a 100% owned subsidiary of VRX.

The Project area is predominately native vegetation but is criss-crossed with cleared tracks previously used over the last 40 years for oil and gas exploration. The Company has been able to use these tracks to access areas for exploration and sampling.

11.3.3 Socio-economic Context

The project can provide significant benefits to the State through very long-term employment and Royalties and locally provide employment and contract opportunities.

The Project will also use the under-utilised rail system and potentially significantly increase exports through the Geraldton Port.

11.3.4 Potential Development

Once the Project has reached an expected production rate and quality of final product the Company can consider further downstream processing of silica sand in to glass products.

Any further processing will have to consider the logistics of transporting both raw material and final products and the economic imperative of supplying a potential domestic and international market.

12 Project Implementation

12.1 Staged Construction

The Project will have two stages of construction. Initially the Project will require the construction of the processing facility and the remote feeder station. Mining will initially include an excavation and trucking component to remove up to 2 million tonnes of sand to establish a level route corridor for the ultimate conveyor system.

Implementation of the Project in 2 stages will minimise upfront capital costs and enter the market in a more sustainable and less disruptive Manner.

This staged approach will support the planned ramp up of production as the plant will initially operate for up to 3 years at 1 million tonnes per year as the project allows for silica sand products to be introduced to the glass making and foundry industries in Asia before maximising production at 2 million tonnes per year.

12.2 Implementation Plan

The Company will complete detailed mining and processing scheduling before commencing construction of the processing plant. Fortunately, the scheduling detail is made significantly simpler due to the consistency of the ore source which will also reflect in the consistent quality of the final products.

The Implementation plan for the Project will depend on:

- Final approvals for mining
- Final offtake contract for at least 1 million tonnes per year
- Definitive Feasibility Study
- Financing of construction and working capital
- Construction
- Commencement of mining and processing

12.3 Contracting Strategy

The Company will own, operate and maintain the feeder station, processing operations and manage the project operations.

The Company will however contract the supply of mining and power supply equipment.

12.4 Early Engineering

The Company has undertaken preliminary engineering within 10% capital cost estimates and power requirements for the processing plant (CDE Global) and the feeder and trommel stations, pumping and conveyor system (ProjX).

The processing plant is designed for 300 tonnes per hour throughput (2 million tonnes per year) and will produce up to 3 separate silica sand products.

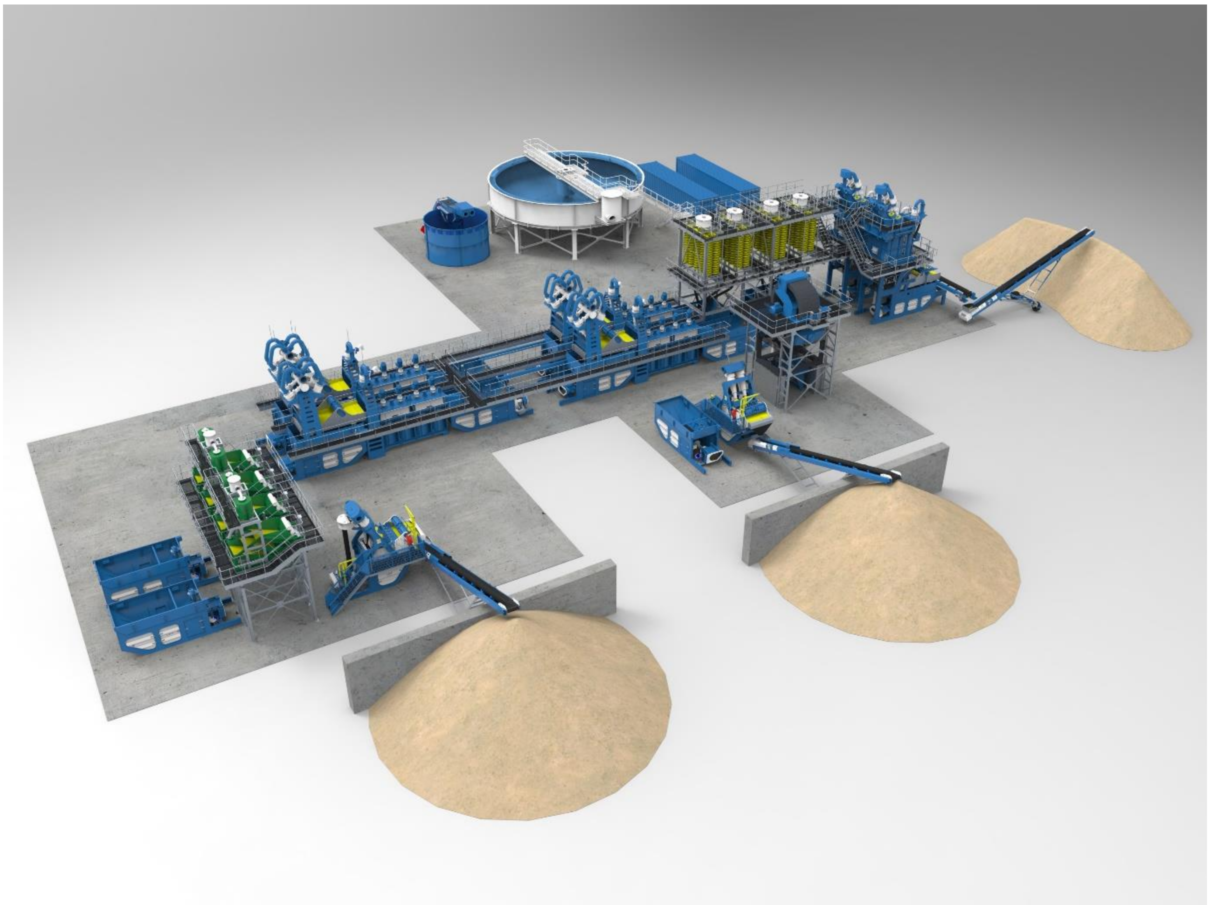


Figure 45: Processing Plant General Arrangement

The feeder station will take ore feed from a front end loader, with a conveyor to transport feed to a trommel which will screen feed to 3 mm before pumping to the processing plant.

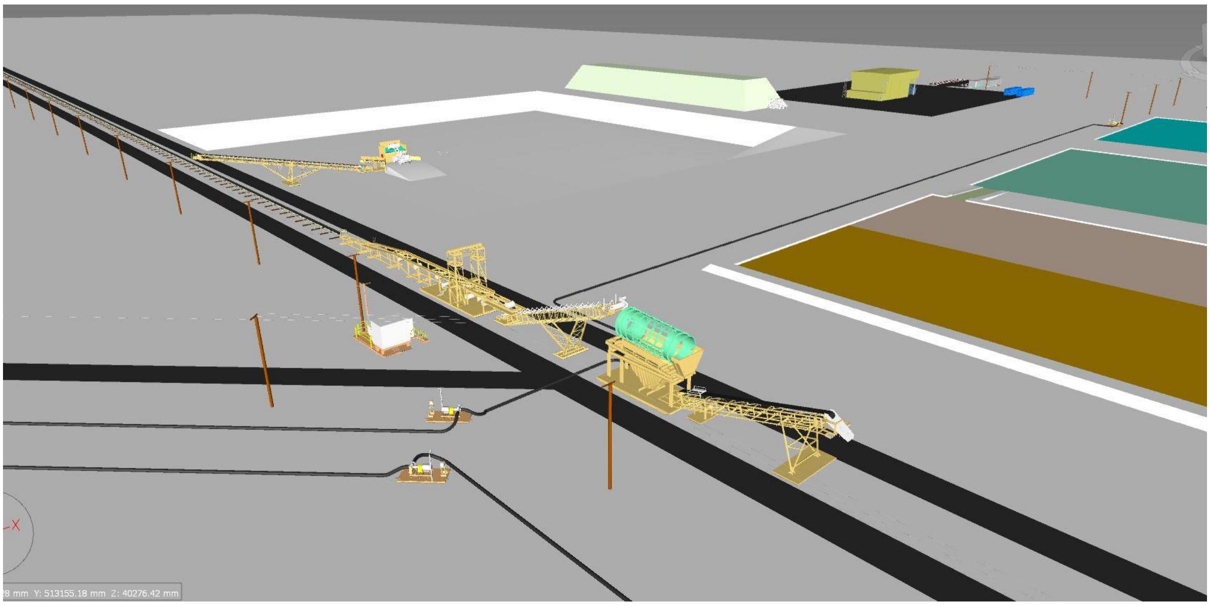


Figure 46: Feeder and Trommel Arrangement

12.5 Detailed Engineering

The Company will undertake detailed engineering to confirm final designs before construction. Detailed engineering will commence following a final Board decision and will complete the critical path associated with the timely construction of the project.

13 Operational Readiness

VRX will develop a comprehensive risk-based program to ensure VRX has the requisite capability and systems to operate the Arrowsmith North Silica Sand Project successfully from day one.

This approach will commence with a thorough enterprise-wide risk assessment and identification of the standards, controls and systems which will be required to mitigate these risks through the life of the operation. The outcome is an intellectual architecture comprising of well thought, thorough and effective operating systems, which will be designed to ensure operational readiness and logical prioritisation of the project's many moving parts.

The process will be detailed and involve a higher level of operational systems design than is typically undertaken by single asset sponsors for new projects of this scale. This is done primarily due to the high bar of performance that VRX has set for the project and the strong business imperative to have the asset predominantly run and operated by persons living locally. In addition, VRX recognizes that the bulk silica sand mining industry is an emerging industry in WA and thus has fewer established practices and less depth of expertise than is typical in other sectors of the mining industry.

The key aims of this approach are:

- To rigorously and effectively manage the project execution and the project start up and ramp-up to full capacity, thereby avoiding operational start-up dip.
- To align the Company with ISO 9000 quality compliance through effective controls and management of those controls governing product quality.
- To control the scope of roles within the Company and to manage the amount of discretion that people have in their roles so that they are positioned to focus on the project outcomes.
- To facilitate role clarity and enabling effective decision making, successful team work, and accountability.
- To achieve the Company's vision of being "a globally significant silica sand producer, who is recognised for our great quality of products produced safely and ethically".
- To achieve the Company's planned localisation targets and strategy, which will provide sustainable business opportunities and jobs for locals, and a sense of ownership of the asset within the district.
- To minimise the dependence on expensive contracting resources.
- To drive safety, productivity and product quality through an in-built and inherent business improvement mindset.
- To enable the most efficient management of the asset in a global market, with all the inherent challenges involved in managing markets and cultures.

13.1 Company Values

A set of company values has been firmly established within VRX that will underpin the operational strategy of the Company.

