GRUYERE GOLD PROJECT

EPA REFERRAL
SUPPORTING DOCUMENT

PREPARED FOR:

GOLD ROAD RESOURCES LIMITED

MARCH 2016

PREPARED BY:

Martinick Bosch Sell Pty Ltd
4 Cook Street
West Perth WA 6005
Ph: (08) 9226 3166
Fax: (08) 9226 3177
Email: info@mbsenvironmental.com.au
Web: www.mbsenvironmental.com.au

GRUYERE PROJECT
EPA REFERRAL SUPPORTING DOCUMENT

Distribution List:

Company	Contact name	Copies	Date
Environmental Protection Authority	Sally Bowman, Mining & Industrial Assessments North Peter Tapsell, Principal Environmental Officer	[01]	31 March 2016
Gold Road Resources	Glenn Firth, Approvals Manager Sim Lau, Project Manager	[01]	31 March 2016

Document Control for Job Number: GRREPA

Document Status	Prepared By	Authorised By	Date
Draft report (excluding process water borefield) for client review	Nicole Garbin / Hilary Chin	Kristy Sell	18 September 2015
Draft report (excluding process water borefield) for EPA review	Nicole Garbin / Hilary Chin	Kristy Sell	28 October 2015
Draft report for client review	Nicole Garbin / Talia Warda	Kristy Sell	29 February 2016
Final report	Nicole Garbin / Talia Warda	Kristy Sell	2 March 2016
Revised final report (Rev 1)	Nicole Garbin / Jonathon Barker/ Talia Warda	Kristy Sell	31 March 2016

TABLE OF CONTENTS

TABLES

FIGURES

CHARTS

APPENDICES

Appendix 8: Baseline Stygofauna Survey of the Gruyere Gold Project Borefields (Bennelongia 2016)

Appendix 9: Stakeholder Consultation Register

1. PROPONENT AND KEY PROPOSAL CHARACTERISTICS

1.1 BACKGROUND

The Gruyere Gold Project is a greenfields gold deposit in the Yamarna greenstone belt of Western Australia and is owned by Gold Road Resources Limited (Gold Road). The Yamarna greenstone belt is a newly discovered gold region covering approximately 5,000 km^2 on the eastern side of the Yilgarn Craton. Gold Road aims to develop an open pit mining operation to extract and process gold from the Gruyere deposit.

This document has been prepared to support Referral of the proposal to the Western Australian Environmental Protection Authority (EPA) in accordance with EAG 1 (EPA 2012), EAG 6 (EPA 2013), EAG 8 (EPA 2015), EAG 9 (EPA 2015a) and EAG 16 (EPA 2015b). This document is intended to inform and assist in determining the appropriate environmental assessment and approval pathway for the proposed Gruyere Gold Project under Part IV of the *Environmental Protection Act 1986 (EP Act).* The information provided within it is consistent with the *Environmental Impact Assessment (Part IV Division 1 and 2) Administrative Procedures 2012*. EPA guidelines and policies that are relevant to this proposal (including study specific guidelines) are presented in Table 1 and Section 3.1.

This document was originally submitted as a draft to the EPA for review on 28 October 2015; however that version of the document excluded the saline water borefield within the Yeo Palaeochannel which was planned to be subject to separate approvals upon completion of investigations. Further to feedback received from the EPA and a meeting held between Gold Road and the EPA on 6 November 2015, it was concluded that a water source needed to be identified which is included within this EPA Referral.

The scope of this EPA Referral includes:

- Development of an open pit gold mining operation at the Gruyere deposit.
- Processing of ore using conventional gold extraction methods.
- A brackish-saline water borefield located within the Central Palaeochannel (Anne Beadell borefield) to be used in the raw water system during the construction phase (1 - 2 years) and thereafter to supply non-process water requirements during the operational phase (10 - 15 years).
- A hypersaline water borefield located within the Yeo Palaeochannel to be used for process water during the operational phase (10 – 15 years).
- Construction of infrastructure necessary to allow development and operation of the Gruyere Gold Project.

Gold Road makes this EPA Referral recognising the potential for environmental impact of the proposal and to establish the requirements for environmental assessment and approval.

A gas pipeline to support the proposed 40 MW gas power plant is not part of the scope of this EPA Referral and will be submitted as a separate EPA Referral upon completion of further investigations.

Gold Road has decided to not refer the Gruyere Gold Project under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*). Gold Road considers that implementation of the Gruyere Gold Project represents a low risk to matters of 'National Environmental Significance' and therefore the Gruyere Gold Project does not require assessment under the *EPBC Act*.

Table 1: EPA Policy Applicable to the General Preparation of this Supporting Document

Topic	Applicable Policy	Document Section	Rational in Meeting Policies and Guidelines
Preparation of Environmental Referral Document	*Environmental Assessment Guideline for Defining the Key Characteristics of a Proposal* (EAG 1) (EPA 2012).	Section 2.2 Section 2.2	Section 2.2 identifies the key characteristics of a proposal as required in EAG 1.
	Environmental Assessment Guideline for Referral of a Proposal under s38 of the Environmental Protection Act 1986 (EAG16) (EPA 2015).	Referral Form and this Supporting Document	The Referral Form and this Supporting Document follows the content and applicability of EAG 16.
	Environmental Assessment Guideline for Environmental Principles, Factors and Objectives (EAG 8) (EPA 2015).	Section 4	The content of Section 4 describes the key environmental principles, factors and objectives relating to the Gruyere Gold Project and how these have been derived.
Significance Framework	*Environmental Assessment Guideline for Application of a Significance Framework in the Environmental Impact Assessment Process* (EAG9) (EPA 2013).	Section 4	The works presented in Section 4 of this Supporting Document are based on the application of management and mitigating measures in order to demonstrate that the EPA objectives applicable to each Environmental Factor are likely to be achieved.

1.2 PROPONENT DETAILS

The manager and proponent of the Gruyere Gold Project is Gold Road. Gold Road is a company incorporated in Australia and has shares listed on the ASX (GOR). Gold Road is the owner of all tenements associated with the Gruyere Gold Project.

All compliance and regulatory requirements regarding this assessment document should be forwarded by email, fax, post or courier to the following address:

Name: Glenn Firth
Company: Gold Road Resources Limited
Title: Approvals Manager

Address: Level 2, 26 Colin Street
West Perth WA 6005
Postal Address: PO Box 1157
West Perth WA 6872
Phone: (08) 9200 1600
Fax: (08) 9481 6405
Email: glenn.firth@goldroad.com.au

1.3 LOCATION AND LAND TENURE

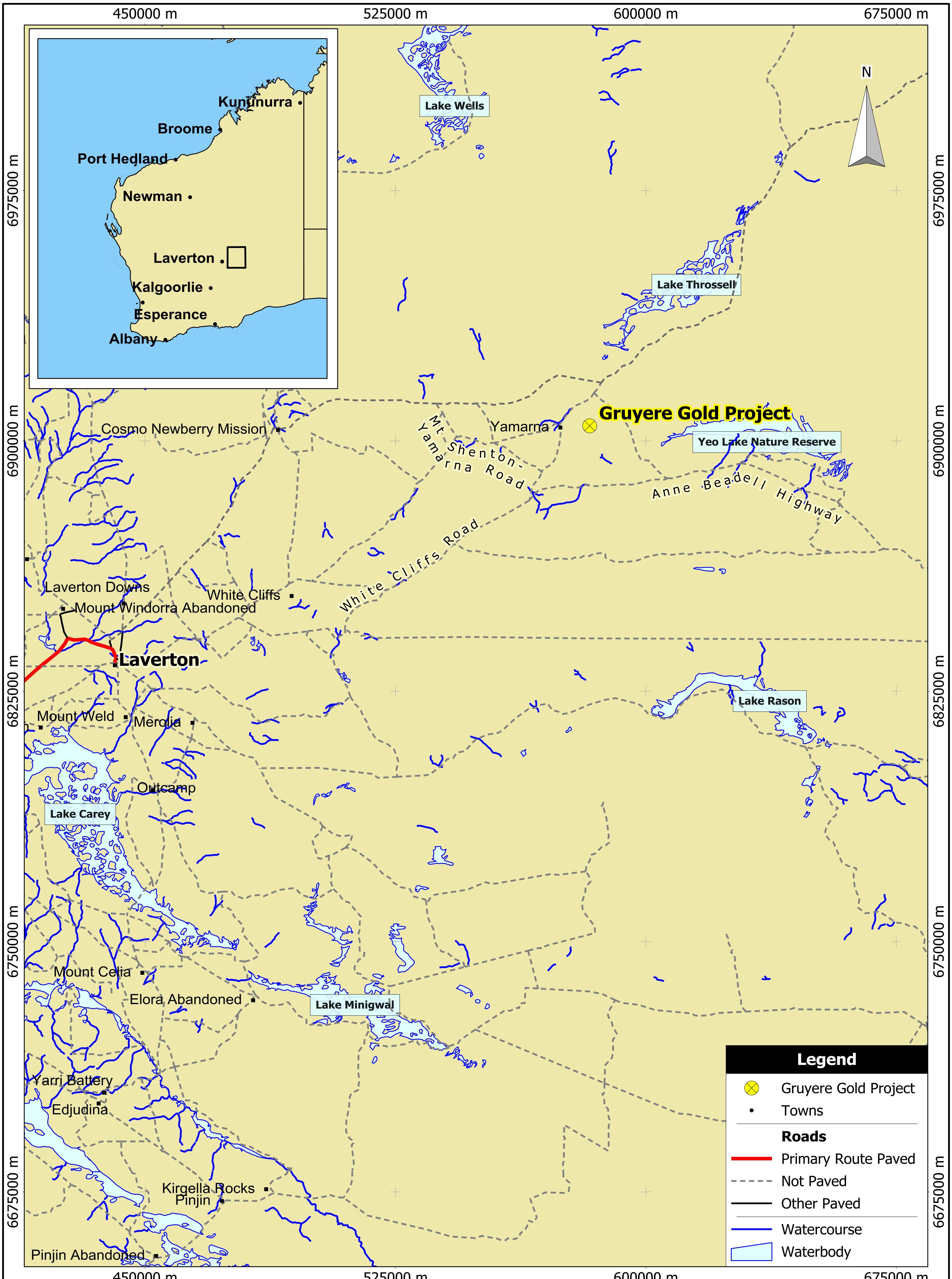
The Gruyere Gold Project is located approximately 200 km north-east of Laverton in Western Australia (Figure 1). Gold Road currently holds a number of Exploration Licenses over the area (Figure 2). The Gruyere Gold Project is located within the Yamarna Pastoral Lease (PL N49674) which is wholly owned and managed by Gold Road.

A Mining Lease (MLA38/1267) was applied for in September 2014, totalling approximately 6,846 ha and will be granted by the end of Quarter 2 2016 following signing of the Mining Agreement with Traditional Owners. Miscellaneous Licence applications will be made for the airstrip, both borefields, access roads and borrow pits. A tenement summary is provided in Table 2 for tenements associated with the Gruyere Gold Project which are held by Gold Road.

The closest community is Cosmo Newberry located approximately 80 km north-west of the Gruyere Gold Project. A '*Yamarna Pastoral Lease Heritage Project Agreement*' and the '*Yamarna Project Agreement*' was made in 2004 between Gold Road and Harvey Murray as applicant for and on behalf of the Cosmo Newberry Claim Group which governs exploration activities inside the Pastoral Lease. A Native Title Mining Agreement is currently being negotiated with a Claimant Group (Native Title Claim WC2008/005 registered on 6 August 2009). Grant of tenure for the Mining Lease is subject to the Native Title Agreement being finalised which is expected to be completed by the end of Quarter 2 2016.

Table 2: Gruyere Gold Project Tenement Summary

Tenement	Area (ha)	Grant Date	Expiry Date
MLA 38/1267	6,845.5	*Pending*	*Pending*
E38/2362	5,750.0	26/08/2010	25/08/2020
E38/2447	5,142.0	02/06/2011	01/06/2016
L38/211	24,801.8	16/05/2013	15/05/2034
L38/180	4,422.0	21/09/2011	20/09/2032
L38/210	59,562.3	16/05/2013	15/05/2034
L38/229	178.7	*Pending*	*Pending*
L38/237	4,299.3	06/10/2015	06/10/2036
L38/241	5,743.3	*Pending*	*Pending*
L38/243	236.6	*Pending*	*Pending*



