SOUTHERN CROSS GOLDFIELDS LTD

MINING PROPOSAL
MARDA GOLD PROJECT

Appendix 6
Surface and Ground Water Assessment

bioscope environmental

Surface and Ground Water Assessment Mining Proposal

Tenements Marda: M77/394, King Brown: M77/931 and M77/646, and Golden Orb: M77/962

Southern Cross Goldfields

Revision 4
November 2013

pendragon environmental solutions
ABN: 92 147 485 416

Leaders in Environmental Practice

Pendragon Environmental Solutions

ABN: 92 147 485 416

Address and Contact Details:

310 Newcastle Street

Northbridge WA 6003

Tel: +61 (8) 9382 8286

Mobile: +61 439 993 933 (Carel)

+61 430 310 085 (Ryan)

e-mail: info@pendragonenvironmental.com

Website: www.pendragonenvironmental.com

Report

Title:	Surface and Ground Water Assessment for Mining Approval Tenements Marda: M77/394, King Brown: M77/931 and M77/646 and Golden Orb: M77/962 Southern Cross Goldfields
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Author(s):	Edgardo Alarcón León and Carel van der Westhuizen
Client:	Southern Cross Goldfields
Contact:	Stephen Jones and Tim Dobson
Synopsis:	This document details the surface and ground water conditions and potential impacts as a result of mining and beneficiation at the Southern Cross Goldfields Tenements Marda: M77/394, King Brown: M77/931 and M77/646, and Golden Orb: M77/962.

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Executive Summary

Introduction and Background

Pendragon Environmental Solutions Pty Ltd (Pendragon) was engaged by Southern Cross Goldfields Ltd (SXG) to undertake a review of water sources and the potential impacts of mining and processing at the Marda Gold Project (Project) in the Southern Cross District of Western Australia. The Project comprises six deposits; four at Marda Central, and one each at the King Brown and Golden Orb deposits. The Project also includes a gold processing facility and a tailings storage facility on the Marda Central tenement. A mining camp and airstrip to service the workforce are to be located nearby. The Project has a life of 48 months, comprising 6 months construction and 42 months of mining and processing. The throughput is 720ktpa of ore over the operating life of the Project.

The primary aims and objectives of this assessment are to ascertain the presence of water resources and to assess the potential impacts and risks mining and processing may have upon surface and ground water resources and particularly residual impacts post closure. As a consequence it was the intention to build a conceptual model detailing pre and post mining ground water conditions with the aim to ascertain ground water influx and dewatering requirements as well as the potential for the presence of pit lakes post mining.

This document builds on an assessment of water sources for the Project (Pendragon Environmental Solutions, 2013; Appendix A) which includes a detailed assessment of the drilling testing and sampling of a production bore at Marda including the subsequent analysis of the test and water quality data and recommendations made. This document also includes the findings and/or data gathered during other investigations comprising geological exploration programs, ground water level surveys and water quality sampling that are referenced throughout this document where relevant.

Key Issues

The key issues are:

- Availability of water to supply the Project.
- Influx into the open pits.
- The presence of pit lakes post closure, particularly at Marda Central where the open pits are located within a proposed Section 5(1)(H) reserve and the possible impacts of this on the environment and other uses of the area.

Assessment of these impacts demonstrated that there are no significant impacts and risks during operations and/or residual impacts and risks remaining after closure.

Water Requirement and Availability

The Project will require water from ground water sources at a rate of 40m^3/hr during construction and 80m^3/hr during mining and processing. SXG will source water for the gold processing plant, RO plant and dust suppression from existing and planned bores at Marda, which have been or will be drilled, into the main ground water aquifer located between 95m and 150m below ground level. Supplementary sources will include dewatering of the open pits and return water from the Tailings Storage Facility (TSF). The dewatering requirement at King Brown could be used as a backup source of water. Ground water is brackish to saline and not potable, but is suitable for gold processing.

There is an existing production bore at the Python deposit with a sustainable yield of 20.0m^3/hr. Additional bores with similar capacities will be constructed near the Dolly Pot Pit to meet the operational water

requirement. Anticipated average medium to long term mine influxes and dewatering rates amount to some 30.6m^3/hr. Excess dewatering effluent not required for mining or dust suppression may be used at the plant at Marda which would reduce the water demand from bores. Alternatively, excess water will be evaporated mechanically using a pond and evaporators. Since the water demand will be met by bores predominantly, abstraction will be used to control the water balance and surplus water. There will be no discharge into the receiving environment.