Safety: All of us have an equal right to go home safely.

Team Work: We achieve superior results by working together.

Accountability: We are accountable to our family, our community and our colleagues – do them proud, give it your best.

Respect: We are a diverse organisation who respect each other.

Stakeholders: Our stakeholders measure our success – our customers, our investors and our community all have expectations of us.

13.2 Operational Strategy

VRX is staffed by experienced mining and mineral industry veterans. Our experienced team has a clear opportunity to provide a fresh approach to operations of a Western Australian Silica Sand mining and processing facility, and a global marketing function, with best operating and management practice supported by an Australian (Perth) head office governance team.

The Arrowsmith North mine and processing facility will be operated by a predominantly local workforce and an experienced leadership team. This strategy will create a high level of government and local community support.

To ensure the Project is run safely and will reliably produce an on-specification product at nameplate capacity and cost from day one, a robust suite of management systems and operating standards will be developed jointly by an early recruited leadership team and the Perth head office, and will be implemented during commissioning.

Capable local operational staff will be recruited with sufficient lead time to be fully trained in the operation of mine and plant with emphasis on the key controls and expectations by which their performance will be measured.

There will be early recruitment of key management and technical roles for the express purpose of developing and implementing the management systems, and then training the operating staff in the lead up to operations.

The design of the organisation structure and operational systems will be fit for purpose striking the right balance between the required level of governance and operating efficiency which will ensure sustained performance of safe, efficient, on specification operational delivery through the life of the project.

13.3 Risk Based Approach

An operational readiness will be developed using a strong risk-based approach. The lesson from other projects is that where there is a failure to fully understand and prepare for operational risks early, projects are exposed to significant value loss arising from production shortfall, out of specification product, and cost increases, collectively referred to as "start-up dip". In addition, there is often a high level of safety and environment incidents.

Project risk workshops identify the following key project risks:

- failure to achieve project financing
- failure to achieve project permitting and land compensation arrangements
- project cost overrun or delay resulting in significant dilution of value for existing shareholders
- excessive working capital requirements for the project and possible loss of market niche for VRX's high value silica sand products, due to:
  - inadequate orebody knowledge or unexpected complexity
  - inadequate operational preparedness and capability resulting in out of specification product
  - product logistics delays
  - sales and marketing issues - production issues
- loss of government or community support for the project
- health, safety and environmental (HSE) risks.

These risks will be captured in a detailed risk register. The approach will be to prepare mitigation strategies accordingly.

Risk controls will be identified for all risks, comprising:

- mitigation actions to be completed prior to commencement of operations
- operational standards and management systems which will govern operations and mitigate risks through the life of the project.

Risk mitigation actions include:

- Specific studies to ensure full anticipation of technical, quality, reliability and environmental issues.
- Engagement of specialist consultants to advise on critical technical, marketing and government and community aspects of the project.
- Design reviews to ensure engineering controls are included in plant design.
- Specific obligations to include in third-party contracts that will be critical to safety, environment, production and product quality.
- Definition of infrastructure upgrades and government co-commitments.
- Establishment of project control for construction management.
- Planned and targeted early recruitment and training.

On-going control of risk through the life of the operation will be through effective implementation of standards and management systems.

In particular, the controls for HSE risks will be documented in a set of HSE standards and systems which collectively define the Health, Safety and Environment Management System (HSEMS) for the project. The HSEMS, consists of a set of Health and Safety standards, Environment standards, and systems which are critical to effective HSE management. This will provide a comprehensive risk management framework for the project.

13.4 Development of Operational Readiness Plan

Risk mitigation actions will be prioritised and sequenced into a comprehensive work plan for operational readiness. The work plan will also include completion of the design of standards and systems in a prioritised way and implementing these as required for the project construction phase and for the operations phase of the project.

The operational readiness project plan will have clear links to the financing, permitting, and construction project plans.

13.5 Implementation of Operational Readiness Plan

The operational readiness plan will be implemented by an early recruited operations team, supported by expert consultants where required, and with a Project Management Office (PMO) function to track and report on status throughout. The recruitment schedule is aligned with the operational readiness plan to ensure timely implementation of key roles to complete the work plan tasks. The clear remit of early recruited roles will be to build the organisational systems and to have their teams fully operationally-ready at start of operation.

A readiness methodology will be used to support key aspects of the implementation including coaching and training on standards and systems design, access to a comprehensive library of checklists and requirements from equivalent operations design, and executive leadership advice where required.

There is a close relationship between the operational readiness plan and the human resources strategy for the project. In particular, the design of the standards and systems will provide clear role clarity for all operations positions. The training and development of personnel recruited into leadership roles will include training in standards and systems design methodology and in the style of leadership required of VRX managers at all levels to ensure that the management systems are effectively utilised.

14 Human Resources

Where possible the Company will source employees from the local communities of Eneabba and Dongara.

The skills required to operate this type of mining equipment and processing are well represented within the Western Australian mining industry personnel.

The Company will operate and maintain the feeder and processing equipment but contract the power generating equipment and mining operations equipment and relevant personnel.

Where possible the Company will preferentially offer opportunities to local Indigenous operators.

15 Operating Cost Estimate

Operating costs have been determined from either first principles or contract budget submissions and estimates and estimated on 1 million tonnes per year throughput, with expected unit cost savings if throughput is increased as anticipated to potentially 2 million tonnes per year.

Operating costs are divided amongst the follow categories of expenditure:

- administration
- mining
- processing
- product handling, and
- royalties and marketing.

15.1 Administration

Administration costs are estimated on adequate site management with a project manager and deputy, two vehicles, site services including offices and ablutions, lease rents and rates and site insurances.

Total costs estimated at an average A$0.46 per tonne processed.

15.2 Mining

Section 6 sets out the unique and flexible mining and rehabilitation method proposed for the Project to maximise production and the recovery of rehabilitated mined areas.

For the first 3 years the equipment list will be 1 dozer with a scythe ripper, interchangeable front mounted mulcher or push blade, 4 front end loaders (**FEL**), one with a modified bucket to be used in the rehabilitation process for sod recovery and replacement, one to be used in excavation from a working face to 2 x 6 wheel drive 20 tonne articulated trucks and 1 FEL to load from a stockpile to a feeder trommel.

This fleet will operate for 12 hours per day at a rate of up to 1 million tonnes per year until an adequate level route is established with a continuous 15 m high and 1.5 km long operating face and a caterpillar type feeder conveyor is installed. This will take up to 3 years and excavate 3 million tonnes of material. This will eliminate the requirement for the 2 trucks and 1 FEL.

The reduced fleet can increase operating times to 24 hours per day to increase the throughput to 2 million tonnes per year.

A water cart may be required during the hotter months if any dust is generated.

Production and cost estimates are based on budget wet hire contract rates and estimated operating times for each piece of equipment as required. Labour, fuel and maintenance costs are included in the contract rates.

Total costs estimated at an average A$3.03 per tonne processed.

15.3 Processing

Figure 34 illustrates the proposed processing circuit for the Project.

Processing barrier limits include the initial production feeder that transfers to the rotating drum trommel screen which in turn will screen organic material from the ore feed and add water to a slurry feed of 30% by weight.

Costs include the power and water required to pump the slurry to the processing plant and the plant operations. These costs are based on engineering power and water estimated requirements and industry standard unit costs. Further engineering estimates are used for the maintenance requirements for all the processing equipment but generally based on 5% of the initial capital cost per year.

Costs also include labour costs of processing and maintenance personnel.

Overall this type of processing is very similar to the mineral sands wet concentrators with well-established maintenance schedules and routines in Western Australia.

Total costs estimated at an average A$6.54 per tonne processed.

15.4 Product Handling

Product handling costs include the loading of rail cars, rail transportation to the Geraldton Port and handing costs for ship loading. Sales prices are based on FOB Inco Terms which will be based on a loaded ship.

Estimated costs are based on multiple submitted contract rates for rail and port operations.

Total costs estimated at A$18.63 per tonne processed.

15.5 Royalties and Marketing

Estimated royalties and based on the existing rate for the State Royalty (which is reviewed every 5 years), an allowance for an expected negotiated Native Title party royalty based on production tonnes and a further industry standard agent's fee for marketing and sales of exported products.

Total costs estimated at A$1.52 per tonne processed.

15.6 Total Operating Costs

Total net direct cash cost (**C1**) per tonne processed is estimated as follows:

Administration (site management)	$0.46
Mining (inc excavation and rehab)	$3.03
Processing (inc power,water and maintenance)	$6.54
Product Handling (inc loading, rail and port)	$18.63
Royalties and Marketing	$1.52
Total Cash Costs of Production	$30.18

* Australian dollars

16 Capital Cost Estimate

CDE Global has provided VRX with a cost estimate for a 2 million tonne per annum (Mtpa) processing plant which, due to its modular nature, is a detailed proposal and accurate to ±15% in pricing. Table 39 sets out a summary of this cost estimate.

Processing Plant Costs ± 15%

	CDE Quote GBP	$AUD
Mechanical Equipment, lighting, wiring, pipework	£6,800,000	$12,716,000
WHIM Module (optional)	£700,000	$1,309,000
Installation & commissioning Labour	£1,100,000	$2,057,000
Crane Hire and EWP's	£400,000	$748,000
Freight (C.I.F Fremantle) (65 containers)	£420,000	$785,400
Contingency (5% of mech.)	£340,000	$635,800
Total	£9,760,000	$18,251,200

Table 39: Summary of quote details for processing plant (exchange rate of 1GBP = 1.87AUD)

Further testwork is underway to finalise the requirements for the magnetic separation component. This is not anticipated to materially affect the costs.

The Company has commissioned a cost estimate for the feeder, trommel and pump station from a local engineering company ProjX.

Feeder, Conveyor, Trommel Pump Station Costs ±15%	ProjX Estimate	Contingency 15%	TOTALS $AUD
Feed bin, conveyor and feed bin over overland conveyor inc components and power supply.	$656,681	$98,502	$755,183
Trommel, pump and 4.5km pipeline including power supply.	$4,927,848	$739,177	$5,667,025
Ancilliary equipment, dams, bore water supply and power supply.	$2,643,090	$396,464	$3,039,554
	$8,227,619	$1,234,143	$9,461,762

Table 40: Summary of quote details for feeder, trommel and pumpstation

The Project metrics have depreciated all of the capital cost at 15% per year.

17 Marketing

Globally, silica sand is in a growth phase due to increasing demand from the construction sector, with both volume and value having increased worldwide. Sales of silica sand experienced a compound annual growth rate of approximately 8.7% in value terms from 2009 to 2016, with a market value of US$6.3 billion. This was due to its applications across a range of industries, including glass making as well as foundry casting, water filtration, chemicals and metals, along with the hydraulic fracturing process.