Scale: 1:1500000
Original Size: A4
Grid: Australia MGA94 (51)
0 40 km

Gold Road Resources Limited
Gruyere Gold Project
EPA Referral

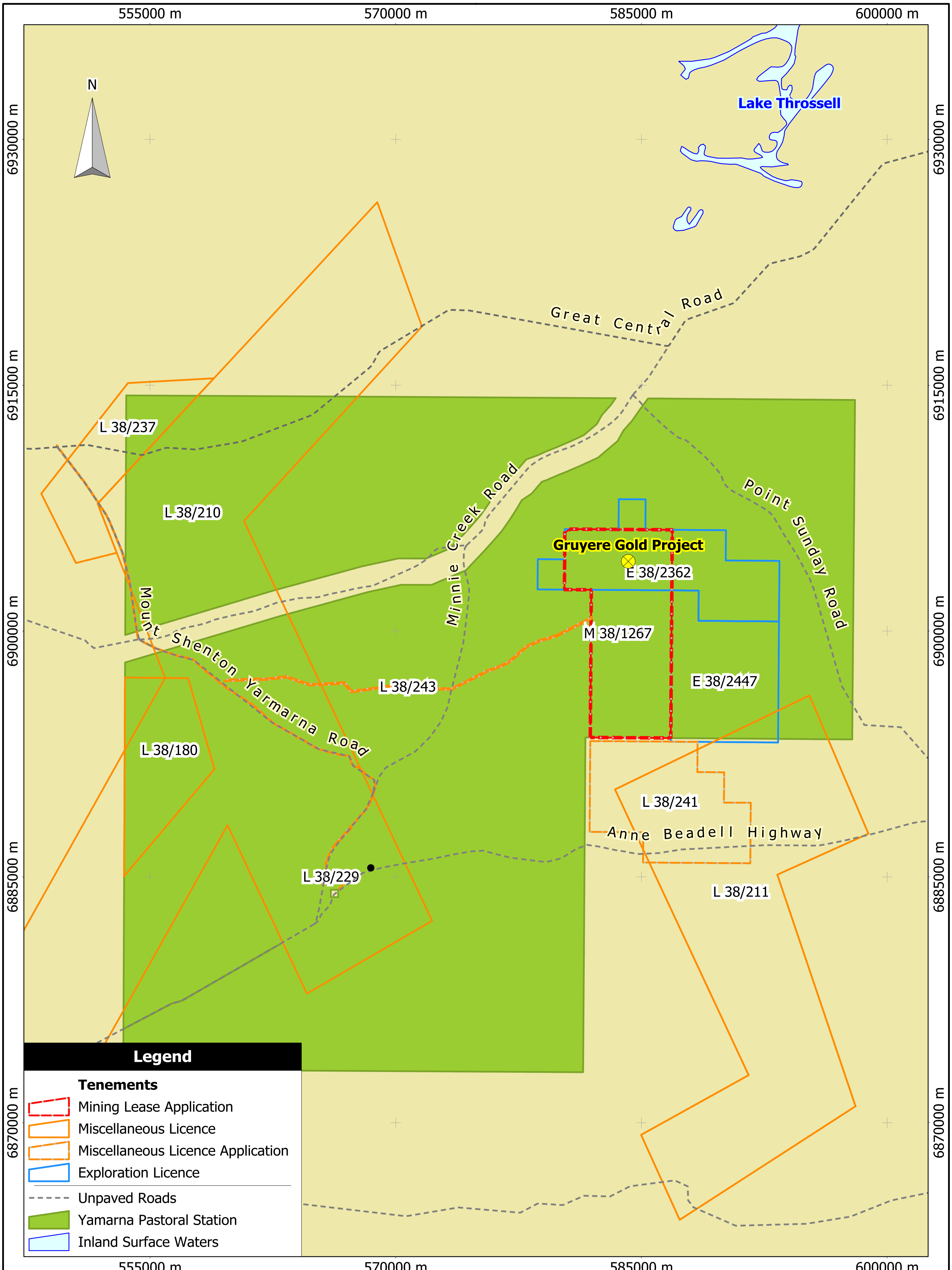
Figure 1

Location Plan

Martinick Bosch Sell Pty Ltd
4 Cook St
West Perth WA 6005
Ph: (08) 9226 3166
Fax: (08) 9226 3177
info@mbsenvironmental.com.au
www.mbsenvironmental.com.au

MBS ENVIRONMENTAL

W:\Gold Road Resources\Gruyere\Feasibility\Location Maps for Glenn\Location Plan.map 31/03/2016 F1 A4P



Scale: 1:300000
Original Size: A4
Grid: MGA94(51)

0 10 km

Gold Road Resources Limited
Gruyere Gold Project
EPA Referral

Figure 2

Tenement Plan

Martinick Bosch Sell Pty Ltd
4 Cook St
West Perth WA 6005
Ph: (08) 9226 3166
Fax: (08) 9226 3177
info@mbsenvironmental.com.au
www.mbsenvironmental.com.au

W:\Gold Road Resources\Gruyere\Approvals\EPA Referral\Drawings\Tenement Plan.map 31/03/2016 F2 Tenement Plan Layout

1.4 PROJECT SCHEDULE

The proposed schedule for the Gruyere Gold Project is described in Table 3.

Table 3: Proposed Schedule for the Gruyere Gold Project

Project Description	Schedule
Scoping Study	Completed Quarter 1 2015
Prefeasibility Study (PFS)	Completed Quarter 1 2016
Native Title Agreement	Aim to complete by end of Quarter 2 2016
Granting of Mining Lease	Aim to complete by end of Quarter 2 2016
Feasibility Study (FS)	Aim to complete by Quarter 4 2016
Construction	Aim to commence by Quarter 1 2017
Operations	Aim to commence Quarter 4 2018

2. PROJECT DESCRIPTION

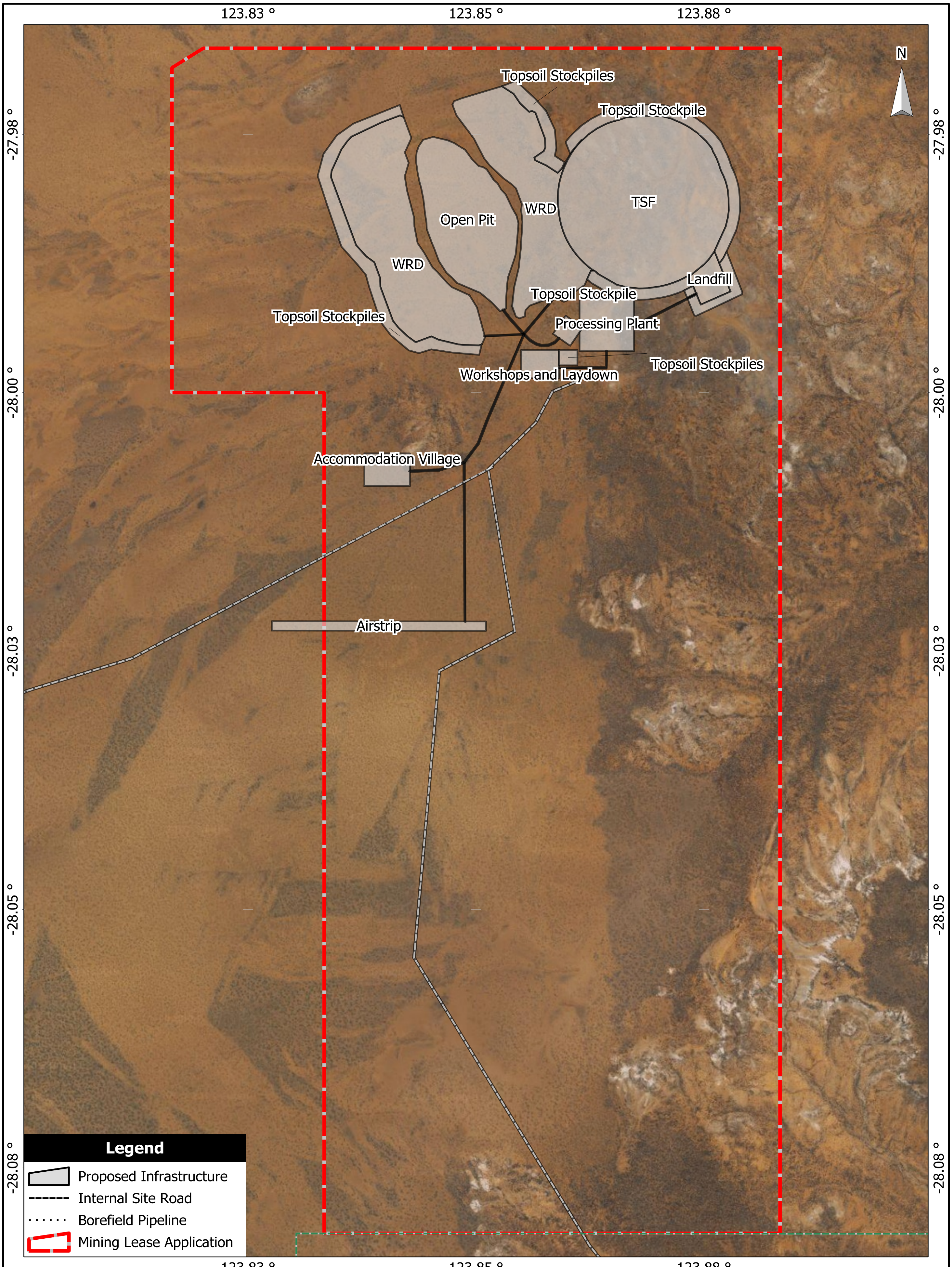
2.1 PROJECT OVERVIEW

The Gruyere Gold Project is a gold deposit in the Yamarna Greenstone Belt of Western Australia. The Maiden Mineral Resource for the Gruyere Deposit was described in an ASX announcement made by Gold Road on 4 August 2014 (Gold Road 2014). The updated JORC 2012 Mineral Resource (refer to ASX announcement dated 16 September 2015) stated that the Gruyere Gold Project presently has a defined Resource of 5.62 Moz of gold over 128.4 Mt at an average of 1.36 g/t gold and 0.7 g/t cut-off (Gold Road 2015a). A Scoping Study was announced and completed in January 2015 (Gold Road 2015b; 2015c) which concluded the Gruyere Gold Project presents a viable opportunity for development. A Prefeasibility Study (PFS) for the Gruyere Gold Project was completed 7 February 2016 (Gold Road 2016) and a Feasibility Study (FS) is anticipated to be completed by Quarter 4 2016.

Gold Road aims to develop an open pit gold mine at Gruyere with the potential to transition to underground mining operations at depth in the future. The processing facility will be designed to process 7.5 Mt/a of Gruyere fresh ore and up to 8.8 Mt/a of oxide ore in a Carbon in Leach (CIL) processing plant. In addition, the Gruyere Gold Project will involve the construction and use of:

- An integrated waste landform (IWL) *i.e.* a combined tailings storage facility (TSF) and waste rock dump (WRD).
- A brackish-saline water borefield located within the Central Palaeochannel (Anne Beadell borefield) to be used in the raw water system during the construction phase (1 - 2 years) and thereafter to supply non-process water requirements during the operational phase (10 - 15 years).
- A hypersaline water borefield located within the Yeo Palaeochannel to be used for process water during the operational phase (10 - 15 years).
- Support infrastructure including a run of mine (ROM) pad, workshops, laydown areas, gas power station, reagent storages, explosives magazine, washdown facility, fuel facility, stormwater management infrastructure (bunds and drains), water storage ponds and tanks, wastewater treatment plant (WWTP), landfill, construction camp, accommodation village, buildings, offices, telecommunications infrastructure, access road, internal mine roads and an airstrip.

Key characteristics of the Gruyere Gold Project are provided in Table 4 and the conceptual site layout is shown in Figure 3. The Gruyere Gold Project operational life is estimated to be 12 years; however exploration is ongoing and extension of project life is considered highly probable.



Scale: 1:60000 Original Size: A4 Air Photo Date: 2013 Grid: Latitude / Longitude 0 2000 m	Gold Road Resources Limited Gruyere Gold Project EPA Referral	**Figure 3** **Mine Site Layout**	Martinick Bosch Sell Pty Ltd 4 Cook St West Perth WA 6005 Ph: (08) 9226 3166 Fax: (08) 9226 3177 info@mbsenvironmental.com.au www.mbsenvironmental.com.au

W:\Gold Road Resources\Gruyere\Approvals\EPA Referral\Drawings\EPA Referral March 2016.map 31/03/2016 F3 Mine Site Layout Layout

2.2 KEY PROPOSAL CHARACTERISTICS

Key proposal characteristics for the project are shown in Table 4. Three development envelope areas totalling 35,430 ha have been defined for the Gruyere Gold project. These reflect the geographically separated Mine Site components (including the Anne Beadell borefield) and Yeo Palaeochannel borefield and the Access Corridor which links these two components. The development envelopes are shown in Figure 4. The approximate land areas for each development envelope are:

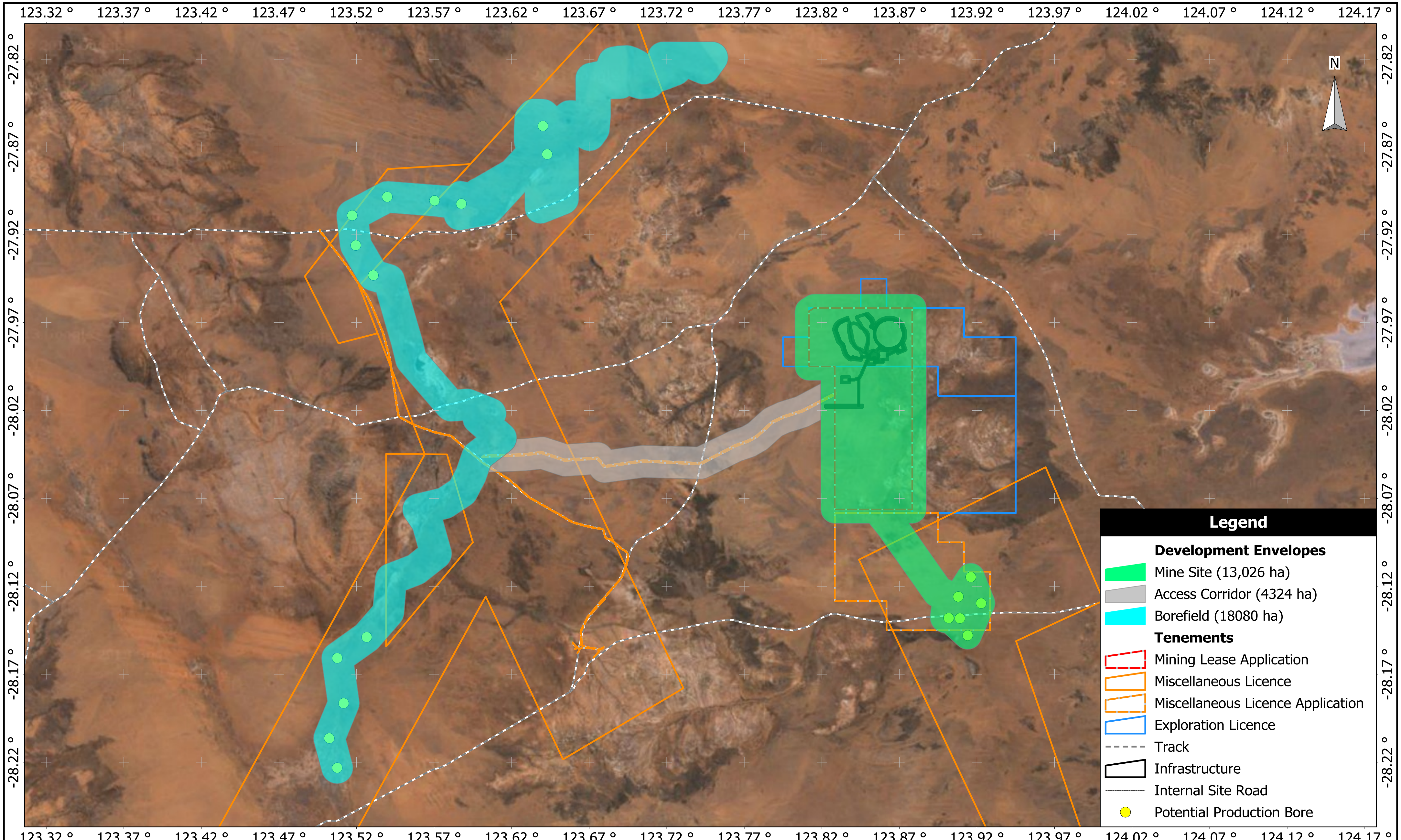
- Mine Site (including the Anne Beadell borefield) - 13,026 ha.
- Access Corridor - 4,324 ha.
- Yeo Palaeochannel Borefield – 18,080 ha.