Management of Impacts during Operations

Acid Mine Drainage

Following waste characterisations Rapallo Environmental concluded that *all the wastes are classifiable as benign* and that a*part from the possibility of encountering fresh rock if mining proceeds below currently planned levels, it is safe to predict that no wastes from this Project will produce Acid Mine Drainage*.

Surface Water

Owing to the topographic location and elevations of the proposed open pits and related mine infrastructure coupled with the absence of streams, flooding is unlikely. The primary impact on surface water resources pertain to minor reductions in catchment runoff. Clean storm runoff will be diverted around the areas of disturbance. Rain falling within the perimeters of the open pits, the processing plant and the TSF will be collected, retained, and managed within the Project.

The impacts from rainfall or surface water flows on operations are considered negligible and no special mitigation and/or management measures will be required.

Groundwater Dependent Ecosystems

Based upon deep ground water levels Groundwater Dependent Ecosystems (GDEs) are absent at Marda Central and Golden Orb due to deep (greater than 60m) ground water levels. Whilst GDEs may occur at King Brown where shallower ground water levels prevail, they are unlikely to be present since ground water at this location is structurally controlled and generally encountered in weathered and fractured bedrock deeper than 15m. These observations are to be confirmed by an assessment of vegetation.

Ground Water

The Marda Central, King Brown and Golden Orb deposits are located in the Marda-Diemals Greenstone Belt. Outcrops of bedrock are generally variable and sparse and blanketed by ferruginous gravels and lateritic duricrusts. Patchy outcrops of Banded Ironstone Formation (BIF) at the Python deposit trend approximately west-north-west. Structures with a bearing on the occurrence and movement of ground water comprise deep weathering (between 60m and 100m depth), steeply dipping open folds, shear, faults, brecciation and fracturing. The aquifer across the Project is generally regarded as predominantly fractured with secondary porosity.

The depth to ground water is paramount in assessing the impact of mining on ground water. Since mining will utilise/exploit ground water resources, impacts on the ground water regime pertain to:

- Infiltration of water from surface impoundments such as the TSF to ground water.
- Abstraction of ground water at Marda to supply water to the processing plant and camp (treated).
- Dewatering at King Brown and elsewhere where mining intersects the ground water level.
- Pit lakes at closure where mining intersected the ground water level.

There are no beneficial downstream users.

The small foot print and operating the TSF with a minimum water pool and storage in the return water dam are unlikely to impact on the deep ground water levels other than to increase storage in the shallow soils and fractures and is unlikely to impact on bore and/or aquifer yields therefore. Owing to the elevated salinities of ground water, impacts on water quality, in the absence of acid mine drainage, are considered inconsequential.

Drawdown zones of influence

Detailed estimations indicated that drawdowns and the cone of abstraction and/or dewatering at Marda Central will be well within the tenement boundaries and thus not have any impacts on vegetation or other downstream users across the broader area.

The drawdown and cone of abstraction from dewatering at King Brown and Golden Orb may extend beyond the boundaries of Tenements M77/931 and M77/646 and Tenement M77/962. In the absence of other users within the radius of influence, these impacts are regarded as inconsequential and of short to medium duration and will not require special mitigation and/or management measures.

Management of Residual Impacts After Closure

Pit Lakes

The DPaW advised that they are concerned about pit voids containing water (pit lakes) on land it manages where these may cause unacceptable public liability issues (public safety) and impacts on biological values that may occur if grazing animals congregate causing indirect impacts by over grazing. Closure designs should take cognisance of safety and environmental issues.

At Marda Central, a shallow pit lake is likely to develop after closure at the Dolly Pot open pit. The Goldstream open pit does not intersect the regional ground water level. At the Python and Dugite open pits, deep ground water levels and little influx subject to large evaporation are unlikely to result in pit lakes after closure.

Pit lakes at King Brown and Golden Orb are inevitable due to deep open pits that will extend below the ground water level.

The closure designs of all the pits should seek to manage any unacceptable impacts on the environment from these pit lakes.

Summary of Risks, Impacts and Management Measures

Summary of risks, impacts and management measures indicate appropriate mitigation and management is possible and residual risks may be regarded as low with a short to medium duration.