Accelerations in construction spending and manufacturing output worldwide are expected to drive growth in important silica sand-consuming industries, including the glass, foundry and building products sectors. Significant growth is projected for the hydraulic fracturing market as horizontal drilling for shale oil and gas resources expands, largely in North America.

The Asia-Pacific region is expected to remain the largest regional consumer of industrial sand through 2025, supported by the dominant Chinese market. The country's container glass industry will drive further silica sand sales, supported by rising production of glass bottles, particularly in the alcoholic beverage sector including wine and beer.

In India, foundry activity has shown strong growth, driven by the production of sand moulds to manufacture metal castings. Indonesia will also register strong growth in silica sand sales through 2022, supported by rapid advances in the output of glass products and metal castings, combined with increased hydraulic fracturing activity.

Outside of the Asia-Pacific region, demand for silica sand in North America is forecast to rise at a faster annual pace than any other regional market. The US and Canada will lead regional growth, driven by expansion in the countries' respective hydraulic fracturing segments. Strength in US oilfield activity will boost demand for sand proppants, as will increases in the number of fracturing stages per well.

Consumption of silica sand in Western Europe is projected to see more modest annual gains through 2020, although such growth will mark a rebound from the declines registered during 2008 to 2015. Recoveries in building construction and manufacturing activity, including a turnaround in flat glass output, will stimulate renewed demand for industrial sand in the region. (Source: Ceramic Industry Website – Reference A)

17.1 Silica Sand Markets

High-grade silica sand is a key raw material in the industrial development of the world, especially in the glass, metal casting, and ceramics industries. High-grade silica sand contains a high portion of silica (over 99% SiO_2) and is used for applications other than construction aggregates. Unlike construction sands, which are used for their physical properties alone, high-grade silica sands are valued for a combination of chemical and physical properties. Global consumption of industrial silica sand is expected to climb 3.2% per year through 2022. Asia Pacific growth is higher than global growth and is expected to be around 5-6% per year. Ongoing economic and infrastructure development in the Asia/Pacific region will drive growth, as will hydraulic fracturing activity in North America. Frac sand will be used increasingly in Asia Pacific in future years but unlikely to match the use in North America where 100 million tonnes are used annually.

17.1.1 Glassmaking

Silica sand is the primary component of all types of standard and specialty glass. It provides the essential SiO_2 component of glass formulation; its chemical purity is the primary determinant of colour, clarity and strength in glass. Industrial sand is used to produce flat glass for building and automotive use, container glass for foods and beverages, and tableware. In its pulverised form, ground silica is required in the production of fibreglass insulation and for reinforcing glass fibres. Specialty glass applications include test tubes and other scientific tools, incandescent and fluorescent lamps.

Over the past 20 years, growth in glass demand has exceeded GDP growth and continues to grow at circa 5% per annum.

The Asia Pacific region has dominated the glassmaking industry for some time and Australia is uniquely positioned to supply this increasing demand.

The Company continues to monitor the various markets for silica sand for glass making and the foundry industry via market specialists and contacts within the industry.

17.1.2 Specialty Markets

Metallurgical Uses

In metal production, silica sand operates as a flux to lower the melting point and viscosity of slag to make them more reactive and efficient. Lump silica is used either alone or in conjunction with lime to achieve the desired base/acid ratio required for purification of final metals. These base metals can be further refined and modified with other ingredients to achieve specific properties such as greater strength, corrosion resistance or electrical conductivity. Ferroalloys are essential in specialty steel production. Industrial sand is used by the steel and foundry industries for de-oxidation and grain refinement.

Chemical Production

Silicon-based chemicals are found in thousands of everyday applications ranging from food processing to soap and dye production. In this case, SiO_2 is reduced to silicon metal by coke in an arc furnace, to produce the Si precursor of other chemical processes. Industrial sand is the main component in chemicals such as sodium silicate, precipitated silica, silicon tetrachloride and silicon gels. These chemicals are used in products such as household and industrial cleaners, in the manufacture of fibre optics and to remove impurities from cooking oil and brewed beverages.

Paint and Coatings

Paint formulators select micron-sized industrial sands to improve the appearance and durability of architectural and industrial paint and coatings. High purity silica produces critical performance properties such as brightness and reflectance and colour consistency. In architectural paints, silica fillers improve tint retention, durability, and resistance to dirt, mildew, cracking and weathering. Low oil absorption allows increased pigment loading for improved finish colour. In marine and maintenance coatings, the durability of silica imparts excellent abrasion and corrosion resistance.

Ceramics

Ground silica is an essential component of the glaze and body formulations of all types of ceramic products, including tableware, sanitary ware and floor and wall tile. In the ceramic body, silica is the skeletal structure onto which clays and flux components attach. The SiO_2 contribution is used to modify thermal expansion, regulate drying, contain shrinkage and improve structural integrity and appearance. Silica products are also used as the primary aggregate to provide high temperature resistance to acidic attack in industrial furnaces.

Filtration and Water Production

Industrial sand is used to filter water to become drinkable. It is also necessary in the processing of wastewater and the production of clean water from wells. Uniform grain shapes and grain size distributions produce efficient filtration bed operations (including multimedia) for the removal of contaminants from wastewater to provide potable water. As silica is chemically inert, it will not degrade or react when it comes in contact with acids, contaminants, volatile organics or solvents. Silica is used as packing material in deep-water wells to increase yield from the aquifer by expanding the permeable zone around the well screen and by preventing the infiltration of fine particles from the formation.

Fibreglass including optical fibres

Washed, correctly sized and dry sorted, the silica sand from the Projects can potentially be targeted for high-grade applications in the glass industry. The main export destination countries for these types of products are China, Japan, Taiwan and Korea.

Suppliers need to work with the customers and or distributors in each key market to provide the required tonnages of suitably specified high grade sand delivered in container loads, or bulker bags and that the sand would be delivered from the site to a port facility. Final delivery is often in pneumatic tanker or bulker bags. Some large producers have on-site grinding facilities using flint pebbles as media.

17.1.3 Container Glass

The introduction and use of lightweight containers is critically dependent upon the glass forming technologies available for their manufacture. For many years, 'blow-blow' technology was the dominant glass bottle forming process. However, more recently 'narrow neck press and blow' (NNPB) has become the dominant technology for the production of lightweight bottles. Superior dimensional control and consistency available from NNPB allows lighter bottles to be produced without compromising fitness for purpose or market appeal. The current NNPB process inevitably has limitations on the minimum bottle weight which can be achieved, this also being critically dependent on bottle design and volume.

17.2 Market Risk

A key challenge for industrial minerals projects is not meeting market specifications. The silica sand market has specifications for parameters such as purity (e.g. SiO_2 content) in addition to tight specifications for trace elements such as Fe and Ti and Cr in the glass industry.

Failure to meet specifications may result in selling the products at discounted rates, or indeed not finding markets at all.

Other risks for silica sand may include particle size distribution and physical strength (crush resistance) as in the case of proppants for the oil industry.

Industrial minerals are generally considered to be bulk commodities and are therefore susceptible to distance to market and transport costs; therefore, logistics may pose a risk to supplying markets.

17.3 Glassmaking Silica Sand Pricing

Chemical Composition (%)

Product	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	K_2O	May 2019 Price FOB (US$/metric tonne)
F80	99.95	0.02	0.008	0.030	0.005	0.001	0.004	US$35-53 per dmt (subject to quality, contract terms and quantity)
F80C	99.95	0.02	0.005	0.030	0.005	0.001	0.004	
F150	99.8	0.07	0.015	0.035	0.020	0.001	0.004	
F200	99.9	0.06	0.02	0.030	0.010	0.001	0.020	
F350	99.5	0.30	0.050	0.030	0.010	0.002	0.050	
F400	99.6	0.25	0.040	0.030	0.005	0.001	0.050	
F500	99.7	0.20	0.050	0.035	0.010	0.002	0.030	

Table 41: Glassmaking Silica Sand Pricing

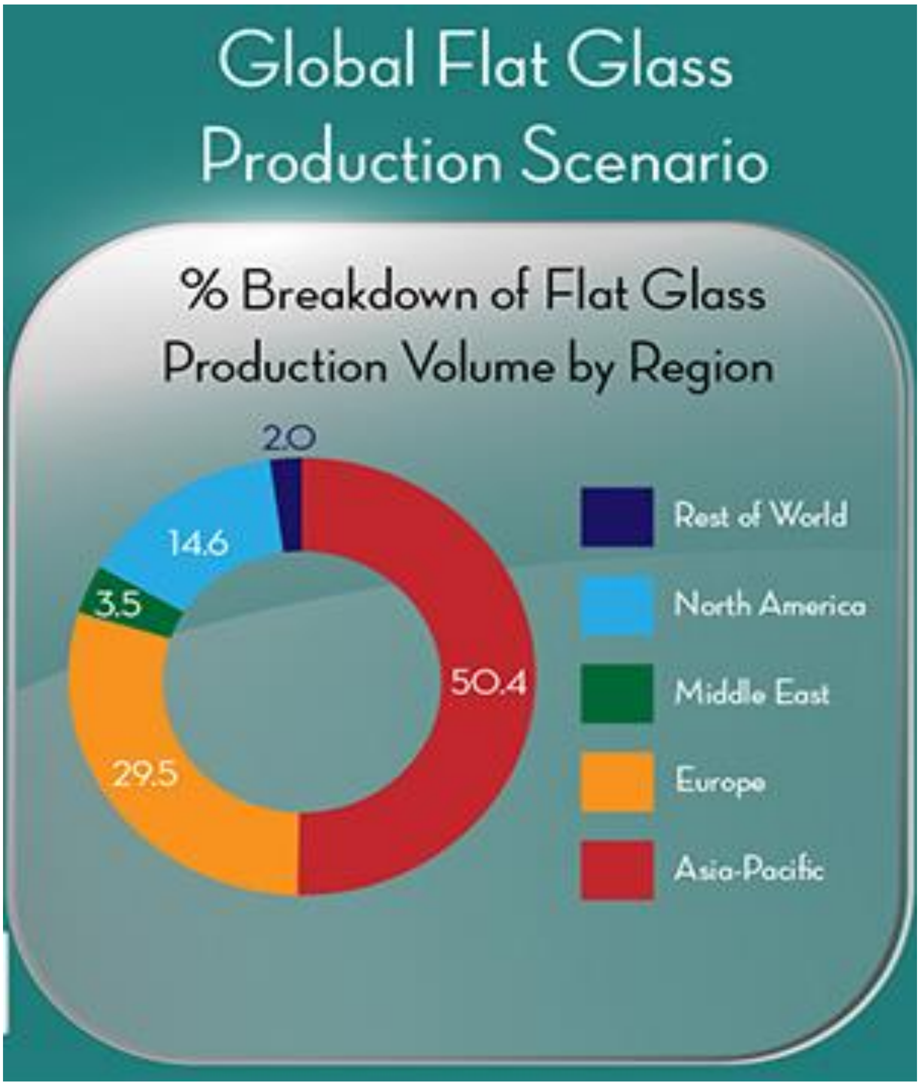
Particle Size **Sieve Opening / µm retained**

Product	850	600	425	300	212	150	106	75	53
F80		0.5%	49%	50%	0.5%				
F80C	9.0%	90.0%	1.0%						
F150				0.5%	88%	11%	0.5%		
F200		0.5%	30%	40%	21%	8%	0.5%		
F350		0.5%	40%	39%	16%	1%			
F400		0.5%	44%	39%	16%	0.5%			
F500		0.5%	40%	42%	17%	0.5%			

Table 42: Glassmaking Silica Sand Particle Sizes

17.4 Glassmaking Silica Sand Demand

The Asia Pacific region has dominated the glassmaking industry for some time and Australia is uniquely positioned to supply this increasing demand.