Table 4: Key Proposal Characteristics

Summary	
Proposal Title	Gruyere Gold Project
Proponent Name	Gold Road Resources Limited
Short Description	This proposal is for open pit mining and processing of gold bearing ore at the Gruyere Gold Project, located approximately 200 km north-east of Laverton in Western Australia. Ore will be processed using conventional CIL treatment methods. The project will result in an integrated waste landform (IWL) i.e. a tailings storage facility and waste rock dump) being constructed to store mine and process wastes. The proposal also includes construction of associated mine infrastructure (run of mine (ROM) pad, workshops, laydown areas, gas power station, reagent storages, explosives magazine, washdown facility, fuel facility, stormwater management infrastructure (bunds and drains), water storage ponds and tanks, wastewater treatment plant (WWTP), landfill, construction camp, accommodation village, buildings, offices, telecommunications infrastructure, access road, internal mine roads and an airstrip).

Physical Elements		
Element	**Location**	**Proposed Extent Authorised**
Mine Site Development Envelope		
Waste Landforms	Figure 3	Clearing no more than 590 ha within the 13,026 ha Development Envelope.
Minesite Infrastructure	Figure 3 Figure 7	Clearing no more than 305 ha within the 13,026 ha Development Envelope.
Open Pit	Figure 3	Clearing no more than 130 ha within the 13,026 ha Development Envelope.
Yeo Palaeochannel Envelope		
Process Water Borefield (Pipeline & Inspection Track)	Figure 7	Clearing no more than 80 ha within the 18,080 ha Development Envelope.
Access Corridor Envelope		
Borefield Access Corridor	Figure 3	Clearing no more than 55 ha within the 4,324 ha Development Envelope.

Operational Elements		
Element	**Location**	**Proposed Extent Authorised**
Mine Site Development Envelope		
Ore Processing Waste	Integrated Waste Landform - Figure 3	Total storage capacity 56.95 Mt.
Mining Waste	Waste Rock Dump - Figure 3	300.2 Mt.
Ore Processing	Processing Plant – Figure 3	7.5 Mt/a conventional SABC gravity CIL plant with capacity to treat 8.8 Mt/a of oxide ores.
Dewatering	Non-Process Borefield - Figure 7	0.8 GL/a.
Power Supply	Processing Plant - Figure 3	40 MW – gas power plant and diesel backup of four x 1.0 MW units.
Open Pit	Open Pit - Figure 3	1,900 m long x 1,000 m wide x 450 m deep.
Yeo Palaeochannel Envelope		
Dewatering	Process Borefield - Figure 7	7.8 GL/a.



Scale: 1:350000
Original Size: A4
Air Photo Date: 2013
Grid: Latitude / Longitude

0 10 km

Gold Road Resources
Gruyere Gold Project
EPA Referral

Figure 4

Development Envelope Areas

4 Cook St
West Perth WA 6005
Ph: (08) 9226 3166
Fax: (08) 9226 3177
info@mbsenvironmental.com.au
www.mbsenvironmental.com.au
MBS ENVIRONMENTAL

2.3 PROPOSED LAND DISTURBANCE

Land disturbance required for implementation of the Gruyere Gold Project will be located on MLA38/1267 and Miscellaneous License applications will be obtained for the airstrip, borefields, access roads and borrow pits.

Estimated total land disturbance is approximately 1,200 ha for the Gruyere Gold Project. Indicative land disturbance for key components of the Gruyere Gold Project are shown in Table 5 for each development envelope.

Table 5: Estimated Land Disturbance for Key Project Components

Project Component	Estimated Disturbance Area (ha)
Mine Site Development Envelope	
Waste Rock Dump	319
Tailings Storage Facility	270
Borrow Pits and Topsoil Stockpiles	131
Open Pit	130
Non-Process Water Borefield (Pipeline and Inspection Track)	47
Run of Mine	6
Processing Plant	35
Airstrip	24
Accommodation Village/Wastewater Treatment Plant	18
Landfill	14
Internal Site Roads	13
Workshops and Laydown Areas	13
Yeo Palaeochannel Development Envelope	
Process Water Borefield (Pipeline and Inspection Track)	80
Access Corridor Development Envelope	
Process Water Pipeline and Inspection Track	53
Total	**~1,200**

2.4 MINING

Gold Road proposes to mine gold from the Gruyere Deposit using conventional drill, blast, load and haul open pit mining methods. The maximum dimensions of the open pit will be about 1,900 m long by 1,000 m wide by 450 m depth and there is a potential to transition to underground mining operations at depth in the future. A cross section of the Gruyere orebody is shown in Figure 5.

The Gruyere Deposit has a presently defined Mineral Resource of 5.62 Moz of gold over 128.4 Mt (Gold Road 2015a) and the Gruyere open pit averages more than 9,000 reserve ounces per vertical metre (Gold Road 2016a). Gold was intercepted in every RC drill hole along the 1,900 m strike length. The orebody is closed off along strike both to the north and south however remains open at depth. Deeper drilling has intersected mineralisation approximately 1,200 m below surface and the width varies from 7 m to 190 m (average 90 m). The estimated mine waste volume from the presently optimised pit is around 250 Mt (Gold Road 2015b).

Mining equipment will include excavators, haul trucks, surface drill rigs, dozers, water trucks, service trucks and graders. Dozer ripping will be utilised in the oxidised upper layers, with light drilling and blasting in the transitional zones and conventional drilling and blasting in the fresh rock. Marginal grade ore will be utilised in the construction of a ROM pad at the processing plant. Ore will be brought to the surface by truck and transferred to the ROM pad. Overburden material will be stockpiled for use during rehabilitation activities. An explosives magazine will store explosives for open pit blasting activities.

Water inflows to the open pit will include groundwater and mine service water used in various mining activities such as drilling, washing down and dust suppression. A dewatering system will be installed to allow safe mining operations. Dewatering will be achieved using a combination of in-pit sumps, out of pit dewatering bores and horizontal seep wells. Dewatering water will be brackish-saline (TDS of approximately 5,000 to 16,000 mg/L) and the mine watering water demand from years 1 to 15 is expected to be ~2,200 kL/day and the water quantity will be approximately ~0.8 GL/year (Pennington Scott 2016).

The existing water table in the operational area is about 30 m below ground. The predicted drawdown expected at the Gruyere open pit after 12 years life of mine (LoM) dewatering is shown in Figure 6. At the end of the 12 year LOM the Gruyere pit will be dewatered to its base, being 380 m below ground level (i.e. 350 m below the existing water table); the 20 m drawdown contour will extend about 1 km from the pit and the 2 m drawdown contour may extend up to 6.5 km from the pit. These simulated dewatering impacts are considered to err towards a conservative case because the numerical model is calibrated to long term average rainfall recharge/discharge conditions. Groundwater recharge associated with rare cyclonic storms can cause higher than average regionally distributed groundwater recharge over a wide area, largely ameliorating the drawdown simulated at the margins of the model.

Notwithstanding the conservative nature of the simulations, no discernible impacts (i.e. drawdowns less than 0.1 m) are expected in the hard rock terrain by the end of LoM. No impacts are anticipated to Gold Road's pastoral lease stock bores or any potential third party water users off tenement.

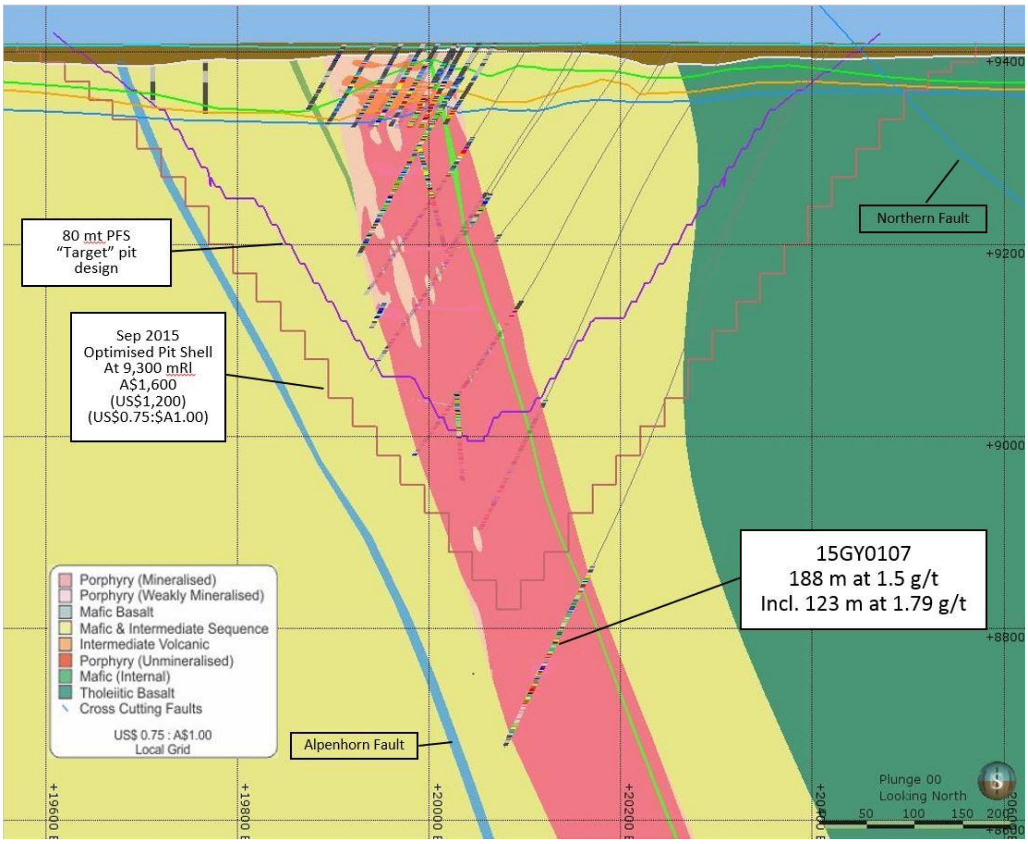
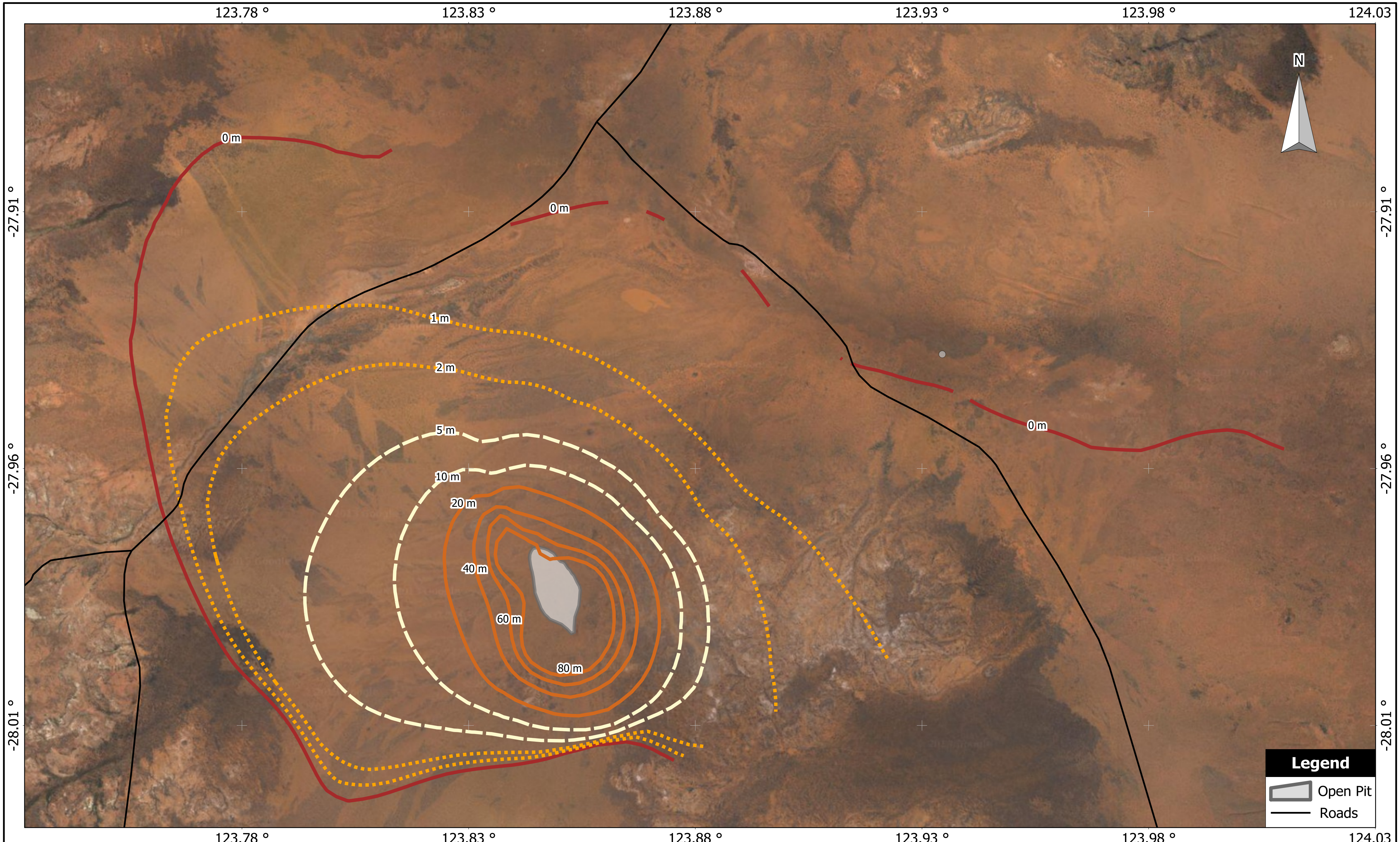


Figure 5: Cross Section of the Gruyere Orebody



Scale: 1:120000
Original Size: A4
Air Photo Date: 2013
Grid: Latitude / Longitude

0 4000 m

Gold Resources Limited
Gruyere Gold Project
EPA Referral

Figure 6

Mine Pit Groundwater Drawdown

4 Cook St
West Perth WA 6005
Ph: (08) 9226 3166
Fax: (08) 9226 3177
info@mbsenvironmental.com.au
www.mbsenvironmental.com.au
MBS ENVIRONMENTAL

W:\Gold Road Resources\Gruyere\Approvals\EPA Referral\Drawings\EPA Referral March 2016.map 31/03/2016 F6 Mine Pit Groundwater Drawdown Layout

2.5 ORE PROCESSING

The processing facility will be designed to process 7.5 Mt/a of Gruyere fresh ore and up to 8.8 Mt/a of oxide ore in a CIL processing plant with primary crushing followed by semi-autogenous ball crusher (SABC) grinding. The processing plant will be located near to the ROM pad and outside of the blast zone around the pit. The processing circuit will comprise the following unit processes:

- Single staged crushing to a P80 of 135 mm.
- Semi-autogenous grinding (SAG) and ball milling with pebble crushing and cyclone classification to a P80 of 125 micron.
- Centrifugal gravity concentration and intensive cyanidation of the resulting gravity concentrate.
- Pre-leach thickening.
- Leaching and CIL adsorption of gold onto activated carbon.
- Recovery of loaded carbon, elution and electrowinning of gold and silver from the pregnant eluate.
- Smelting dore.
- Tailings will be thickened and disposed to an above ground IWL.

ROM ore will be hauled from the mine to the ROM pad and will be either direct tipped or loaded by front end loader into the primary gyratory crusher. The crushing circuit will be open circuit, single stage with a throughput rate of 1100 t/h. The crushed ore will report to a crushed ore stockpile with a live volume of 22,500 t. The grinding circuit will consist of a primary SAG mill with pebble crushing and a secondary ball mill in closed circuit with cyclones.

A gravity circuit will be utilised to treat a portion of the cyclone underflow stream to recover coarse free gold from the recirculating load. The recovered gold concentrate will be leached in an intensive leach reactor. A separate electrowinning circuit has been provided for the intensive cyanidation solution to eliminate any potential impact on the operation of the carbon elution and electrowinning circuit. Two vibrating trash screens have been selected to prevent any mis-reporting coarse ore particles, wood fragments, organic material and plastics from entering the CIL circuit and blocking the inter-tank screens. A pre-leach thickener has been selected to maximise water recovery and allow optimal cyclone overflow density to be produced from the classification circuit.

The CIL circuit will consist of one leach tank and six stages of adsorption. The leach tank has been sized to provide a minimum of four hours residence time when at full production and the CIL tanks have been sized to provide a minimum total residence time of 24 hours for leach and adsorption. The acid wash and elution will be completed in separate columns.

Two screw compressors with integrated dryers will provide compressed air to the plant air receiver, from which the air will be reticulated to points of use in the plant. The two compressors will also provide compressed air to the instrument air receiver. Two separate screw compressors will provide air into the two, three tonne per day (six tonne in total) pressure swing absorption (PSA) oxygen plant, which will produce 90% oxygen gas which will be fed into the oxygen receiver. Oxygen gas from the receiver will then be reticulated to the leach and CIL tanks down shaft through the agitators. The processing plant control room will be located adjacent to the grinding and CIL area in order to monitor system process.

Reagents likely to be used during ore processing include quicklime, sodium cyanide, hydrochloric acid, sodium hydroxide, flocculant, activated carbon, oxygen and gold room fluxes. The reagent store will include a concrete floor and concrete apron slabs extending out of the open side to facilitate forklift access. Reagents will be received and used as delivered, except for flocculant which will be received as dry powder and mixed with water to a concentration of 0.25% by weight. A metallurgical laboratory will be constructed near to the processing plant to support ore processing operations.

2.6 INTEGRATED WASTE LANDFORM

A purpose built engineered IWL will be constructed for long term disposal of waste rock and tailings. A conceptual IWL layout with waste rock and pit outline is shown in Figure 7. The development of the IWL will be in stages to suit tailings and mine waste production. Waste rock will be placed using traditional dump construction techniques (*i.e.* paddock dumping and dozer spreading) and a compacted zone will be constructed within the mine waste annulus to form the TSF. The results of waste characterisation will be used to determine the most appropriate use of waste rock (see Section 3.11). Tailings will be pumped out to the TSF at a density of 60% solids with a pulp SG of 1.62 t/m³.

Stage 1 will comprise construction of a starter embankment to crest level RL 412 m, using compacted clayey mine waste (*i.e.* clayey cover material and saprolite) from pit pre-stripping. A cut-off trench of compacted clayey soil will be constructed in order to reduce lateral seepage losses. The mine waste component will be constructed behind the starter embankment and the embankment (comprising an upstream compacted zone) will be raised in stages to final crest level RL 440 m using downstream construction techniques. The targeted embankment height of the upstream compacted zone will be approximately 40 m. The cumulative final storage capacity will be 56.95 Mt.

The design concept includes a central pumped decant for water recovery. The pump will be deployed within a decant tower surrounded by filter rock. Access to the decant tower will be via a causeway constructed using traffic compacted mine waste. The decant tower and decant access way will be raised with the perimeter embankments. The design concept incorporates an underdrainage system, primarily around the perimeter embankment upstream toe and around the decant structure. The underdrainage system will drain by gravity to an internal underdrainage sump. Recovered water will be pumped to the decant system and back to the processing plant. A diversion channel will be established around the perimeter of the IWL to direct clean stormwater runoff away from the structure and to minimise erosion of the IWL and associated infrastructure.

The clay/loam plain soil and landform unit is expected to provide most of the soil materials for construction of the TSF and water storage compacted earth liners embankments (MBS 2015a).

Coffey Mining undertook a geotechnical investigation in September 2015 as part of the IWL PFS Tailings Storage Design (Coffey 2015). Sampling consisted of:

- Excavation of 22 test pits (denoted TP1 to TP13 and TP1A to TP6A which were excavated on the eastern side of the pit area and TP7A to TP9A which were excavated on the western side) to nominal depths of 2.5 m or refusal in proposed IWL footprint areas.
- Sampling of foundation materials.
- Sampling of selected drill samples from the pit area.

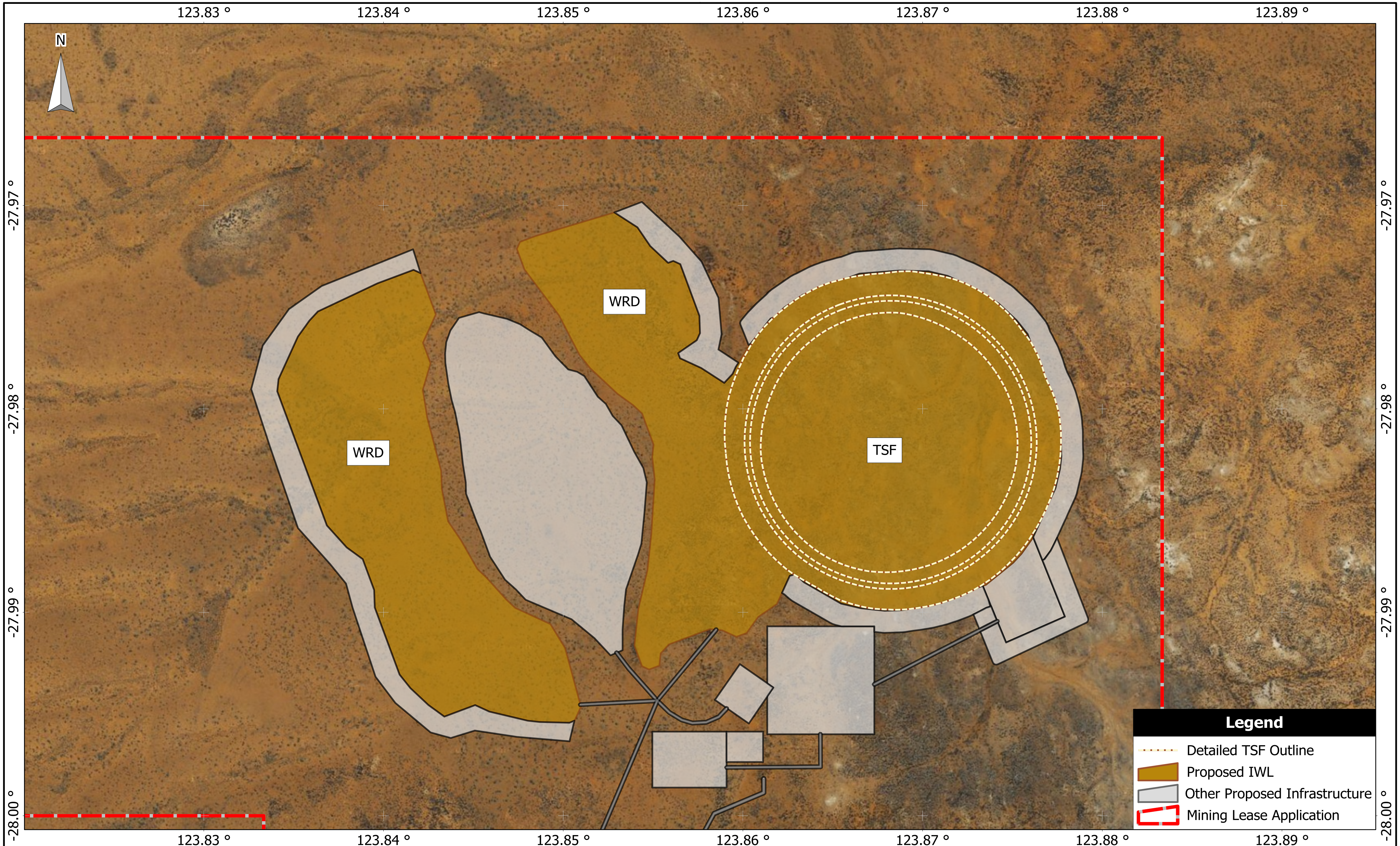
Test pitting was carried out by Cosmo Newberry Community members under supervision by a Coffey Associate Geotechnical Engineer. Results concluded that the area to the east of the proposed open pit is considered to be adequate for its intended use, i.e. construction and operation of an IWL.

Groundwater was not encountered in any of the test pits over the depth range investigated. A network of groundwater monitoring bores located around the IWL will be determined by Project Hydrogeologists and will be used to monitor potential impacts to groundwater. In years 3 to 15, TSF recovery bores water demand will be <1,500 kL/day and the water quantity will be <0.3 GL/yr, with water being hypersaline (TDS of approximately 20,000 to 100,000 mg/L) (Pennington Scott 2016).

Overall, the design of the IWL minimises potential impacts and a number of alternative locations were considered. This took into consideration such aspects as:

- Avoiding geological faults and fractures.
- Suitable geotechnical conditions.

- Avoiding potential mineralised areas.
- Minimising total land and thus vegetation disturbance for the IWL footprint and associated pipelines.
- Proximity to the processing plant.
- Avoiding watercourses and areas of potential flooding.
- Avoiding heritage sites or areas of cultural importance.
- Avoiding impact on conservation significant flora and fauna.
- Minimising disruption to pastoral activities on the Yamarna Pastoral Lease.
- Proximity to construction materials for use in embankments.



Scale: 1:30000
Original Size: A4
Air Photo Date: 2013
Grid: Latitude / Longitude

0 1000 m

Gold Road Resources
Gruyere Gold Project
EPA Referral

Figure 7

Conceptual IWL Layout

4 Cook St
West Perth WA 6005
Ph: (08) 9226 3166
Fax: (08) 9226 3177
info@mbsenvironmental.com.au
www.mbsenvironmental.com.au
MBS ENVIRONMENTAL

2.7 WATER SOURCES AND INFRASTRUCTURE

2.7.1 Water Sources

2.7.1.1 Existing Borefield

Gold Road has developed a small borefield within the Yeo Palaeochannel which is located approximately 25 km west of the Gruyere Gold Project for the purpose of initial pump testing and modelling of the Project's water requirements.

This small borefield will not have sufficient resources to sustain the minimum expected Gruyere Gold Project water demand of 8.6 GL/year (i.e. 7.8 GL/a for the process water borefield and 0.8 GL/a for the non-process water borefield) and therefore two borefields as described below are proposed.

2.7.1.2 Process Water Borefield

A process water borefield will be developed within the Yeo Palaeochannel (Figure 8). Water from this borefield is hypersaline (TDS is approximately 25,000 to 75,000 mg/L) and will be used for process water during the mine's life. It will consist of a lateral line to the north and south and is intended to provide raw water to the processing plant. The preliminary borefield design included in the PFS is for a borefield about 65 km in length with the capacity to produce approximately 20,000 kL/day (238 L/s). In years 3 to 15, the water demand on the Yeo Palaeochannel borefield will be 20,500 kL/day and the water quantity available is 7.5 GL/yr (Pennington Scott 2016).

About 30 bores are proposed, contributing 12 L/s per bore. The locations of these bores have been based on modelling scenarios to minimise groundwater drawdown in areas of potentially significant stygofauna habitat. Modelling was on the basis of 13 bores being pumped at a rate greater than12 L/s, however discussions with DoW indicate preferences for installation of a larger number of bores in the same area being pumped at a lower rates. This will not affect the predicted drawdown contours.

2.7.1.3 Non-Process Water Borefield

There are no natural sources of fresh water within 50 km of the Gruyere Gold Project. A non-process water borefield will be located within the Central Palaeochannel (Anne Beadell borefield) (Figure 8), which is located approximately 20 km southeast of the Gruyere Gold Project. Water from this borefield is brackish-saline (TDS is approximately 5,000 to 25,000 mg/L) and will be used in the raw water system during the construction phase (1 - 2 years) and thereafter to supply non-process water requirements during the operational phase (10 - 15 years). Mine dewatering water will also supplement water needs during the construction phase. All of the potable water for the Project will need to be produced through treatment of up to 600 kL/day of brackish water via a reverse osmosis (RO) water treatment plant.

The preliminary borefield design included in the PFS for the non process water borefield is for a borefield about 42 km in length with the capacity of <1 GL/day (11 L/s). In years 1 - 2, the water demand on the Anne Beadell borefield will be 1,500 kL/day and the water quantity will be 0.5 GL/a (Pennington Scott 2016). In years 3 to 15, the water demand will be 600 kL/day and the water quantity will be 0.2 GL/a (Pennington Scott 2016). About three bores will be located around 1 km apart over a distance of 3 km, contributing 4.2 L/sec per bore.