Asian Silica Sand Markets

Use	Spec	Market in Asia	Growth in Asia
Float (Plate) Glass	99.5% SiO_2	**60 - 65Mt**	**5% - 6%**
Container Glass	99.5% SiO_2	**70 - 75Mt**	**5% - 6%**
Cover Glass (Solar Panels)	99.5% SiO_2 & Low Fe	**5 - 6Mt**	**+30%**
Smart Glass (Ultra Clear)	99.5% SiO_2 & Low Fe	**1 - 2Mt**	5% - 6%
Specialist Glass (Thin Screen)	99.7% SiO_2	**500 - 600 kt**	**+10%**

Table 43: Asian Silica Sand Markets

Source: Stratum Resources

Asian Growth Sectors

- Increase in Automobile Production
- Rebound in Building Construction Activity
- Rising Demand for Energy Efficient Windows
- Strong Demand for Fabricated Flat Glass Products
- Use of Glass in Solar Thermal Panels & Photovoltaic Modules
- Expanding Applications of Glass in Healthcare & Electronics Sectors
- Demand for Glass Products with Solar Control & Impact Resistance Features

Year / Country	2017a	2018a	2019e	2020f	2021f	2022f	2023f	2024f	2025f
China	0.89	1.9	2.4	2.8	3.4	3.6	4.2	4.4	5.6
Japan	1.16	1.18	1.2	1.3	1.3	1.4	1.4	1.5	1.5
South Korea	1.05	0.94	1.2	1.3	1.4	1.5	1.6	1.6	1.7
Taiwan	1.42	1.47	1.5	1.5	1.6	1.6	1.7	1.7	1.7
Philippines	0.35	0.49	0.51	0.53	0.6	0.6	0.7	0.7	0.8
Thailand	0.19	0.15	0.17	0.2	0.3	0.3	0.4	0.4	0.5
Subtotal (rounded)	**5.6**	**6.13**	**6.9**	**7.6**	**8.6**	**9**	**10**	**10.3**	**11.8**

Table 44: Silica sand estimated demand in selected Asian countries Mt to 2025

Source: ITC Trade map, Stratum estimates. A-actual, e-estimate, f-forecast

Product requirements will be based on SiO_2 content, other impurities and particle size distribution. There are many and varied requirements generally dependent on the final product.

17.5 Foundry Silica Sand Pricing

Chemical Composition (%)

Product	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	K_2O	May 2018 Price FOB (US$/metric tonne)
F20	99.7	0.20	0.05	0.035	0.010	0.002	0.03	US$38-53 per dmt (subject to quality, contract terms and quantity)
F20 - B	99.9	0.02	0.008	0.03	0.005	0.001	0.004	
F40	99.7	0.20	0.05	0.035	0.010	0.002	0.03	
F20 - B	99.6	0.25	0.04	0.030	0.005	0.001	0.05	
F50	99.6	0.25	0.04	0.030	0.005	0.001	0.05	

Table 45: Foundry Silica Sand Pricing

Particle Size **Sieve Opening/Mesh retained**

Product	10	20	30	40	50	70	100	140	200	AFS No
F20	0.1%	3%	87%	8%	1%	0.1%				21
F20 - B		9.0%	90.0 %	1.0%						20
F40		0%	21%	36%	24%	13%	5%	1%	0%	36
F20 - B	6%	22%	30%	38%	3%	0.3%	0.1%	0%		22
F50		0%	0.3%	32%	28%	17%	14%	8%	1%	49

Table 46: Foundry Sand Particle Sizes

17.6 Foundry Silica Sand Demand

Metal Casting / Foundry: Industrial sand is an essential part of the ferrous and non-ferrous foundry industry. Metal parts ranging from engine blocks to sink faucets are cast in a sand and clay mould to produce the external shape, and a resin bonded core that creates the desired internal shape. Silica's high fusion point (1,760°C) and low rate of thermal expansion produce stable cores and moulds compatible with all pouring temperatures and alloy systems. Its chemical purity also helps prevent interaction with catalysts or curing rate of chemical binders. Following the casting process, core sand can be thermally or mechanically recycled to produce new cores or moulds. Chromite, zircon and olivine sand all compete with silica but usually in small quantities and mainly as a thin covering on top of the silica for actual molten metal contact.

It is becoming increasingly difficult to source appropriate sand in Asia suitable for the foundry industry and VRX Silica is ideally placed to supply this market from it Arrowsmith North Silica Sand Project.

18 Financial

Based on the capital and operating cost estimates a financial model was developed for the purpose of evaluating the economics of the Project.

18.1 Key Assumptions

The financial analysis for the Project has been undertaken based on the following key assumptions:

Currency	Australian dollars *Sales contracts in Asia for silica sand are invariably based $US and a A$0.70 exchange rate has been applied*
Project life	25 years Total probable Ore Reserve is well in-excess of this time period, however the model is conservatively restricted to 25 years
Depreciation	15% rate on capital
Corporate tax rate	27% on taxable profit
Production	Steady state of production from Probable Ore Reserves over life of mine, with the first 3 years at 1 million tonnes per year and thereafter at 2 million tonnes per year (see Section 15.2) *The Company has currently expressions of interest and letters of intent to purchase 1.5 million tonnes per year of Arrowsmith North products and expects further interest once these products are made available to the market*
Shares on Issue	404,318,617
NPV estimation discount rates	Standard financial modelling conducted at both 10% and 20% discount rates. *The 20% rate is generally above standard reporting rates but demonstrates that the Project is still financially robust at this higher rate*
Capital cost	Based on estimates ±15% from engineering companies with extensive experience in sand separation
Operating costs	A$30.18 in aggregate (see Section 15) *Based on first principles and current rates for equipment*
Sales revenue	US$35-53 per dry metric tonne dependent on product type, product quality, contract terms and quantity (see Section 17) *Revenue is constant based on current prices and ignores any projected growth in prices*
Maximum debt	A$26 million
Borrowing rate	12%
Accounts receivable	30 days
Accounts payable	30 days
Plant maintenance	5% of capital cost per year
Environmental bond	A$500,000 *May be substituted by the WA Department of Mines, Industry Regulation and Safety's "Mining Rehabilitation Fund"*
Capex contingency	20%
Recoveries	N40 (Foundry ASF 40) 40% N20 (Foundry ASF 20) 24% NF400 (Glass 400 ppm Fe_2O_3) 20% *Recoveries are based on CDE testwork at ±5%*

18.2 Project Metrics

Summary results from the financial model outputs are set out in Table 47:

Post Tax, ungeared NPV_{10}	\$242,300,000
Post Tax, ungeared NPV_{20}	\$99,800,000
Post Tax, ungeared IRR	79%
Payback period (yrs) (post tax) (ramp up rate)	2.4
Exchange Rate US\$/A\$	\$0.70
Life of Mine (yrs) (Scope of BFS)	25
EBIT	\$1,144,000,000
Total Sales (initial 25 years) (no escalation)	\$2,773,000,000
Cashflow after finance and tax	\$835,000,000
Capex (2 mtpa)	\$28,260,000
Capex contingency (inc)	20%
Life of Mine C1 costs, FOB Geraldton (inc Royalties)	\$30.18
Tonnes Processed initial 25 years (million tonnes)	53
Production Target initial 25 years (million tonnes)	47.7
Probable Ore Reserves @ 99.7% SiO_2 (million tonnes)	204
Ore Reserve life (yrs)	102
JORC Resources (million tonnes)	771

Table 47: Project Metrics

Notes:

1: Steady state of production from Probable Ore Reserves over life of mine, based on assumed throughput of 1Mtpa increasing to 2Mtpa in year 4 (see Section 15.2). Assumes 90% recovery rate from tonnes processed (see Table 24).
2. Refer to Section 18.1 for underlying assumptions.
3. A life of mine production profile is set out in Section 18.3.
4. A sensitivity analysis is set out in Section 18.4.
5. All figures are presented in Australian dollars, unadjusted for inflation
6. Rounding errors may occur.