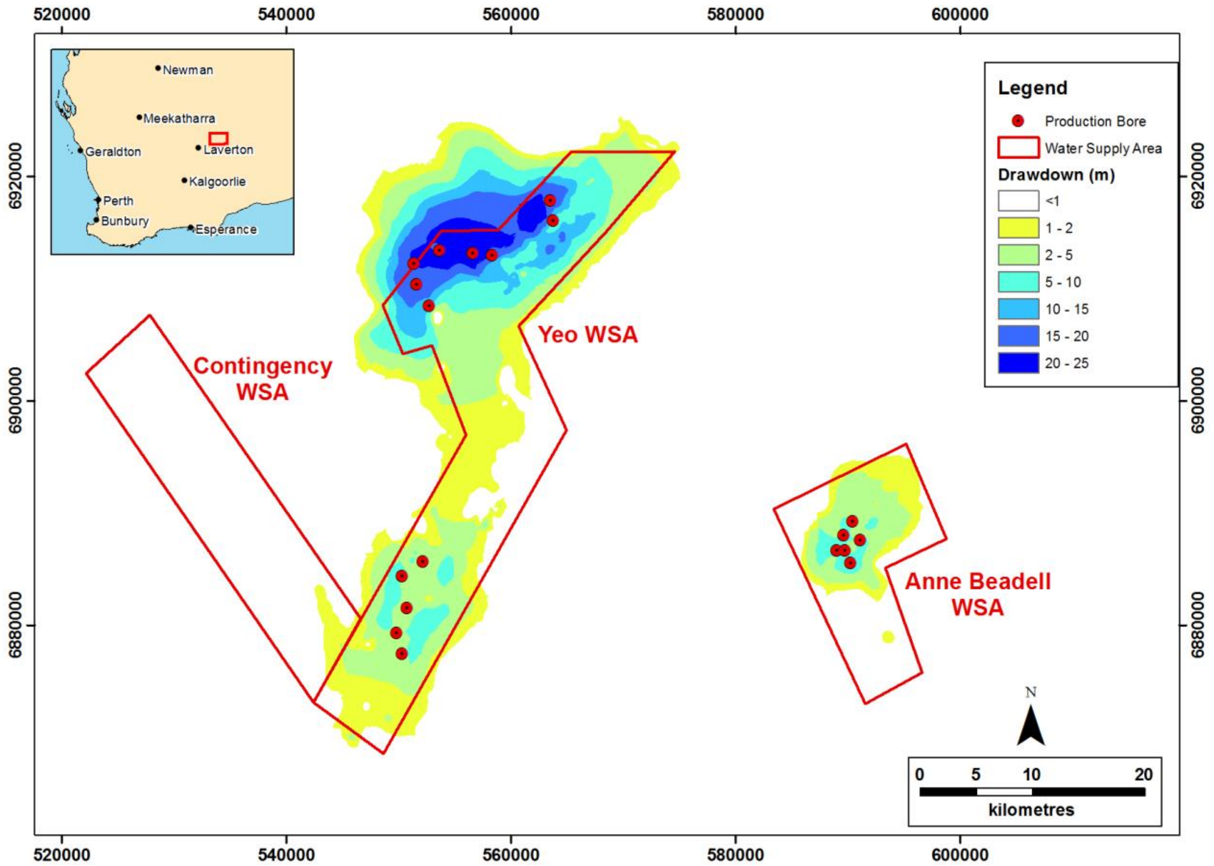


Figure 8: Predicted Borefield Groundwater Drawdown

(Source: Pennington Scott 2016)

2.7.2 Water Licences

Gold Road currently has two 5C groundwater licences issued by the Department of Water (DoW) these being:

- GWL 176189 which allows Gold Road to abstract 600,000 kL/year from the palaeochannel aquifer.
- GWL 177087 which allows abstraction of 600,000 kL/year from the fractured rock aquifer.

Gold Road has applied to the DoW to increase the allocation limit on GWL 176189 to abstract 7,800,000 kL/year from the Yeo Palaeochannel and Anne Beadell borefields and to increase the allocation on the fractured rock licence, GWL 177087, to 800,000 kL/year to cover the Project's mine dewatering and construction water supplies (Pennington Scott 2016). Correspondence was received from DoW in February 2016 regarding this application. DoW intend to grant a licence for this volume pending OEPA approval of the Project and a Letter of Intent is expected to be received in March 2016.

2.7.3 Water Transfer Infrastructure and Storages

Both borefields will require an inspection track for maintenance purposes and a pipeline corridor for delivery of water to the Gruyere Gold Project. The Yeo Palaeochannel borefield will have an overhead powerline, whilst the Anne Beadell borefield will be operated using diesel gensets. Each borefield will be operated by telemetry from the processing plant. Water flow monitoring at each input point and flow point will be installed to monitor in real time the water flows and to determine by difference any potential loss of pressure or leakage.

2.7.3.1 Process Water Borefield

Borefield pumps will receive power via an above-ground 22 kV high voltage power line constructed along the borefield alignment from the Gruyere Gold Project's power station.

Individual high density polyethylene (HDPE) pipelines will be buried or situated within a bunded trench with scour pits located intermittently along the length of the pipeline to collect potential saline water leaks. The scour pits will be excavated at low points in the pipeline corridor. The borefield will be operated by telemetry from the processing plant. Water flow monitoring at each input point and flow point will be installed to monitor in real time the water flows and to determine by difference any potential borefield pipeline failure. Pumped water will be delivered to the processing plant's HDPE lined Process Water Pond.

Recycling of water will be maximised to minimise the need for abstraction of process water. Water will primarily be recycled from the TSF and thickeners.

2.7.3.2 Non-Process Water Borefield

Raw water bores will be connected by a buried or single bunded HDPE pipeline to the 266 kL Raw Water Break Tank. The transfer pumps will deliver the water to the Raw Water Pond at the processing plant through a 20 km long bunded HDPE pipe. Scour pits will be installed at low points on the pipeline route. Each borefield pump will be powered by a diesel powered generating set equipped with an integral self-bunded fuel tank.

2.7.4 Groundwater Drawdown

Pennington Scott have modelled groundwater drawdowns expected for both borefields at year 15 based on preliminary borefield designs included in the PFS and subsequent design revisions aimed at minimising drawdown in areas of potentially significant stygofauna habitat. This included moving abstraction points to the northern and southern extremities of the process water supply area. Borefield design is continuing to be refined by Pennington Scott as part of ongoing Feasibility Study work. Predicted groundwater drawdown for the current borefield designs is shown in Figure 8.

Lake Throssell is located approximately 15 km northeast of the Gruyere Gold Project area and Lake Throssell lies approximately 20 km north of Yeo Lake. Yeo Lake is located approximately 13 km to the east of the Gruyere Gold Project area. Hydrogeological studies undertaken by Pennington Scott as part of the PFS for the Gruyere Gold Project have shown that modelled drawdown does not demonstrate adverse impacts on sub surface flows to Lake Throssell or Yeo Lake.

2.7.5 Water Balance

A water balance model is further being developed by hydrogeological consultants Pennington Scott and will consider all water sources and uses from construction, through to operations and for the remaining life of Project.

The water balance currently shows that the Gruyere Gold Project will not require any excess water discharge. Most water consumed in mineral processing will be lost from the mine water balance as retained moisture in the emplaced tailings, evaporation from the drying beaches or seepage loss to the groundwater beneath the TSF. However TSF seepage loss will be minimised by discharging a thicker than normal tailings slurry to the TSF in the order of 60% solids by weight (Pennington Scott 2016). Groundwater modelling from the PFS indicates that the bulk of the TSF seepage ultimately migrates to the Gruyere Pit, which acts as a regional groundwater sink. However, groundwater below the south-eastern side of the TSF, will not be captured in the flow to the pit and would otherwise naturally migrate in an easterly direction (Gold Road 2016). Several recovery bores will be located along the south-eastern edge of the facility to capture seepage for re-use in the process plant (Gold Road 2016).

A preliminary water balance by Coffey on the TSF indicates an estimated annual average water return (as a % of tailings slurry water) will be 17% or approximately 830,000 m^3 per year, which is based on a tailings discharge density of 60% solids by weight and is additional to the water recovered from the processing plant tailings thickener (Coffey 2015).

2.8 POWER SUPPLY

A gas power plant of 40 MW is proposed with four dual fuel (gas with diesel backup) units of 10 MW capacity. Power will be supplied to site transformers and substations within the processing plant. Overhead power lines will be installed to distribute 22 kV and 11 kV power to areas. Power line corridors will typically align with roads and alongside established pipeline corridors to minimise vegetation disturbance.

Investigations are ongoing for a gas pipeline lateral to be constructed from the Eastern Goldfields pipeline (EGP), 200 km south-west of the Gruyere Gold Project that follows the public White Cliffs Road reserve from Laverton. The gas pipeline project is not part of the scope of this EPA Referral and will be submitted as a separate Referral to the OEPA upon completion of further investigations.

2.9 SUPPORT FACILITIES

Support facilities at the Gruyere Gold Project will include:

- **Airstrip**: A sealed airstrip is proposed to be constructed in close proximity to the accommodation village for a fly in/fly out (FIFO) workforce. Airstrip dimensions are proposed to be approximately 2,100 m long by 30 m wide. A terminal facility building will be located adjacent to the airstrip consisting of a lounge area and ablutions. Refuelling facilities will also be constructed as part of the airstrip design.
- **Construction Camp**: A construction camp peak of up to 600 ensuite rooms will accommodate personnel involved in the construction and early operation phase of the Project. The construction camp will be decommissioned and removed once the permanent accommodation village is fully operational.
- **Accommodation Village**: A permanent accommodation village is proposed to be constructed and is designed to support the long term operation of the Gruyere Gold Project of up to 400 ensuite rooms. The village is planned to be situated approximately 4 km from the processing plant facility and 1 km from the airstrip. It will be designed to accommodate 100% of the permanent operational workforce, plus short term contractors and visitors and will cater for major maintenance shutdowns. The village will include a gymnasium, wet mess, laundries, ablutions block, potable water tanks, kitchen, dining room, medical room, administration office and parking areas.
- **Landfill:** An onsite landfill will be required for disposal of putrescible waste. The landfill is proposed to be incorporated into the IWL at this stage.
- **Wastewater Treatment Plant:** Waste water treatment plants will be located near to the accommodation camp and office/workshop areas and will process wastewater from ablution and shower facilities. Waste water from these systems will either be recycled or disposed of via evaporation or discharge to land.
- **Washdown Facility**: A washdown facility will be constructed consisting of light/heavy vehicle drive through areas with high pressure spray water for cleaning. Solids and dirty wash down water will drain to a primary settlement sump where the solids settle out. Oily water will overflow to an adjacent cell where oil will be separated using an oil skimmer and the oil will be pumped directly to a small waste oil tank.
- **Fuel Facility**: Diesel fuel storage facilities will be required at the power station and mining area workshops with road access for both areas to accommodate fuel deliveries. Power station diesel fuel will be stored in one 55 kL self bunded diesel storage tank. Diesel fuel for the mining fleet and operations vehicles will be stored in five 110 kL self bunded diesel storage tanks whereby they can be accessed for refuelling purposes. Oil storage facilities comprising one 68 kL self bunded tank will be located at the mining facilities. An LPG storage facility will be located adjacent to the gold room and will consist of three 22.5 kL

LPG storage vessels provided by a gas supplier. LPG will be reticulated to the carbon regeneration kiln, elution heater and the gold room via buried pipelines.

- **Workshops/Laydown Areas**: A heavy/light vehicle workshop, maintenance workshop, boilermaker workshop and driller's workshop are proposed to be constructed to support mining and processing operations. A core yard laydown area will be necessary to support ongoing exploration programmes.
- **Buildings/Offices**: A warehouse/stores building will be constructed for the procurement and transfer of goods on site. A medical facility including parking for an ambulance and fire tender will be constructed, in addition to a gatehouse to assist with site security. Mining, processing and administration office buildings will be required.

The location of support facilities has considered factors such as:

- Avoiding potential mineralised areas.
- Landform and topography.
- Presence of conservation significant flora and fauna species and communities.
- Locations of watercourses and associated flood zones.
- Heritage sites.
- Prevailing wind directions (airstrip).
- Distances to other associated Gruyere Gold Project items.
- Separation distances to protect human health.

2.10 ACCESS ROADS

The Gruyere Gold Project is accessed from Laverton, east along the Laverton–Warburton Highway, commonly known as the Great Central Road and then south along the existing Mt Shenton–Yamarna Road. Access to the Gruyere Gold Project will be via a new dedicated 25 km private road eastwards towards Gruyere. In addition to the new sealed airstrip to be constructed, the Gruyere Gold Project can also be accessed by charter plane through an existing landing strip at Yamarna or alternatively via a commercial airport in Laverton. Proposed new access roads will be unsealed, properly formed and compacted with appropriate drainage.

Internal roads shall generally be 12 m wide for two way traffic and constructed with v-drains on either side to allow for runoff water. The roads will be designed to accommodate heavy vehicles that will be required to supply the Gruyere Gold Project with construction equipment, deliveries of fuel, consumables, reagents and other general goods.

2.11 FIRE MANAGEMENT

Gold Road will liaise closely with the Department of Fire and Emergency Services (DFES) to determine the optimal time to undertake prescribed burns on site so that potential environmental damage from extreme and out of control wildfires is minimised and that community and infrastructure is protected during the life of the Gruyere Gold Project. The process plant will have a dedicated fire water system in the event of an emergency.

2.12 CLOSURE AND REHABILITATION

Closure of the Gruyere Gold Project will be detailed within the site wide Mine Closure Plan, which will be written in accordance with the DMP Guidelines for Preparing Mine Closure Plans (DMP & EPA 2015). The following specific closure aspects for the IWL and open pit are planned.

2.12.1 Integrated Waste Landform

Two waste rock landforms are planned and will form part of the IWL. Mine waste will be used for construction materials where suitable. The TSF portion of the IWL will dry out and will be covered with an appropriately engineered capping material. Stockpiled overburden material will be used during rehabilitation activities.

2.12.2 Open Pit

Underground mining and backfilling of the Gruyere open pit is not proposed. The Gruyere Pit will become a groundwater sink and a pit lake will form. Water levels in the pit lake after closure are expected to recover to 170 m below ground within 30 years of closure, but may take several hundred years more before it stabilises at its final water level about 100 m below ground level, being 70 m below the original water table and the water quality in the pit lake after closure will become steadily more saline over time due to evaporative concentration (Pennington Scott 2015). The salinity is expected to reach the salt saturation point, around 270,000 mg/L TDS, within several hundred years of closure (Pennington Scott 2015). Water levels and groundwater quality will be managed through the implementation of an appropriate groundwater monitoring strategy.

3. EXISTING ENVIRONMENT

3.1 STUDIES AND INVESTIGATIONS

A number of baseline surveys have been commissioned to date for the Gruyere Gold Project and Yeo Palaeochannel and Central Palaeochannel (Anne Beadell) borefield areas, which have greatly contributed to the scientific understanding of the western part of the Great Victoria Desert (GVD). Gold Road's other prospect on the pastoral lease *i.e.* Central Bore which is located approximately 21.5 km to the south-west of the Gruyere Gold Project, has also accumulated additional regional environmental information that supports the Gruyere Gold Project. Baseline surveys undertaken to date and their completion status are shown in Table 6.

Table 6: Summary of Baseline Surveys Undertaken at Central Bore and Gruyere Gold Projects

Aspect	Survey	Project	Undertaken By	Year Undertaken	Status	Applicable Policy and Limitations
Flora	Level 1 flora and vegetation survey - proposed haul road (Autumn).	Central Bore	Botanica Consulting	2011	Complete	• Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004b). • Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002). The only limitation to this survey was that fieldwork was not completed during the EPA's recommended time period. It was noted however that above average rainfall had occurred in the months prior to the survey and as such many plants were in flower.
	Level 2 flora and vegetation survey (Spring).	Central Bore	Botanica Consulting	2011	Complete	• Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004b). • Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002).
	Level 2 flora and vegetation survey (Autumn).	Central Bore	Botanica Consulting	2012	Complete	• Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004b). • Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002).
	Level 1 flora and vegetation survey (Autumn).	Gruyere	Botanica Consulting	2014	Complete	• Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004b). • Position Statement No. 3: Terrestrial Biological

Aspect	Survey	Project	Undertaken By	Year Undertaken	Status	Applicable Policy and Limitations

						Surveys as an Element of Biodiversity Protection (EPA 2002).
						• There were two minor limitations to the survey these were:
						  • Timing of survey, weather and season - above average rainfall had been received before the survey, however the survey was conducted outside of optimal flowering period for the majority of species.
						  • Survey intensity – Additional survey work may be required during optimal flowering periods.

	Level 2 flora and vegetation survey (Spring).	Gruyere	Botanica Consulting	2014	Complete	• Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004b). • Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002). • The only limitation to this survey was the fact that rainfall for the winter months preceding the survey were below average. This was considered a minor limitation.
	Level 2 flora and vegetation survey (Autumn).	Gruyere	Botanica Consulting	2015	Complete	• Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004b). • Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002). • The only limitation to this survey was relating to PATN data analysis due to BC staff only having basic statistical training. This was considered a

Aspect	Survey	Project	Undertaken By	Year Undertaken	Status	Applicable Policy and Limitations
						minor limitation. The potential limitation was addressed by a peer review by an experienced statistician.

	Level 1 flora and vegetation survey (Autumn)	Gruyere Borefields	Botanica Consulting	2015	Complete	• Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004b).
						• Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002).
						• There were two minor limitations to the survey these were:
						  • Mapping reliability – high quality ortho aerial images were unobtainable, however aerials used were considered sufficient.
						  • Area disturbance – vegetation was in various stages of fire regrowth.

Fauna	Level 1 vertebrate fauna survey (Autumn).	Central Bore	Greg Harewood/ Botanica Consulting	2011	Complete	• Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment (EPA 2004b). • Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002). • Technical Guide: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessments (EPA 2010).

Aspect	Survey	Project	Undertaken By	Year Undertaken	Status	Applicable Policy and Limitations
	Level 2 vertebrate fauna survey (Spring 2011, Autumn 2012).	Central Bore	Keith Lindbeck & Associates	2011 2012	Complete	• Guidance Statement No. 20: Sampling of Short Range Endemic Vertebrate Fauna for Environmental Impact in Western Australia. (Epa 2009) • Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment (EPA 2004b). • Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002). • Technical Guide: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessments (EPA 2010). • The single limitation noted during this survey was the inability to access and dig pit traps into the granite areas.
	Level 1 vertebrate fauna survey (Autumn).	Gruyere	Greg Harewood/ Botanica Consulting	2014	Complete	• Guidance Statement No. 20: Sampling of Short Range Endemic Vertebrate Fauna for Environmental Impact in Western Australia (EPA 2009). • Guidance Statement No. 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Assessment in Western Australia (EPA 2003). • Guidance Statement No 54a: Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia (EPA 2007). • Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment (EPA 2004b). • Position Statement No. 3: Terrestrial Biological

Aspect	Survey	Project	Undertaken By	Year Undertaken	Status	Applicable Policy and Limitations

						Surveys as an Element of Biodiversity Protection (EPA 2002).
						• Technical Guide: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessments (EPA 2010).
						• Limitations for this survey included:
						  • No seasonal sampling being undertaken.
						  • Some fauna species have been reported to potentially occur in the survey area based on there being suitable habitat.

	Level 2 vertebrate fauna survey and SREs (Spring).	Gruyere	Rapallo Environmental	2014	Complete	• Guidance Statement No. 20: Sampling of Short Range Endemic Vertebrate Fauna for Environmental Impact in Western Australia (EPA 2009).
						• Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment (EPA 2004b).
						• Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002).
						• Technical Guide: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessments (EPA 2010).
						• Two limitations were noted during this survey, they are:
						  • Proportion of fauna identified/recorded – Lower than anticipated numbers of species from common taxonomic groups were recorded.
						  • Timing – hot, dry conditions may have contributed to lower than anticipated faunal abundance although survey timing did conform with EPA (2010) recommendations.

Aspect	Survey	Project	Undertaken By	Year Undertaken	Status	Applicable Policy and Limitations
	Level 1 vertebrate fauna survey (Spring).	Gruyere Borefields	Greg Harewood	2015	Complete	• Guidance Statement No. 20: Sampling of Short Range Endemic Vertebrate Fauna for Environmental Impact in Western Australia (EPA 2009). • Guidance Statement No. 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Assessment in Western Australia (EPA 2003). • Guidance Statement No 54a: Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia (EPA 2007). • Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment (EPA 2004b). • Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002). • Technical Guide: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessments (EPA 2010).
Short Range Endemics	Level 2 SRE survey (Spring).	Gruyere	Greg Harewood.	2015	Complete	• Guidance Statement No. 20: Sampling of Short Range Endemic Vertebrate Fauna for Environmental Impact in Western Australia (EPA 2009). • Guidance Statement No. 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Assessment in Western Australia (EPA 2003) • Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment (EPA 2004b)

Aspect	Survey	Project	Undertaken By	Year Undertaken	Status	Applicable Policy and Limitations
						• Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002) • Environmental Assessment Guideline12: Consideration of Subterranean Fauna in Environmental Impact Assessment in Western Australia (EPA 2013a).
Subterranean Fauna	Desktop review and pilot-scale stygofauna survey.	Central Bore/ Borefield	Bennelongia	2013	Complete	• Guidance Statement No. 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Assessment in Western Australia (EPA 2003). • Guidance Statement No 54a: Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia (EPA 2007).
	Subterranean fauna assessment.	Central Bore/ Borefield	Bennelongia	2013	Complete	• Environmental Assessment Guideline12: Consideration of Subterranean Fauna in Environmental Impact Assessment in Western Australia (EPA 2013a). • Guidance Statement No 54a: Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia. (EPA 2007).
	Subterranean fauna survey (mine area).	Gruyere	MBS Environmental	2015	Complete	• Guidance Statement No 54a: Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia. (EPA 2007) • Environmental Assessment Guideline12: Consideration of Subterranean Fauna in Environmental Impact Assessment in Western Australia (EPA 2013a).

Aspect	Survey	Project	Undertaken By	Year Undertaken	Status	Applicable Policy and Limitations
	Subterranean fauna survey.	Gruyere Borefields	Bennelongia	2015/2016	Complete	• Guidance Statement No 54a: Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia. (EPA 2007)
				Early to Mid-2016	Pending	• Guidance Statement No 54a: Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia. (EPA 2007).
Water	Hydrogeological desktop study.	Central Bore	Golder Associates	2011	Complete	• N/A
	Hydrogeological scoping study.	Central Bore	Pennington Scott	2011	Complete	• State-wide Policy No. 5.12 – Hydrogeological Reporting Associated with a Groundwater Well Licence (DOW2009).
	Hydrogeological study.	Central Bore	Pennington Scott	2012	Complete	• State-wide Policy No. 5.12 – Hydrogeological Reporting Associated with a Groundwater Well Licence (DOW2009).
	Hydrogeological study.	Gruyere	Pennington Scott	2015	Complete	• State-wide Policy No. 5.12 – Hydrogeological Reporting Associated with a Groundwater Well Licence (DOW2009).
Soil and Landform	Soil and landform assessment.	Gruyere	MBS Environmental	2015	Complete	• Guideline on Laboratory Analysis of Potentially Contaminated Soil. Schedule B3 (NEPM 2013a). • Guideline on Investigation Levels for Soil and Groundwater. Schedule V1 (NEPM 2013 b).
Waste Characterisation	Waste geochemical characterisation.	Central Bore	Coffey	2013	Complete	• Guidelines for Fresh and Marine Water Quality (ANZECC 2000).
	Waste rock characterisation.	Gruyere	MBS Environmental	2015	Complete	• Guidelines for Fresh and Marine Water Quality (ANZECC 2000)
	Tailings geochemical characterisation.	Gruyere	MBS Environmental	2015	Complete	• Global Acid Rock Drainage Guide (INAP 2009)

Aspect	Survey	Project	Undertaken By	Year Undertaken	Status	Applicable Policy and Limitations
Heritage	Heritage survey.	Yamarna Exploration Area	Traditional Owners Archaeologists	2004	Complete	• N/A
	Ethnographic Cultural Mapping survey (Spring).	Gruyere	Anthropologists Senior Men	2015	Complete	• Guidance for the Assessment of Environmental Factors - Assessment of Aboriginal Heritage No. 41) (EPA, 20004).

3.2 REGIONAL SETTING

The Gruyere Gold Project is located within the north-eastern Goldfields region of Western Australia. This area contains Unallocated Crown Land and reserves and is used for grazing, tourism, exploration and mining.

The Yeo Lake Nature Reserve, which is listed as a Class "A" Nature Reserve and is managed by the Department of Parks and Wildlife (DPaW), is located approximately 13 km to the east of the Gruyere Gold Project area.

The Gruyere Gold Project area lies within the GVD of Western Australia of the Eremaean Province in a region known as the Helms Botanical District. The GVD region is further divided into four subregions (Shield, Central, Maralinga and Kintore) based on the Interim Biogeographic Regionalisation of Australia (IBRA), with the majority of the survey area being located within the Shield (GVD1) subregion. However the survey area occurs in close proximity (approximately four km) to the Central (GVD2) subregion (Barton & Cowan, 2001).

Vegetation of the Helms Botanical District (as described by Beard, 1990) comprises a mosaic of tree and shrub steppe between sand dunes and on sandplains, consisting of Marble Gum, Mallee and Spinifex (*Eucalyptus gongylocarpa* (9-12 m), *E. youngiana*, *Triodia basedowii*). Beard states that dunes in the west, are rather thinner, few and weak. *E. gongylocarpa* is comparatively scarce with *E. youngiana* replaced by *E. kingsmillii* and *Acacia aneura* and *A. linophylla* becoming frequent on the sandplain.

The Shield subregion contains Spinifex (*Triodia* spp.) and Mallee (*Eucalyptus kingsmillii*, *E. youngiana*) over hummock grassland dominated by *Triodia basedowii* on aeolian sand plains. Scattered Marble Gum (*E. gongylocarpa*) and native pine (*Callitris* sp.) occur on the deeper sands of the sand plains. Mulga and Acacia woodland occur mainly on the colluvial and residual soils. Halophytes such as Salt Bush (*Atriplex*), Bluebush (*Kochia*) and Samphire (*Arthrocnemum*) occur on the margins of salt lakes and in saline drainage areas (Barton and Cowan, 2001).

The Central subregion vegetation is primarily a tree steppe of *Eucalyptus gongylocarpa*, Mulga and *E. youngiana* over hummock grassland dominated by *Triodia basedowii* on the aeolian sands. *Acacia* dominates colluvial soils with *Eremophila* and *Santalum* spp., while halophytes are confined to edges of salt lakes and saline drainage systems (Barton and Cowan, 2001).

Beard (1974) describes the sandy areas of the desert as dune sands that are red in colour and incoherent with sandplains formed of the same material. The soil is unstructured and may be very deep. In sandhill areas, the soil between dunes may or may not be sandy and frequently seems to be developed on a truncated profile from which sand has been removed. For this reason, vegetation between the sandhills is not uniform and may consist of a variety of communities (Beard 1974).

On Precambrian rocks, Beard describes the outcropping ranges as extremely rocky with no soil in the strict sense. On flatter ground there is typically a red loam on which Mulga (*Acacia aneura*) grows. This is loose and friable with a few small ironstone and quartz pebbles and overlies a massive siliceous hardpan. The surface may frequently be strewn with small stones all with an iron oxide patina. A structurally similar soil, but with a high pH occurs in the vicinity of basic rock outcrops. Close to salt lakes a whitish colour appears due to the accumulation of lime and gypsum. The beds of salt lakes are formed by extremely stiff red clay, frequently with a surface efflorescence of salt crystals in dry weather (Beard 1974).

The Gruyere Gold Project occurs within the Gunbarrel Province of Western Australia and within the north-western GVD soil-landscape zone, an area of 94,450 km^2 consisting of north-west dunes and hills (Tille 2006). Soils and landscapes of the north-western GVD zone as described by Tille are very similar to Beard's descriptions. The area consists of sandplains and dunes (with some undulating plains and uplands) on sedimentary rocks of the Gunbarrel Basin. Soils are typically red sandy earths and red deep sands with some red loamy earths and red-brown hardpan shallow loams.