18.3 Production Profile

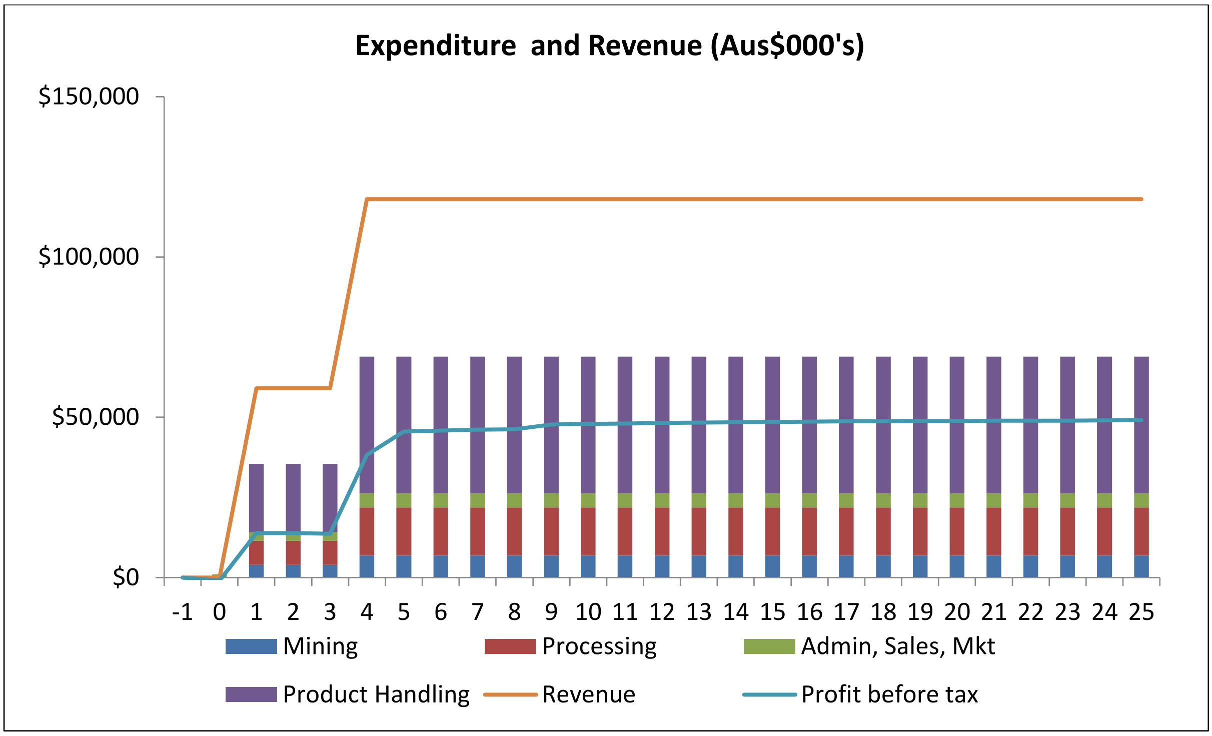


Figure 47: Production Expenditure and Revenue

18.4 Sensitivity Analysis

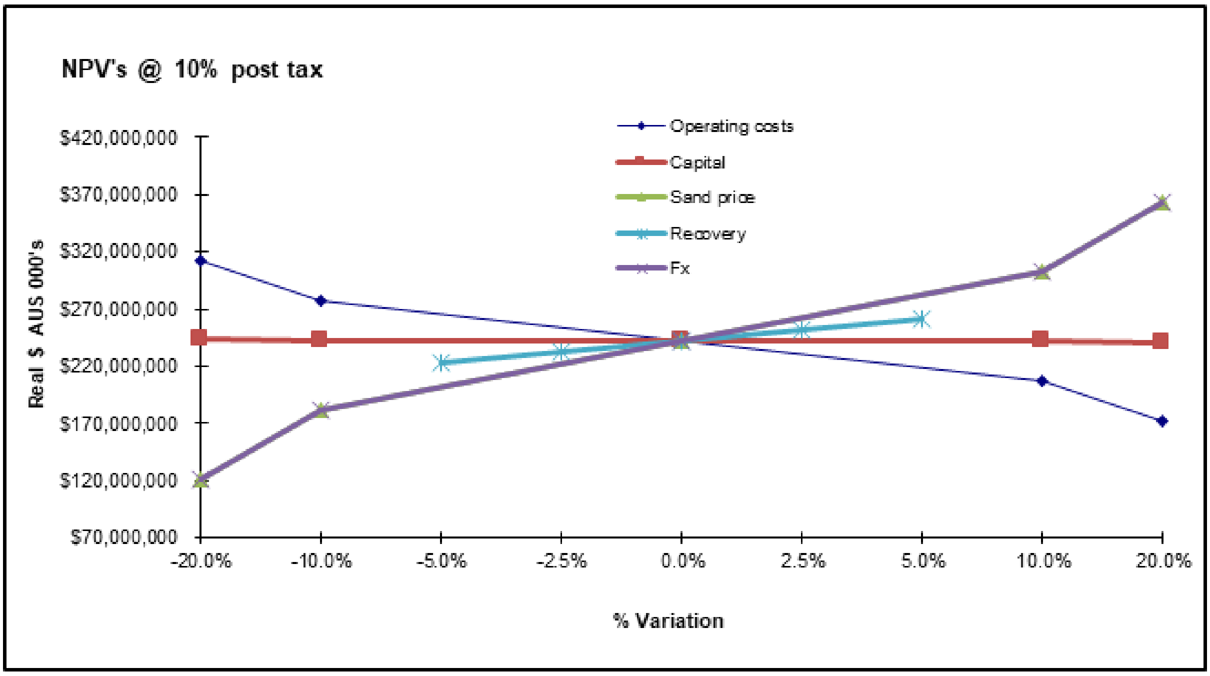


Figure 48: Sensitivity Analysis

19 Resources and Reserves JORC Tables

19.1 JORC Code 2012 Edition Table 1

Sampling Techniques and Data

(Criteria in this section apply to all succeeding sections.)

Criteria	Commentary
Sampling techniques	Aircore drilling samples are 1m down hole intervals with sand collected from a cyclone mounted rotary cone splitter, ~2-3kg (representing 50% of the drilled sand) was collected. Two sub-samples, A and B, of ~200g were taken from the drill samples. The remainder was retained for metallurgical testwork. Auger drilling samples are 1m down hole intervals with sand collected from a plastic tub which received the full sample, ~8kg, from the hole. The sand was homogenised prior to sub sampling, two sub-samples, A and B, of ~200g were taken from the drill samples. A bulk sample of ~5kg was retained for each 1m interval for metallurgical testwork. The “A” sample was submitted to the Intertek Laboratory in Maddington, Perth for drying, splitting (if required), pulverisation in a zircon bowl and a specialised silica sand 4 Acid digest and ICP analysis. All auger samples were weighed to determine if down hole collapse was occurring, if the samples weights increased significantly the hole was terminated to avoid up hole contamination. The targeted mineralisation is unconsolidated silica sand dunes, the sampling techniques are “industry standard”. Due to the visual nature of the material, geological logging of the drill material is the primary method of identifying mineralisation.
Drilling techniques	Vertical NQ sized aircore drilling was completed by a contract drilling company using a Landcruiser mounted Mantis 82 drill rig. A 100mm diameter hand screw auger was used to drill until hole collapse.
Drill sample recovery	Aircore Visual assessment and logging of sample recovery and sample quality Reaming of hole and clearance of drill string after every 3m drill rod Sample splitter and cyclone cleaned regularly to prevent sample contamination No relationship is evident between sample recovery and grade Hand Auger All material recovered from the hole is collected in a plastic drum and weighed, the weights are used to determine when the hole is collapsing, and drilling is terminated. No relationship is evident between sample recovery and grade
Logging	Geological logging of drill samples is done by the field geologist with samples retained in chip trays for later interpretation. Logging is captured in an excel spreadsheet, validated and uploaded into an Access database
Sub-sampling techniques and sample preparation	Aircore drill samples are rotary split 50:50 into a calico bag resulting in 2-3kg of dry sample, 2 x 200g sub-samples, A and B, are taken from the drill sample. The A sample is submitted to the laboratory and the B sample is retained for repeat analysis and QA/QC purposes. The bulk sample is retained for later metallurgical testwork. Auger drill material, ~8kg, is collected in a plastic tub and homogenised, 2 x 200g sub-samples, A and B, are taken from the drill material. The A sample is submitted to the

Criteria	Commentary
	laboratory and the B sample is retained for repeat analysis and QAQC purposes. A 5kg bulk sample is retained for later metallurgical testwork. The sample size is considered appropriate for the material sampled. The 200g samples are submitted to the Intertek Laboratory in Maddington, Intertek use a zircon bowl pulveriser to reduce the particle size to -75um.
Quality of assay data and laboratory tests	Samples were submitted for analysis to the Intertek Laboratory in Maddington in Perth WA. The assay methods used by Intertek are as follows: multi-elements are determined by a specialised four-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids in Teflon tubes. Analysed by Inductively Coupled Plasma Mass Spectrometry, silica is reported by difference. The assay results have also undergone internal laboratory QAQC, which includes the analysis of standards, blanks and repeat measurements. The Company has been validating a high-purity silica standard that was created for the Company by OREAS Pty Ltd. This was required as there is no commercial standard available for high purity silica sand. The standard was “round robin” assayed at several laboratory’s in Perth prior to the commencement of drilling. The standard was then included in the drill sample submissions to Intertek, in sequence, on a ratio of 1:20. Field duplicate samples were submitted in a ratio of 1:20 and in addition to this Intertek routinely duplicated analysis from the pulverised samples in a ratio of 1:25. The number of QAQC samples therefore represents ~14% of the total assays. A full analysis of all the quality control data has been undertaken. This analysis validates the drill assay dataset and conforms with the guidelines for reporting under the JORC 2012 code.
Verification of sampling and assaying	Significant intersections validated against geological logging Three AC twinned holes have been completed.
Location of data points	Auger drill hole locations were measured by hand-held GPS with the expected relative accuracy; GDA94 MGA Zone 50 grid coordinate system is used. Aircore drill holes have been surveyed by RM Surveys using base stations on GOLA SSM DON53 and a Project Control point established as GFM001, situated within the Arrowsmith North prospect and coordinated by RTK from DON53, with the expected relative accuracy compared to the control of 0.05m E, N and RL. Due to RL issues with the SRTM topographical surface the drill collar RL’s were transformed to the SRTM surface. No material difference in the interpreted mineralisation volume is expected once a more accurate topographic surface is sourced.
Data spacing and distribution	Initial auger drilling at Arrowsmith were spaced 400-1,000m apart along existing tracks. The aircore drilling in the indicated resource was spaced 400m, along lines spaced 450m apart. In the Inferred area holes were spaces 800m apart, on line spaces 800m apart. No sample compositing (down hole) has been done.
Orientation of data in relation to geological structure	Sampling is being undertaken on aeolian sand dunes; the drill orientation is therefore considered appropriate.
Sample security	All samples are selected onsite under the supervision of Ventnor Geological staff. Samples are delivered to the Intertek laboratory in Maddington. Intertek receipt received samples against the sample dispatch documents and issued a reconciliation report for every sample batch.
Audits or reviews	There has been no audit or review of sampling techniques and data at this time.

19.2 JORC Code 2012 Edition Table 2

Reporting of Exploration Results

(Criteria listed in the preceding section also apply to this section.)

Criteria	Commentary
Mineral tenement and land tenure status	All drilling has been within Tenement E70/5027, which is owned by Ventnor Mining Pty Ltd a 100% owned subsidiary of VRX Silica Limited. The tenement was granted 29 August 2017 and all drilling was conducted on VCL.
Exploration done by other parties	Minor exploration for mineral sands has been completed by various Companies. Other than work completed by VRX, no exploration for silica sand has been done.
Geology	Most economically significant silica sand deposits in Western Australia are found in the coastal regions of the Perth Basin, and the targeted silica sand deposits are the aeolian sand dunes that overlie the Pleistocene limestones and paleo-coastline, which also host the regional heavy mineral deposits. Within the project area, data obtained from the Department of Agriculture soil mapping shows there are pale and yellow deep sands predominating with lesser swampy areas and occasional ironstone ridges.
Drill hole Information	Not relevant. Exploration results are not being reported. Mineral Resources are being disclosed (see Section 3). Sample and drillhole coordinates are provided in previous market announcements.
Data aggregation methods	Not relevant. Exploration results are not being reported. Mineral Resources are being disclosed (see Section 3).
Relationship between mineralisation widths and intercept lengths	Not relevant. Exploration results are not being reported. Mineral Resources are being disclosed (see Section 3).
Diagrams	Refer to figures within the main body of this report.
Balanced reporting	Not relevant. Exploration results are not being reported. Mineral Resources are being disclosed (see Section 3).
Other substantive exploration data	Geological observations are consistent with aeolian dune mineralisation Four, certified, dry in-situ bulk density measurements were completed at Arrowsmith by Construction Sciences Pty Ltd using a nuclear densometer. The arithmetic average of these was used in the determination of the exploration targets. Groundwater was intersected in only a few holes that were drilled deeper deliberately to ascertain the position of the water table. The water table is typically below 15m depth. The mineralisation is unconsolidated sand. There are no known deleterious substances at this time.
Further work	*With the estimation of an Indicated Mineral Resource the Company can now complete a Feasibility Study and estimate a Ore Reserve for the Project. A positive Feasibility Study will allow for the project to progress through mining approvals, financing and into construction and the commencement of Operations.* *A further testwork program will be undertaken on the "White Sand" at Arrowsmith North to determine the products that can be beneficiated from the higher-grade source.*

19.3 JORC Code 2012 Edition Table 3: Estimation and Reporting of Mineral Resources

(Criteria listed in the preceding section also apply to this section.)

Criteria	Commentary
Database integrity	Data used in the MRE is sourced from a Microsoft Access database. Relevant tables from the Microsoft Access database are exported to Microsoft Excel format and converted to csv format for import into Datamine Studio 3 software. Validation of the data imported comprises checks for overlapping intervals, missing survey data, missing analytical data, missing lithological data, and missing collars.
Site visits	A site visit by Grant Louw of CSA Global took place on 3 July 2019. Geology – Mr Louw noted that the Arrowsmith tenements are primarily underlain by unconsolidated white / yellow silica sand, covered by low scrub and very few trees. Topographic relief is low. It was noted that the material recorded as ironstone ridges by the DOAG mapping is in fact a more iron rich sand unit, and not an ironstone. Drill collars – Mr Louw recorded and verified several marked drill sites using hand-held GPS. Project location – several points such as road intersections were located and plotted in Google Earth™ to verify the tenement location. The CP has visited the VRX sample storage on 17 October 2018 and addressed the following: Sample storage – originals, field duplicates, pulps, standards and chip trays are housed appropriately. Some chip trays were photographed by the CP as a check against Company photographs and geology logs.
Geological interpretation	Silica sand mineralisation at Arrowsmith North occurs within the coastal regions of the Perth Basin, and the targeted silica sand deposits are the aeolian sand dunes that overlie the Pleistocene limestones and paleo-coastline. Within the project area, data obtained from the Department of Agriculture soil mapping shows there are pale (logged by Ventnor as white sands) and yellow deep sands predominating, with lesser swampy areas and occasional iron rich sand ridges. The geological modelling was completed based on this soil mapping data in conjunction with the auger and aircore drill logging data. The Mineral Resources were estimated above 3-d wireframe basal surfaces for the white and yellow sands, with the surfaces being based on the geological boundaries defined by logged sand types and chemical analysis results from the drill data. The air core drilling demonstrated that the white sand layer extends to the west, past the interpreted contact, under the yellow sand in approximately the northern half of the modelled area. The basal surface of the yellow sand is defined by this lithological contact, or is limited by interpretation of nominal average thickness of the sand layer based on the data from surrounding deeper drill holes as required. The white sand layer basal surface is similarly defined by the drilling data and or is limited by interpretation of nominal average thickness of the sand layer based on data from surrounding deeper drill holes as required. The horizontal extents of the interpreted sand layers are limited to within the Ventnor nominated Arrowsmith North target area and with reference to the publicly available soil mapping data. The surface humus layer is typically about 300 mm thick. In consultation with Ventnor, CSA Global considered that the upper 500 mm (overburden) is likely to be reserved for rehabilitation purposes. This overburden surface forms the upper boundary of the estimated Mineral Resource and is depleted from the reported Mineral Resources. Comparatively minor areas that are mapped as iron richer sand ridges, swamp or sandy swamp are also depleted from the Mineral Resources Despite both white and yellow sands being readily amenable to beneficiation, they have been separately modelled, based on the drill logging data and mapped soil type boundaries, as they are separately estimated due to differences in grades of the various mineral components. Assumptions have been made on the horizontal extents of the mineralisation based on the soil mapping data and the spacing and extents of the drilling information. A nominal maximum horizontal extrapolation limit of 200 m past known drill data points has been applied with the material types additionally constrained within the Ventnor nominated target

Criteria	Commentary
	area and by the mapped material type boundaries. The vertical extents of the sand layers have been limited by interpretation of the nominal average thickness of each layer based on data from the deeper drilled aircore holes. The nominal maximum interpreted combined layer sand vertical thickness is roughly 25 m and the nominal average interpreted thickness of sand is about 12 m. Approximately 15% of the modelled mineralisation zones can be considered to be extrapolated. Alternative interpretations based on the currently available data are considered unlikely to have a significant influence on the global MRE. Continuity of geology and grade can be identified and traced between drillholes by visual and geochemical characteristics. Confidence in the grade and geological continuity is reflected in the Mineral Resource classification.
Dimensions	The modelled and classified extents of the yellow sand material within the target area are roughly 10 km north to south, and on average roughly 2.5 km west to east. The modelled and classified extents of the white sand material within the target area are roughly 4.6 km north to south, and on average roughly 1.5 km west to east. The modelled aeolian sand is roughly horizontal, with low relief. The currently modelled thickness of the sands is on average about 12 m, ranging up to a nominal maximum thickness of 25 m.
Estimation and modelling techniques	Ordinary Kriging (OK) was the selected interpolation method, with Inverse distance squared (IDS) used as a check estimate. Grade estimation was carried out at the parent cell scale, with sub-blocks assigned parent block grades. Grade estimation was carried out using hard boundaries between the two sand type zones. Statistical analysis on the 1 m downhole composited drillhole data to check grade population distributions using histograms, probability plots and summary statistics and the co-efficient of variation, was completed on each sand type for the estimated grade variables. The checks showed there were some outlier grades in the interpreted sand types that required top-cutting. Top cuts for the white sand were applied to Fe2O3 (0.5%), and LOI (1%). Top cuts for the yellow sand were applied to Al2O3 (2.8%), Fe2O3 (1.5%), and LOI (1.5%). In addition to SiO_2, the grade variables Al2O3, Fe2O3, LOI, and TiO2 are estimated into the model and reported. A volume block model was constructed in Datamine constrained by the topography, overburden layer, sand type zones, material depletion zones and target area limiting wireframes. Analysis of the drill spacing shows that the nominal average drill section spacing is 400 m with drill holes nominally at 400 m apart on each section over majority of the modelled area. Spatial (variogram) analysis was completed on SiO_2 from the 1 m drill composite samples from the yellow sand zone, as this zone has the most samples. The resultant single spherical modelled variogram parameters were applied to an OK estimation as the primary grade estimation technique. The modelled nugget was a fairly low 15%. There was no preferred orientation for the horizontal variogram so the major axis is modelled towards 000° with the same 700 m range modelled for both major and semi-major axes. The minor vertical axis was modelled with a range of 8.5 m. Based on the sample spacing a parent block size of 200 m(E) x 200 m(N) x 4 m(RL) or nominally half the average drill section spacing, was selected for the model. Sub-cells down to 12.5 m(E) x 25 m(N) x 0.25 m(RL) were used to honour the geometric shapes of the modelled mineralisation. The search ellipse orientations were defined as being horizontal based on the overall geometry of the mineralisation and with reference to the variogram modelling study. The

Criteria	Commentary
	search ellipse was doubled for the second search volume and then increased ten-fold for the third search volume to ensure all blocks found sufficient samples to be estimated. The search ellipse dimensions of 700 m x 700 m x 10 m, have been selected with reference to the variogram modelling. A minimum of 16 and a maximum of 24 samples were used to estimate each parent block for both zones. These numbers were reduced for the second search volume to 12 and 20 samples and in the third search volume to 8 and 16 samples. A maximum number of four samples per drillhole were allowed. Cell discretisation was 3 (E) x 3 (N) x 4 (RL) and no octant-based searching was utilised. Model validation was carried out visually, graphically, and statistically to ensure that the block model grade reasonably represents the drillhole data. Cross sections, long sections and plan views were initially examined visually to ensure that the model grades honour the local composite drillhole grade trends. These visual checks confirm the model reflects the trends of grades in the drillholes. Statistical comparison of the mean drillhole grades with the block model grade shows reasonably similar mean grades. The IDS check estimate shows similar grades to the OK model, adding confidence that the grade estimate has performed well. The model grades and drill grades were then plotted on histograms and probability plots to compare the grade population distributions. This showed reasonably similar distributions with the expected smoothing effect from the estimation taken into account. Swath or trend plots were generated to compare drillhole and block model with SiO_2% grades compared at 400 m E, 800 m N and 2 m RL intervals. The trend plots generally demonstrate reasonable spatial correlation between the model estimate and drillhole grades after consideration of drill coverage, volume variance effects and expected smoothing. No reconciliation data is available as no mining has taken place.
Moisture	Tonnages have been estimated on a dry, in situ, basis. The sampled sand material was generally reasonably dry, with data collected from the density testing of seven intervals showing an average moisture content of 2.9%.
Cut-off parameters	No cut-off parameters have been applied, as both sand types appear to be readily amenable to beneficiation to a suitable product specification through relatively simple metallurgical processes as demonstrated by reported metallurgical testing results.
Mining factors or assumptions	It has been assumed that these deposits will be amenable to open cut mining methods and are economic to exploit to the depths currently modelled. No assumptions regarding minimum mining widths and dilution have been made. No mining has yet taken place.
Metallurgical factors or assumptions	2018 testing: A composite auger sand sample from Arrowsmith North was tested in Ireland. The sample was screened at 4mm to remove oversize particles. The remaining material was then subjected to an attrition process followed by spiral and magnetic separation methods. Attrition testing was carried out a retention period of 5 minutes, with the sample washed after attritioning to remove any liberated fine particles. Spiral testing was then carried out with approximately 80kg of attritioned material, after which the samples then underwent wet magnetic separation to explore the possibility of reducing the magnetic mineral content. Chemical analysis showed a general decrease in the Al_2O_3. Processing, attritioning and washing the material removed the largest fraction of Al_2O_3. The spiral separation process produced samples where the largest fraction of Al_2O_3 was found in the heavy mineral fraction. Magnetic separation resulted in the largest fraction of Al_2O_3 being in the magnetic fraction. The results for Fe_2O_3 follow the same general trend as for Al_2O_3. The percentage fraction of SiO_2 in the samples increased during the test process. Attritioning and washing the material removed fines and silt, which increased the SiO_2 content. The spirals test produced samples where the largest fraction of SiO_2 was found in the light fraction. Magnetic separation indicated that the largest fraction of SiO_2 was in the middling fraction. 2019 testing: raw material remaining from 2018 was removed from storage and was screened at 1 mm to remove oversize material and organics. The sand was then wet