3.3 CLIMATE

The GVD is characterised by an arid climate, with hot summers and cool winters. Summer maximum temperatures average about 35ºC, while winter minimum temperatures are around 5ºC. Rainfall is related both to locally generated thunderstorms and to dissipating tropical cyclones tracking south-east. Thunderstorm activity tends to be greatest between October and December when cool airflows from the south wedges beneath humid north-westerly winds. Remnant cyclonic activity is greatest between January and May, reflecting the tropical wet season in the north of the state.

Yamarna operated as a weather station from 1967 to 1998, the nearest presently operating weather station is now at Laverton 160 km to the west. Gold Road has installed and operated a private weather station at the Yamarna exploration camp since December 2014.

Average annual rainfall in the Yamarna region is 200 to 230 mm. The two mechanisms of rainfall generation in opposing seasons lead to a more evenly distributed annual rainfall distribution than in most of the state. Rainfall is highest in the remnant cyclone season (Chart 1). While relatively evenly distributed, rainfall is very infrequent with only about 30 rain days per year. Most of the annual rainfall is received in one or two significant events and many years have close to zero rainfall. Monthly evaporation data is available from the Bureau of Meteorology (BoM) for Yamarna and is shown in Chart 1.

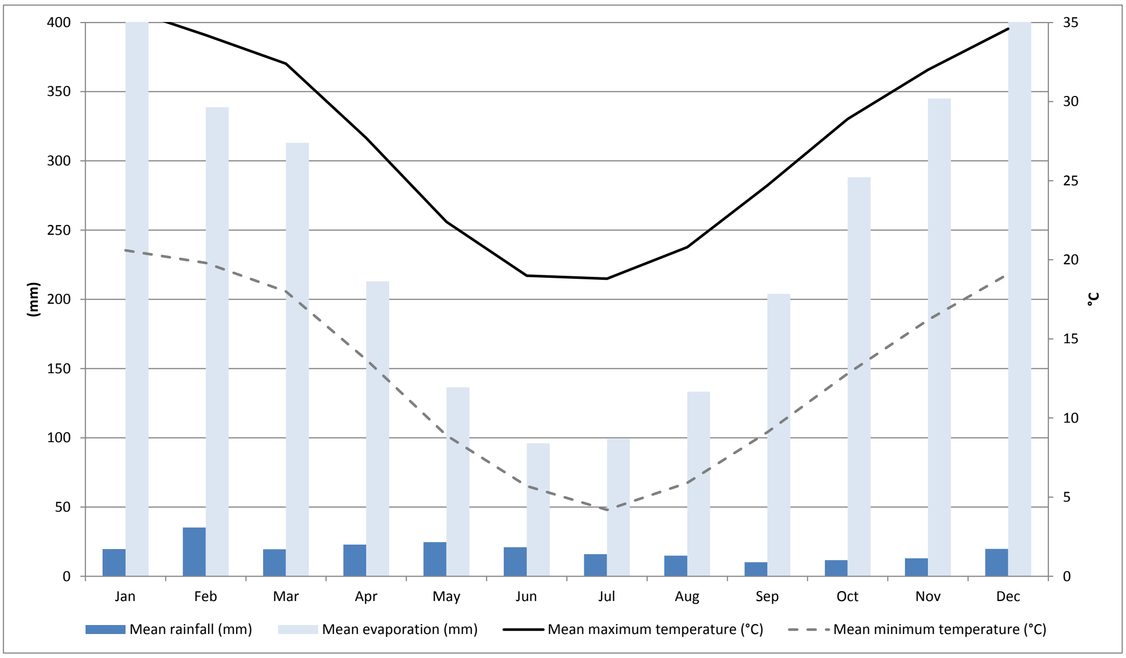


Chart 1: Monthly Mean Rainfall, Evaporation and Temperature Data for Yamarna (1967-98) (BoM 2015)

3.4 GEOLOGY

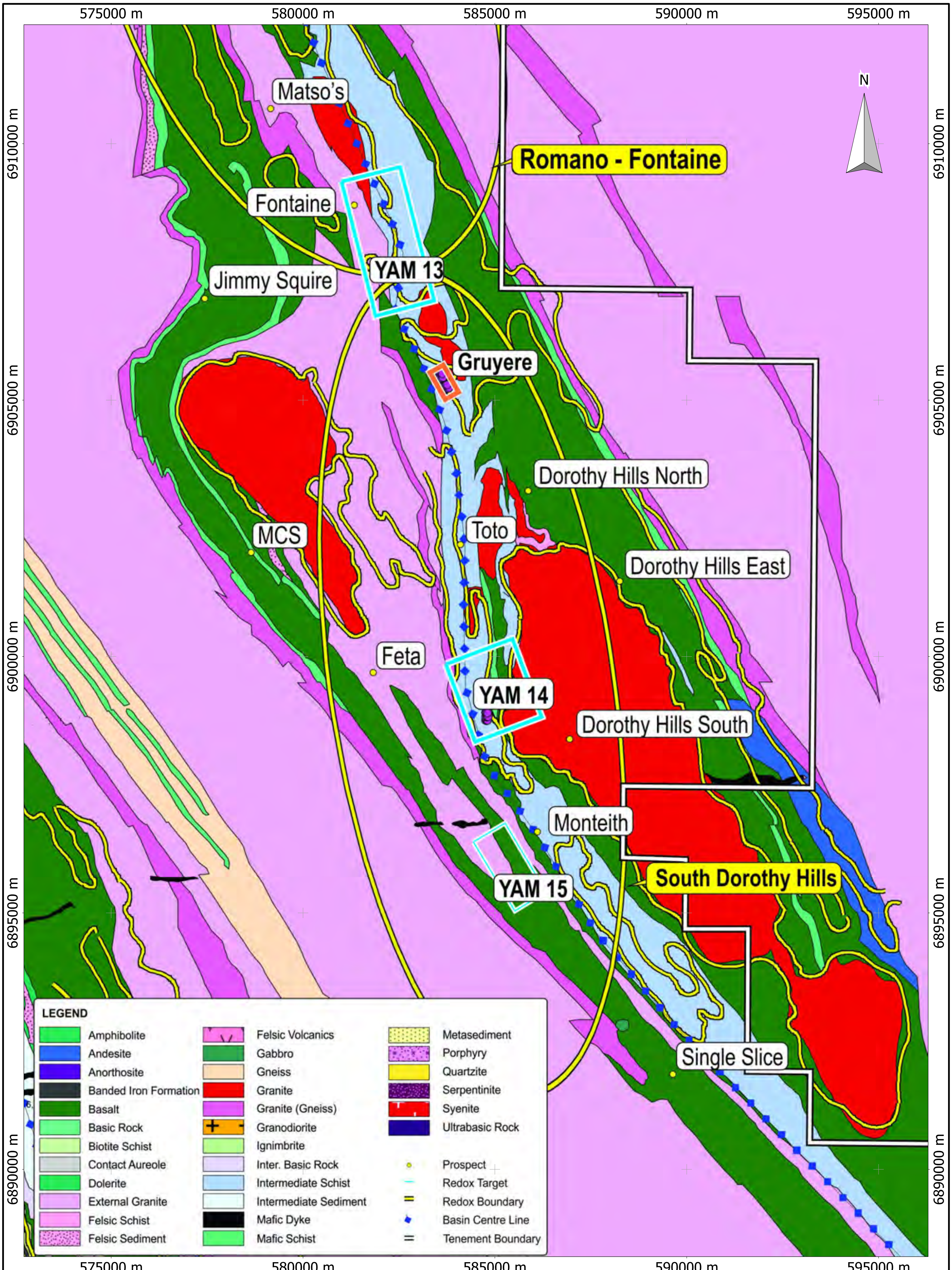
3.4.1 Regional

The Yamarna and Dorothy Hills greenstone belt forms part of the eastern-most geological province (Yamarna Terrane) of the Yilgarn Craton of Western Australia. The Yamarna and Dorothy Hills greenstone belts are aligned in a north-north westerly orientation adjacent to the 500 km long Yamarna shear zone, which is considered the western boundary of the Yamarna Terrane from the Burtville Terrane to the west. The Yamarna Belt felsic volcanic rocks have been dated as approximately 2,683 million years old (Archean) and is in faulted contact with plutonic igneous rocks of similar age, including quartz diorites, granites and quartz migmatites (Gold Road 2013). The Yamarna shear zone is host to significant gold mineralisation (Gold Road 2013). It is partially covered by Permian age glacial sediments of the Paterson Formation and cover is thicker at the southern portion of the Yamarna Belt. The Yamarna Belt is historically underexplored and highly prospective for gold mineralisation as well as other metals. Geologically similar to the prolific Kalgoorlie Gold Belt, the Yamarna Belt has a significant resource of gold, hosts a number of new discoveries and lies north of the 7.9 Moz Tropicana gold deposit. Gruyere regional geology is shown in Figure 9.

3.4.2 Local

The Gruyere Deposit is situated within the Gruyere Intrusive, a tonalitic intrusive dyke approximately 70 to 190 m wide and 1,800 m long, dipping steeply to the north-east and aligned in a south-easterly to north-westerly orientation at the surface (Gold Road 2015b). Gold mineralisation is from the surface to at least 485 m deep and is open at depth. A sequence of intermediate volcanic and volcanoclastic rocks define the stratigraphy to the west of the Intrusive and mafic volcanics (basalt) occur to the east of the Intrusive.

The Gruyere Deposit comprises a coincident structural-geochemical target within a major regional-scale structural corridor associated with the Dorothy Hills Shear Zone. This zone occurs within the Dorothy Hills greenstone belt at Yamarna in the eastern part of the Archaean Yilgarn Craton. The Dorothy Hills greenstone is the most easterly known occurrence of outcropping to sub-cropping greenstone in the Yilgarn province of Western Australia (Gold Road 2015b).



Scale: 1:130000
Original Size: A4
Source: Gold Road Resources
Grid: MGA94(51)
0 4000 m

Gold Road Resources Limited
Gruyere Project
EPA Referral

Figure 9

Gruyere Regional Geology

Martinick Bosch Sell Pty Ltd
4 Cook St
West Perth WA 6005
Ph: (08) 9226 3166
Fax: (08) 9226 3177
info@mbsenvironmental.com.au
www.mbsenvironmental.com.au

3.5 LANDFORM AND SOILS CHARACTERISATION

MBS Environmental was engaged by Gold Road in 2015 (MBS 2015a) to undertake a soil and landform assessment within the Gruyere Gold Project area. From review of aerial photographs, previous flora (Botanica 2015a, b) and fauna (Botanica & Harewood 2014) surveys and site observations, five soil and landform units were identified within the Gruyere Gold Project area and are shown in Table 7 (MBS 2015a).

Table 7: Gruyere Soil and Landform Units

Soil and Landform Unit	Description
Sand Dunes	Low vegetated sand dunes, typically 3 to 5 m high, occurring as a series of parallel linear ridges running in a west-south-westerly to east-north-easterly direction. Although the dominant soil is a loose red-brown medium to coarse sand, the ridges are generally stabilised by vegetation cover consisting of Spinifex, Eucalypts and low to medium shrubs. Geological drill log data indicates the depth of sand varies between 3 and 8 m, typically overlying weathered, gravelly Permian sediments. Slopes are slightly concave, with gentle slopes of approximately one in ten (5°, 10% grade) at the base of the dunes increasing to a maximum slope near the crests of approximately one in four (15°, 25% grade).
Sandplains (including swales between sand dunes)	Extensive sandplains, including swales between sand dunes are the dominant landform within the Project area. Geological drill log data indicates the depth of sand varies between 1 and 5 m, typically overlying weathered, gravelly Permian sediments. Spinifex is the dominant vegetation, accompanied by scattered Eucalypts and medium to tall shrubs. The soil surface between Spinifex is generally bare, unconsolidated red-brown sand, with leaf litter and woody debris present at the base of Eucalypts and shrubs. At some sites, there is evidence of formation of an easily friable silty surface crust and, less frequently, a hard ferruginous/siliceous layer (plinthite) that appears to be associated with termite activity.
Quartz Rocky Plains	Isolated areas, typically to the south and east of the proposed open pit area, comprise red-brown loamy soils with a distinctive quartz surface lag. Vegetation is more diverse than the sand dune and sandplain landform units, with Mulga and mixed taller shrubs dominant.
Clay/Loam Plains	Typically adjacent to the quartz rocky plain, but in topographically lower areas near broad drainage features, are clay loam plains. The distinctive difference in soil type is the absence of the stony quartz surface lag, replaced by a weakly cryptogamic silty crust and greater coverage by leaf litter and woody debris from generally taller shrubs and trees. Wanderrie grasses are common as understory species, with a general absence of Spinifex.
Low Rocky Hills	Low rocky hills are a minor landform within the Gruyere Gold Project area, but are a distinctive landform feature at other locations within the greater Yamarna Belt district. The hills, typically less than 40 m above the surrounding sandplains, are commonly capped with a siliceous / ferruginous caprock and the associated soils are typically gravelly colluvium. Soil depths on the crests and upper slopes are very shallow, ranging from nil on exposed caprock to approximately 300 mm in isolated pockets, small gullies and drainage lines.

Soils at the Gruyere Gold Project area are dominated by red-brown, deep sandy soils of aeolian origin. Assessment of the physical and chemical properties of these soils by desktop studies, field descriptions of profiles exposed in unused drill sumps and laboratory analysis of selected samples indicate the following characteristics (MBS 2015a):

- Surface soils are generally unconsolidated red-brown siliceous sands with low concentrations of soil organic matter and nutrients.
- Surface soils, particularly those associated with a series of parallel linear dune formations; rely on vegetative cover for stability against wind and water erosion. Apart from isolated instances, there is little evidence of surface stability provided by formation of cryptogamic crusts, mineral crusts (calcareous, siliceous or ferruginous) and deep leaf litter and woody debris.
- Sandplain and swale sequences between the dune formations are dominated by deep sand profiles. Subsoil samples indicate a higher degree of soil strength compared to surface soils as a result of compaction, weak ferruginous/siliceous cementation and, at some locations, minor amounts of pedogenic calcrete gravels.
- Surface and subsoil sands are not rated as hostile to plant growth in terms of excessive acidity, alkalinity, salinity or sodicity. Dune and sandplain topsoils and subsoils do not contain dispersive clays. Although they are prone to compaction at depth in their natural state, they are unlikely to become hard-setting or highly compacted during stockpiling or rehabilitation of waste landforms at mine closure.
- Large volumes of soil are available for harvesting and stockpiling for subsequent use as a cover material for rehabilitation of mine waste landforms. All material to a depth of at least 1 m within the footprint of the proposed open pit is expected to be suitable for this purpose. Large additional volumes of soil, if required, can be sourced from the footprints of the proposed waste rock dump and TSF.