Criteria	Commentary
	screened through a 0.212 mm sieve and PSD test run which showed that the +0.212 mm material contains some fines (3.25% passing the 0.212 mm sieve) and in contrast the -0.212 mm sample contains a large amount of fines with 27.2% passing the 0.053 mm sieve. Chemical analysis showed that the -0.212 mm fraction contains more Al_2O_3 and Fe_2O_3 than the +0.212 mm fraction, due to higher clay fraction in the finer sample. The 0.212-1 mm fraction was then attritioned for 5 minutes and washed over a 0.063 mm sieve, highlighting that the attrition and washing process removed fine particles, and reduced Al_2O_3, Fe_2O_3 and TiO_2 contents. The 0.212 mm material was then processed in a spirals test unit and three fractions were produced, namely heavy, middling and light. Particle size distribution analysis showed that the heavies contain the highest amount of fines and that the lights contain the lowest amount of fines, probably because fine-grained dense minerals containing Fe and Ti are concentrated with the heavy fraction. This observation was borne out by chemical analysis which showed that Al_2O_3, $Fe_2O_3$and TiO_2 are highest in the heavy fraction. These elements are lowest in the middling and light fractions, and lower than the feed material. Magnetic separation results in an increase in SiO_2 and a decrease in Al_2O_3, Fe_2O_3 and TiO_2 in the non-magnetic fraction compared with the feed material. The composite sample tested by CDE Global in 2018 and 2019 indicates that a product with AFS ~45 should be achievable and that some coarser AFS ~20 product may also be achievable. Most foundry sands fall into the range of ~0.1mm to 0.5mm and they are produced to meet specific size distributions which are commonly described by a number known as the 'AFS number'. The higher the AFS number, the finer the sand. Other foundry sand specifications include roundness and sphericity, clay content (generally <0.5%), moisture and SiO_2 content, which should be achievable with suitably processed Arrowsmith North silica sand. CSA Global is of the opinion that process testwork on the composite drill sample indicates that the Arrowsmith North deposit should be suitable for the eventual production of silica sand for glass, ceramics and foundry markets. In addition, project location and logistics support the classification of the Arrowsmith North deposit as an Inferred industrial Mineral Resource in terms of Clause 49 of the JORC Code.
Environmental factors or assumptions	No assumptions regarding waste and process residue disposal options have been made. It is assumed that such disposal will not present a significant hurdle to exploitation of the deposit and that any disposal and potential environmental impacts would be correctly managed as required under the regulatory permitting conditions. Ventnor has indicated that initial botanical studies are underway, and in the modelling the top 500 mm is reserved for rehabilitation purposes and is depleted from the model and is not reported.
Bulk density	Seven, certified, dry in situ bulk density measurements were completed by Construction Sciences Pty Ltd using a nuclear densometer. The results from the seven measurements are corrected based on the measured moisture factor. The mean dry in situ density result of 1.66 t/m3 is used for all modelled material reported in the MRE.
Classification	Classification of the MRE was carried out accounting for the level of geological understanding of the deposit, quality of samples, density data and drillhole spacing. The MRE has been classified in accordance with the JORC Code (2012 Edition) using a qualitative approach. All factors that have been considered have been adequately communicated in Section 1 and Section 3 of this Table. Overall the mineralisation trends are reasonably consistent over the drill sections. The MRE appropriately reflects the view of the Competent Person.
Audits or reviews	Internal audits were completed by CSA Global, which verified the technical inputs, methodology, parameters, and results of the estimate. No external audits have been undertaken.
Discussion of relative accuracy/ confidence	The relative accuracy of the MRE is reflected in the reporting of the Mineral Resource as per the guidelines of the JORC Code (2012). The Mineral Resource statement relates to global estimates of in situ tonnes and grade.

19.4 JORC Code 2012 Edition Table 4

Estimation and Reporting of Ore Reserves

(Criteria listed in the preceding section also apply to this section.)

Criteria	Commentary
Mineral Resource estimate for conversion to Ore Reserves	The Mineral Resource Estimate (MRE) used as a basis for conversion to the Ore Reserve was provided by CSA Global Pty Ltd, with Grant Louw and Andrew Scogings as the Competent Persons on the Estimation and David Reid, a full time employee of VRX Silica as the Competent Person on the Exploration Results and data collection. The Arrowsmith North Updated MRE used in this conversion is dated 5th July 2019. The Mineral Resources as reported inclusive of the Ore Reserves.
Site visits	The Competent Person, David Reid, is a full-time employee of VRX Silica and has made numerous site visits to Arrowsmith North. The following observations are applicable to this Conversion; The mining area is located between Eneabba and Dongara in Western Australia, ~270km north of Perth. The area is access via the Brand Highway, with the northern section of the area access via the Mount Adams gravel road. There are numerous existing tracks that also allow for alternative access. The population density is low, 147 persons in Eneabba, and 1,380 persons in Dongara. There are a small number of farming properties in the local area. The mining area is located on unallocated crown land, VRX Silica has 100% ownership of the underlying mining tenure. The topographical relief is a series of low rolling sand dunes covered in covered by low Kwongan Heath. The proposed mining operation will excavate the sand from the top of the sand dunes to a nominal undulating base roughly level with the freehold land which boarders the western edge of the mining area. Th eastern and southern sides of the mining area will be graded up at 1:10 gradient. No ground water was intersected in the mining area drilling and rainfall is expected to drain into the surrounding sand with little or no runoff that could defect the mining operation. The sand to be mined is unconsolidated and will not require blasting. All mining can be carried out by a wheeled front-end loader. There are no power lines or water lines in the mining area. There are gas pipelines and gas production wells to the east of the mining area, however these will not be impacted during mining.
Study status	VRX Silica is finalising a Bankable Feasibility Study (BFS) for the Arrowsmith North project. All the inputs to the BFS are available to the Competent Person to be able to make this conversion of Indicated Mineral Resources to Probable Ore Reserves. It is expected the BFS will be completed in the near future and the results will be available for public release.
Cut-off parameters	Only Indicated resources have been considered for conversion to Ore Reserves. The MRE defines two types of sand "yellow" and "white", both of which have been demonstrated are able to be beneficiated to a saleable product via non-chemical means in a traditional sand processing plant. The MRE did not apply any cut-of grades during estimation as it simply modelled the two different types of sand, there is therefore no waste in the MRE. The MRE differentiated the top 500mm as "topsoil" and excluded it from the estimation as it was assumed it would be retained for rehabilitation purposes..
Mining factors or assumptions	The mining method chosen for Arrowsmith North is a rubber wheeled front-end loader, feeding into a 3mm trommel screen to remove organics. The undersize sand is slurried

Criteria	Commentary
	and pumped to a sand processing plant which is located proximal to the Eneabba to Geraldton railway line. After processing the silica sand is then loaded into railway trucks for bulk export from the Geraldton Port. The front-end loader was chosen due to the flexible nature of the machine combined with a high load rate and low material handling cost. Mining of the dune sand will extract to the base of the Indicated resource / Probable reserve. This level is roughly the same as the freehold land boundary on the western side of the mining area and will leave a slightly undulating surface. On the eastern side of the mining area the sand will slope upward as a 10% gradient to the top of the adjacent dunes. Mining will not excavate below the surface, there are no geotechnical requirements. Active mining faces exceeding 10m may be required, face stability issues will be determined during mining. Pre-production drilling is unlikely to be required due to the low in-situ variation of the bulk sand resource, the aircore drilling used in the MRE is considered to be sufficient. 100% of the material in the Mining Lease application area is considered to be sand that can be beneficiated to a saleable silica sand project. The top 500mm has been excluded from the MRE as it will be reserved for rehabilitation purposes. As there is no waste material, the recovery factor is considered to be 100% and ore loss therefore is considered to be 0%. Depending on the thicknesses of white and yellow sand that are available at anyone time, the decision may be taken to mine as separate units as they have different physical and chemical compositions. This may also depend on the Customers specification. Inferred resources are not used in the Ore Reserve output. There may be a small amount of Inferred material that falls into the Mining Area as the edges are mined, the relative amount of this material is insignificant. Infrastructure required will be office blocks, mining contractor workshop and associated facilities.
Metallurgical factors or assumptions	VRX Silica has completed a rigorous and extensive metallurgical testwork program. Bulk composite sample for Arrowsmith North were tested at the Nagrom Laboratory in Kelmscott, Perth and the CDE Global Laboratory in Cookstown, Northern Ireland. The testwork flowchart followed attritioning, spiral tests, magnetic separation and sizing and assay determination to determine a catalogue of saleable products that could be produced from the Arrowsmith North sand mineral resource. A full summary of the testwork is covered in Section 3 of this Table. The results of the testwork were used by CDE Global to complete an Engineering design and costing for a 300tph and 600tph wet processing silica sand plant for Arrowsmith North. CDE Global is a world leader wet processing plant design and construction with over 1,300 projects delivered over the last 25 years. The silica sand plant utilises commonplace equipment and the process is well proven The sand will be processed through a traditional wet processing plant. A slurried sand will be delivered from the mine via a pipeline to the Plant which will be located proximal to the Eneabba to Geraldton railway line. The process flow in the plant will be; • Sand slurry to a constant density tank, • Attrition Bank #1, deslime • Attrition Bank #2, deslime • Spiral gravity separation • Magnetic separation • Sizing screens to customer specifications The bulk testwork has allowed for generation of a catalogue of products that can be produced from the Arrowsmith North mineral resource. Two high value export products can be produced for 2 different potential markets, the glass making market and the foundry market, with a third product to be sold into the local market. The export products have been

<table>
<tr><th>Criteria</th><th>Commentary</th></tr>
<tr><td></td><td>denoted as Arrowsmith-NF500 for the glass market and Arrowsmith-N40 and Arrowsmith-N20 both for the foundry market. It should be noted that NF500 and N40 are the same product and are of a good specification for both markets. The local market material is fine sand and could be sold into the local filter sand or bunker sand market.

The testwork has determined the mass balance of the various particle sizes during processing and a recovery of each product can be estimated. The following recoveries are used in the conversion of mineral resources to ore reserves;

<table>
<tr><th>Product</th><th>Market</th><th>Recovery</th></tr>
<tr><td>Arrowsmith – N20</td><td>Foundry</td><td>24%</td></tr>
<tr><td>Arrowsmith – N40 / NF500</td><td>Foundry/Glass</td><td>60%</td></tr>
<tr><td>Fine filter sand</td><td>Local Market</td><td>6%</td></tr>
<tr><td></td><td>Total</td><td>90%</td></tr>
</table>
The Ore Reserve conversion is declared as a plant recovered tonnage and is represented by the chemical and physical compositions of the final products that are produced for export, or for the local market.

An independent Technical Summary Report by CSA Global on the Metallurgical Testwork to satisfy Clause 49 of the JORC 2012 code is included as an appendix to this report.</td></tr>
<tr><td>Environmental</td><td>Environmental Characteristics of the Area

The development is located:
• South of the Yardongo Nature Reserve;
• Approximately 10 km inland of the coast;
• North of the Arrowsmith River (Registered Aboriginal Heritage Site); and
• Outside of World Heritage Areas, National Heritage Places, Ramsar Wetlands, Conservation Reserves or Commonwealth Marine Reserves.
The Ore Reserve is located within an area of deep sands, leached of nutrients.

The vegetation is coastal scrub heath (known as Kwongan heath).

There are relict dune structures which are represented as low rolling hills.

Assessment Process

• Referral submission to DotEE;
• Submission of Section 38 referral to WA EPA;
• Seek an Accredited EPBC Act Assessment under the WA EP Act via an Environmental Review Document with public comment;
• May require studies
• Submission of Environmental Review Document
Mitigation Strategies

• Proposed Action lies within a large Development Envelope, allowing for the flexibility to target areas of lower significance to MNES
• Disturbance will be kept to a minimum, up to 30 ha per year and 10 at any one time
• Progressive rehabilitation using topsoil re-location to ensure topsoil and plants are translocated to previously mined areas
• Conduct further surveys to identify Matters of National Environmental Significance
• Use findings to steer the project and avoid MNES where possible
There are no mine tailings storage requirements

There are no waste dumps

Processing requires no chemicals.</td></tr>
<tr><td>Infrastructure</td><td>The project is located within a development envelope bounded by Brand Highway to the east and the Eneabba/Geraldton rail line to the west

Product will be loaded on rail for transportation to Geraldton Port</td></tr>
</table>

<table>
<tr><th>Criteria</th><th>Commentary</th></tr>
<tr><td></td><td>The project will require its own installed power and water infrastructure

Labour will be sourced from the nearest towns (35kms) Dongara and Eneabba

There will be no accommodation installed at the mine site.</td></tr>
<tr><td>Costs</td><td>Operating costs

Costs were determined from first principles and are estimated to include all costs to mine, process, transport and load product on to ships, including;

• Mulching
• Topsoil cut
• Topsoil re-location
• Excavation
• Plant Feed
• Operating the trommel and pumping station
• Processing
• QA/QC
• Power and Water
• Administration
• Product Handling
• Train Feed and Transport
• Port Storage
• Ship Loading

Product Quality

• Multiple products will be differentiated during processing subject to required particle size distribution by screening
• Recovery of products has been independently assessed by CDE Global, a world leading silica sand testing laboratory

Commodity Prices

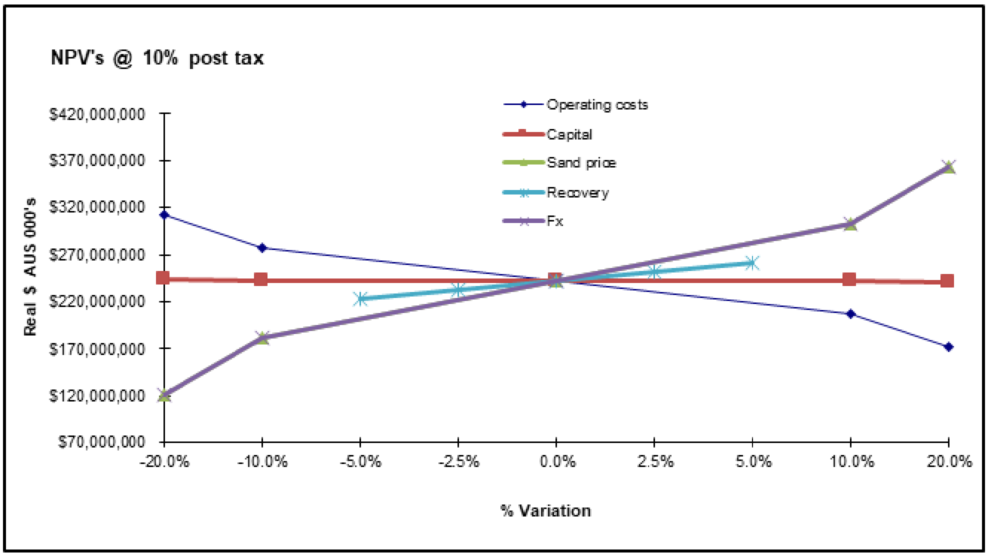
• Commodity prices for VRX silica sand products have been determined by independent industry source Stratum Resources
• The industry standard is that sales contracts are in US dollars
• The exchange rate to convert to Australian dollars will be the prevailing at the time of payment
• Subject to final quality produced the current prices for the commodity will range from US$38 to US$58 per dry metric tonne Free on Board
• There are no shipping cost estimates with all contracts to be based on FOB rates

QA/QC

• The company will undertake constant surveillance of product quality during production
• An independent laboratory will be used to verify the product during loading on behalf of the buyer

Royalties

• The prevailing rate of Royalty due to the State is used in VRX economic assessments
• The Royalty rate is per dry metric tonne ($1.17) and reviewed every 5 years with the next review due 2020
• There are no other private Royalties.</td></tr>
<tr><td>Revenue factors</td><td>Revenue</td></tr>
</table>

Criteria	Commentary
	Revenue will be based on a negotiated per shipment basis per dry metric tonne FOB with payment by demand on an accredited bank Letter of Credit There are no other treatment, smelting or refining charges.
Market assessment	The Company has commissioned an independent assessment of the current market prices for proposed products by industry leader Stratum Resources The assessment includes projections for future demand and supply of Silica Sand The assessment concludes that there is a future tightening of supply suitable glassmaking silica sand with a commensurate increase in price Sales volumes have been estimated as a result of received Letters of Intent to purchase products
Economic	The Company economic analysis has calculated an 10% and 20% discounted ungeared post tax NPV The Company assessment has not escalated future product prices nor any inflation to operating costs The analysis has used a US$/A$ exchange rate of $0.70 Analysis is based on a conservative 25-year production profile despite the Reserves far exceeding that project life Tax rate used is 27% of profit Capital requirements are based on independent estimates Capital borrowings are based on a 12% borrowing rate Capital expenditure contingency is 20% of capital estimates Plant spares are estimated at 5% of capital value The economic analysis is most sensitive to the exchange rate 
Social	VRX made an application for a mining lease, MLA70/1389, on 21/12/2018. The application lies within the Southern Yamatji native title claim boundaries (WC2017/002), which replaced a pre-combination claim (WC2004/002) by the Amangu People. The Company is currently in negotiations with the claimant group with respect to the mining lease application M70/1389. There is no reason to believe that an agreement will not be reached between the parties allowing for the mining lease to be granted. The Project is wholly on vacant, unallocated Crown land.

Criteria	Commentary
Other	There are no known obvious or naturally occurring risks that have been identified which could affect the project and no reason why the Company cannot gain all approvals to mine the project from the relevant Regulatory Bodies, both State and Federal. The Company has received expressions of interest from 20 manufacturers across the Asia Pacific Region for various silica sand products in its published catalogue, including specific requests for Arrowsmith North products. The Company has made an application for a mining lease, M70/1389, on 21/12/2018 and there is no known reason why this lease will not be granted. A number of Letters of Intent to purchase the Projects proposed products have been received from potential customers.
Classification	Probable reserves are converted from Indicated resource materials. Because of the nature of the deposit (consistency, homogeneity, low variability) this is considered reasonable. 100% of the ore reserves are Probable.
Audits or reviews	The Ore Reserve estimate has been reviewed internally by VRX. No external reviews or audits have been undertaken on the Ore Reserve estimate. The BFS is being reviewed externally.
Discussion of relative accuracy/ confidence	The Mineral Resource, and hence the associated Ore Reserve, relate to global estimates. To date there has been no commercial production, therefore no reconciliation can be made. A BFS is being finalised and the results of that study are available to the Competent Person. The BFS has been completed to a high level of detail and therefore the Competent Person can be confident the project is robust and produce positive economic benefit to the Company once in production. Sensitivity analysis made during the BFS process has indicated that the economics are most sensitive to the USD/AUD exchange rate. It is believed that the revenue model is sufficiently conservative to ensure a positive economic return.

19.5 JORC Compliance Statement

The information in this document that relates to Exploration Targets, Exploration Results, Mineral Resources, Ore Reserves and Production Targets have been extracted from the report(s) and announcements listed below.

Arrowsmith North Silica Sand Mineral Resource Estimate Update Ref:R313.2019: CSA Global Mining Industry Consultants (July 2019)

Arrowsmith North Reserve assessment: David Reid, Geologist (July 2019)

Arrowsmith North Silica Sand Mineral Resource Estimate, Metallurgy/Processing: : CSA Global Mining Industry Consultants (July 2019)

CDE Testing Report Revision 2: CDE Global (February 2019)

Desktop Assessment of Potential Flora, Vegetation and Fauna Values at the Arrowsmith Project Area: Mattiske Consulting (March 2017)

Hydrogeological Feasibility Assessments Arrowsmith Projects: HydroConcept Consultants (January 2019)

Silica Sand Markets: Stratum Resources (July 2019)