Coffey Mining undertook a geotechnical investigation in September 2015 as part of the IWL PFS Tailings Storage Design (Coffey 2015). Test pits were excavated on the eastern and western side of the pit area to nominal depths of 2.5 m or refusal in proposed IWL footprint areas.

Surface conditions for the western side of the pit area was typically characterised by sandy soils, spinifex and sparse trees with the surface topography comprising of sand dunes and flat bottomed-interdune swales (Coffey 2015). Sub-surface conditions on the western side of the pit showed sand/clayey sand (fine to medium grained, red-brown, low plasticity fines, dry/loose/friable) to a depth range of 0 to >2.4 m and a thickness of 1.5 to 2.4 m (Coffey 2015).

On the eastern side of the pit area, windblown and alluvial sandy soils were present with local exposures of outcropping basalt and sparse spinifex and scrubby vegetation present across the majority of the site. The topography was varied with a broad lower lying drainage path running south to north (drainage in northward direction) towards the eastern portion of the proposed IWL footprint area (Coffey 2015). Sub-surface conditions on the eastern side of the pit showed:

- Silty sand (fine to medium grained, red-brown, low liquid limit fines, dry/loose) to a depth range of 0 to 0.06 m and a thickness of 0.01 to 0.06 m
- Silty sand (fine to medium grained, red-brown, low liquid limit fines, gravelly in places, dry/loose/friable) to a depth of 0.01 to 0.8 m and a thickness of 0.08 to 0.8 m.
- Silty gravel (fine to coarse grained, angular, red-brown, non-plastic fines, dry/dense) to a depth of 0 to 0.2 m and a thickness of 0.1 to 0.2 m.
- Basalt (ranges from extremely to moderately weathered, grey, low to medium strength, jointed/fractured/blocky, calcretised in places) to a depth of 0.1 to 0.8 m and a thickness of >0.2 to >2.1 m.
- Calcrete (pale grey, medium to high rock strength) to a depth of 0.25 to 0.4 m and a thickness of >0.1 to >0.25 m (Coffey 2015).

3.6 HYDROGEOLOGY

Pennington Scott was engaged to undertake a hydrogeological study for the Gruyere Gold Project as part of the Pre- Feasibility Study completed in January 2016. Hydrogeological investigations are continuing as part of the Feasibility Study. A hydrogeological summary for the Gruyere Gold Project has been produced in February 2016 based on results of work completed for the PFS and more recent field work and groundwater modelling (Pennington Scott 2016). This report is provided in Appendix 1.

Hydrogeological studies have identified a number of different aquifer types in the local area. This includes:

- Alluvial and Calcrete Aquifer.
- Yeo Palaeochannel Aquifer (Werillup Formation).
- Weathered Profile Aquifer.
- Fractured Rock Aquifer.

The nearest aquifer of significance to the Gruyere Gold Project area is the Yeo Palaeochannel, a calcrete aquifer, investigated and described by Pennington Scott (2012) located approximately 25 km to the west of Gruyere. The Yeo Palaeochannel occurs within the Quaternary Deposits, being approximately 14 m thick and extending from Central Bore to at least 65 km to the north. Outside of the Yeo Palaeochannel, other aquifers are present within the weathered profile (saprolite and saprock) and fractured bedrock, however these are considered minor in comparison. A representative graphic profile of the lithology and formation of the Yeo Palaeochannel borefield is shown in Figure 3-2 of Appendix 1 and is reproduced in Figure 10.

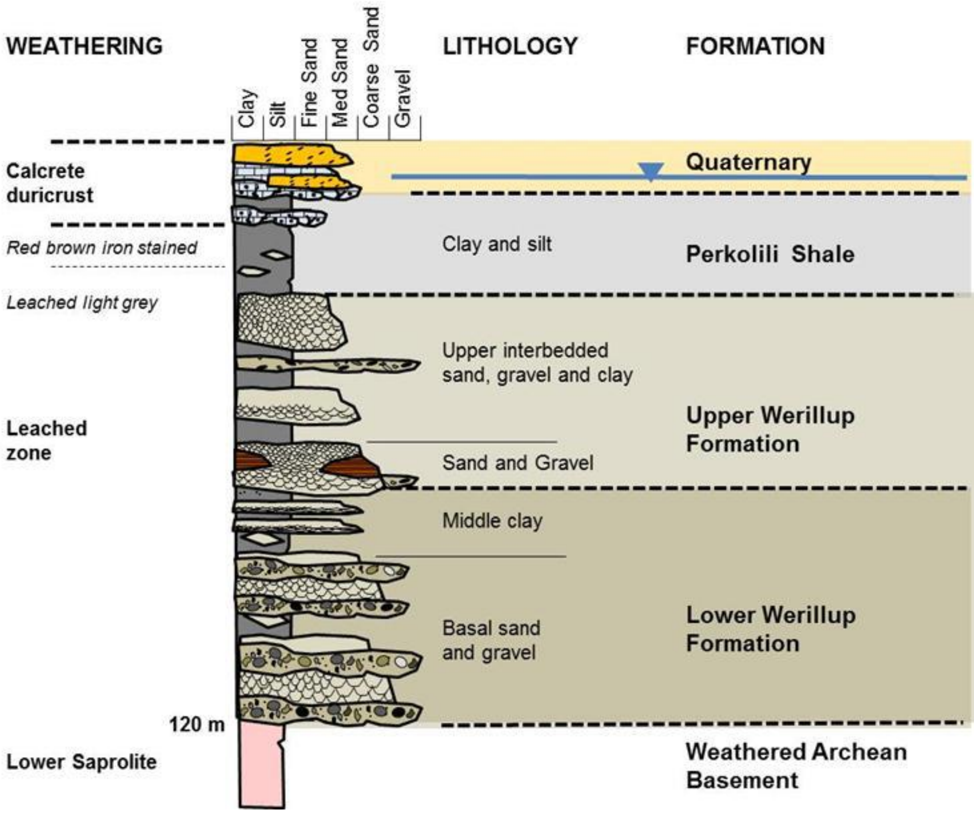


Figure 10: Representative Graphic Profile for the Yeo Palaeochannel

Further details are provided about each aquifer type in the following sub sections.

3.6.1 Alluvial and Calcrete Aquifer

An unconfined aquifer is present within the Yeo Palaeovalley made up of Quaternary deposits of alluvial gravel, sand, silt and clay, and calcrete deposits. Collectively these form the Alluvial and Calcrete aquifer.

Calcrete is present in the Yeo Palaeovalley extending almost continuously through the area of investigation, where it can be up to over 6 km wide. A series of investigation boreholes developed for the Gruyere Gold Project intersected between 2 and 36 m of calcrete (Pennington Scott 2016).

The Alluvial and Calcrete aquifer present in the Yeo Palaeovalley comprises poorly sorted gravel and sand with variable portions of silt and clay, and is partially cemented in some portions. Calcrete is well developed in the central portion of the Palaeovalley, where it forms an unconfined aquifer. The thickest sections of calcrete appear to occur in about the middle of the floodplain, becoming thinner outward. Calcrete is generally very thin or absent within the Palaeovalley beyond the floodplain, and mostly unsaturated about the outer portion of the floodplain. Permeable aquifer zones may be present through the sand and gravel portions and within calcrete where karstic solution cavities have developed significant secondary porosity and permeability.

Calcretes form an important water resource in the Goldfields region (Johnson et al, 1999) and are capable of producing significant bore yields of up to 2,000 kL/d where there is a sufficient thickness of karstic calcrete below the water table. Calcrete is also often associated with lower salinity water than other surrounding and deeper aquifers. Groundwater salinity (mg/L TDS) for the Gruyere Gold Project is shown in Figure 3-6 and the distribution of calcrete within the Yeo Palaeodrainage is shown in Figure 3-4 of Appendix 1.

3.6.2 Yeo Palaeochannel Aquifer (Werillup Formation)

The Werillup formation forms a productive palaeochannel aquifer present in the deepest parts of palaeovalleys upon the eastern Yilgarn craton. It is confined below the Perkolilli shale aquitard and bounded laterally and below by weathered to fresh bedrock.

The aquifer comprises a basal coarse-grained sand and gravel with frequently clayey medium grained sand and interbedded clay in the upper portion. In the Yeo borefield, the palaeochannel aquifer is separated into upper and lower aquifer zones by the middle clay which forms at least a partial aquitard unit, although sand and gravel within the middle clay may facilitate some leakage across the unit. The upper aquifer zone consists of the sand and gravel unit together with the overlying unit of interbedded sand, gravel and clay, while the lower aquifer zone is within the Basal channel gravel and sands.

The potential of palaeochannels for significant groundwater resources was first recognised in 1969 during a water exploration program for the Windarra Nickel Mine and they have now become the main source of process water in the goldfields.

During 2012 and 2015, twenty three investigation bores were drilled and tested for the project in the Yeo palaeochannel aquifer at rates of between 3 and 32 L/s (259 – 2,765 kL/d) with an average starting yield of 24 L/s (>2,000 kL/d) (Pennington Scott 2016). These tests showed that the main palaeochannel sands form a productive aquifer which appeared to be more productive than the palaeochannel aquifer in the Kalgoorlie area. This is likely due to the greater aquifer thickness present in the Yeo palaeochannel at the Project rather than aquifer permeability which is lower than values reported in the Kalgoorlie area.

3.6.3 Weathered Profile Aquifer

The weathered profile and underlying fractured bedrock can form moderately permeable aquifers, and locally may be highly productive. They are characterised by secondary porosity and permeability through the break-down of the primary rock material and fracturing that is typically more extensively developed about fault zones and about lithological contacts. A significant resource of groundwater is stored within the weathered profile, although the unit is not necessarily permeable. A weathered profile aquifer is present within the vicinity of the Gruyere deposit.
The weathered profile normally extends to depths of around 50 m below surface, but can be up to about 80 m thick in areas of shear zones, lithological contacts and areas of mineralisation. Low yields of groundwater are typically produced from bores constructed in the weathered profile, particularly profiles developed upon greenstone rocks which normally weather to very low yielding clay. Moderate yields of up to around 100 kL/day can be obtained from the base of the weathered profile in the transition zone with the underlying bedrock. This is mostly achieved over granitic rocks, and mafic and ultramafic greenstone rocks.

Within the vicinity of the Gruyere orebody the aquifer system generally occurs within the weathered profile (saprolite and saprock) and fractured bedrock. The weathered profile and underlying fractured bedrock can form moderately permeable aquifers, and locally may be highly productive. It is characterised by secondary porosity and permeability through the break-down of the primary rock material. A significant resource of groundwater is stored within the weathered profile, although the unit is not necessarily permeable. In contrast, the fractured rock aquifer contains a very small portion of groundwater relative to its volume, but can have zones of high permeability.

The weathered aquifer system associated with the Gruyere orebody is likely to be disconnected from the Yeo Palaeochannel and associated calcrete aquifer given its distance and local geology. Consequently mining and dewatering of the Gruyere orebody is expected to result in only a localised drawdown of the water table, which will not impact on the more significant aquifers associated with the Yeo Palaeochannel (Figure 6).

3.6.4 Fractured Rock Aquifers

In fractured rock aquifers, fractures developed within bedrock below the weathered profile can form permeable aquifer zones. Fracture development is enhanced by the oxidation and dissolution of minerals, but these tend to close with depth and are typically not significant below 120 m depth. The permeability of fractured rock aquifers is related to the degree of fracturing and how open (or clean) that the fractures are. Fracture zones in some rocks can be clogged by the presence of clay minerals. Fractured Rock aquifers tend to be better developed within greenstone rocks compared to granitoid rocks (Johnson et al, 1999).
Large bore yields can be obtained from fault and shear zones through greenstone rocks, along lithological contacts, intrusive contacts, and mineralised zones. The alignment of fracture zones with tectonic elements such as shear zones and particular rock types tend to make the fractured rock aquifer highly anisotropic.

The fractured rock aquifer, here after referred to as the "Orebody Aquifer", within the vicinity of the Gruyere Gold Project area comprises the steeply inclined tonalitic intrusive dyke within a major regional-scale structural corridor associated with the Dorothy Hills Shear Zone, which is aligned in a south-easterly to north-westerly orientation.

Geological and hydrogeological data from exploration holes indicates that groundwater was intersected at depths varying between 35 and 100 m (average depth of 65 m) within the sequence of felsic and mafic lithologies. Water flows were, for the most part, minor with less than 15% of the holes intersecting moderate to strong flows. Standing water levels measured in exploration holes range between 30 and 40 m depth.

3.6.5 Groundwater Quality

Groundwater salinity in the Yeo borefield appears to be stratified, with better quality brackish water overlying saline to hypersaline water at depth.

Groundwater in the shallow calcrete in the Anne Beadell drainage part of the Yeo palaeochannel is often brackish, but is normally classified as 'hard' due to the high carbonate content.

Previous investigations of the calcrete aquifer in the Yeo Water Supply Area (WSA) found groundwater salinities ranged between 7,200 mg/L and 9,500 mg/L (KH Morgan and Associates, 1996). Groundwater with a salinity of 5,910 mg/L was obtained from calcrete in the Anne Beadell Water Supply Area at one bore constructed for the project.

The pattern of groundwater salinity in the deeper palaeochannel sediments in the Yeo borefield is presented by Figure 3-6, which shows a pattern of increasing salinity down-gradient along the palaeochannel from saline to hypersaline, plus the deeper water tends to be more acidic.

Groundwater salinity from the exploratory water bores in the weathered profile and fractured rock aquifers in the project area was notably better quality brackish, ranging between 1,240 mg/L and 16,000 mg/L TDS (Pennington Scott 2016).

3.7 HYDROLOGY

The hydrology and flood characteristics of the Gruyere Gold Project area are currently being investigated by Pennington Scott. There are no defined rivers, creeks or watercourse within the Yamarna area. Modelling thus far shows that runoff in the Gruyere Gold Project area, drains towards the northeast.

The Gruyere Gold Project area is characterised by sandhills and sandplains bounded to the east by Dorothy Hills, the west by Virginia Range and draining towards Lake Throssell and the southern end of the Newland Range in the north. The Virginia Range forms the western border draining to Minnie Creek, which flows through the Gruyere area north-east to Lake Throssell. Dorothy Hills in the east directs much surface runoff towards Yeo Lake in the east.