Impacts: Mining and Processing	Potential Risk	Comment/Proposed Control/Management	Residual Risk
Availability of water; exploration for ground water supplies	L - M	Existing high yielding bore with suitable targets within mining leases. Licence applications to be renewed Assessment by drilling, testing and sampling to verify yield, water quality and sustainability. Further modelling to ascertain potential impacts (drawdown effects, water quality) in the surrounding environment and to set operational controls and requirements for rehabilitation and closure.	L
Acid Mine Drainage	None	AMD absent, no mitigation/management required	None
Surface Water	L	Devise appropriate surface water management (erosion and sediment control) and monitoring plan.	L

Impacts: Mining and Processing	Potential Risk	Comment/Proposed Control/Management	Residual Risk
Stream diversion		No diversion required; separate of clean and dirty water systems.	
Deterioration of water quality in small creeks		Sufficient storage capacity; contain dirty runoff; zero discharge.	
Reduction in runoff		Separate clean and dirty catchments to minimise the latter.	
Impact on base flow, increase/decrease flow to/from GDEs, impact on biota		No hydraulic connection between creeks and underlying fractured rock aquifers; ground water levels deeper than 10m below surface; no likely hydraulic connection with surface waters.	
Ground Water Abstraction, Influx and Dewatering, Seepage	S	Devise appropriate ground water management and monitoring plans for abstraction from bore fields, mine influx and seepage	L
Impact on aquifer yield		Impacts localised, short to medium term; influxes and dewatering rates generally small; evaporation large.	
Impact on ground water level drawdown		Ascertain hydraulic characteristics by drilling, testing and sampling.	
Impact on water quality		Ground water modelling to set operational controls with the view to manage impacts of abstraction and influx.	
Mine Infrastructure:	S	Devise appropriate ground water management and monitoring plans for mine/process waters.	L
Open Pits		Impacts localised and anticipated to be short to medium term.	
		Confirm pit lake and geochemical modelling and post closure impacts and provide appropriate mining and rehabilitation and closure criteria.	
Seepage from WRDs, TSF, stockpiles, surface impoundments		Contain by appropriate investigation, engineering design and construction.	
Rehabilitation and Closure			
Pit Lakes	L	Mining and processing to be undertaken with the view to minimise residual impacts after mining.	L
		Short to medium duration of ground water level return to pre-mining levels.	
		Pit lakes with little, if any migration of pit waters, acting as evaporative sinks.	
		Monitoring and take appropriate corrective action where and if required.	
Notes: Rank: S denotes Significant, M Moderate and L Low.			

Conclusions and Recommendations

Surface waters are not considered a source of water to the Project largely due to the ephemeral character of the streams and low rainfall. However, an erosion and sediment control plan will be required to ensure that mining and related activities do not impact on downstream receiving environments. Impacts by rain and/or flooding pertain to minor reductions in runoff and are considered inconsequential due to the topographic locations of the open pits and mine infrastructure.

Mineralogical assessments and low sulphur concentrations indicate that it is unlikely that acid mine drainage will occur at the Project.

Adequate ground water resources will meet the water requirements of the Project. The anticipated impacts from the water extraction and dewatering activities are likely to be short term and inconsequential. The primary residual impact pertains to the potential for pit lakes to form after closure at Marda Central where the open pits are located within a proposed Section 5(1)(h) reserve.

Management during construction will include:

- Develop an Erosion and Sediment Control Plan (ESCP) and appropriate management and monitoring plans.
- Ground water modelling to ascertain sustainability of the aquifers and zones of ground water impacts by dewatering and infiltration from the TSF.
- Apply timeously for Section 5C licences to the DoW for taking water for mine operations and undertaking

dewatering upon completion of the drilling, testing and sampling programs.

- Implement a water monitoring program.
- Commence dewatering at King Brown six months prior to mining.

Management during mining operations will consider:

- Implement the Erosion and Sediment Control Plan (ESCP) and appropriate management and monitoring plans.
- Continue monitoring program.
- Further assessments of the sustainability of the production bores should include a re-appraisal of performance following three months of pumping and monitoring. Abstraction bores are to be equipped with 20mm diameter tubes attached to the pump column to allow monitoring of ground water levels. An inline flow meter is required at the pump head to monitor ground water abstraction rates and volumes.
- Monitor and assess infiltration from the TSF and potential impact on ground water levels and water quality. This should be undertaken following geotechnical and detailed hydrogeological assessments complemented by mass transport modelling.
- Refine pit lake models and water balances as further geological and hydrogeological and monitoring data become available. These will further assist in the development of appropriate management measures including backfilling of the pits to a level above the standing water to avoid pit lakes if required and to consider/develop other measures to manage the risks identified by the DPAW from pit lakes at closure.

Management after closure will consider:

- Continue monitoring program.
- Monitor pit lakes and assess requirements including backfilling of the pits to a level above the standing water to avoid pit lakes if needed and consider/develop other measures to manage the risks identified by the DPaW from pit lakes at closure.

1. Introduction

Pendragon Environmental Solutions Pty Ltd ('Pendragon') was engaged by Southern Cross Goldfields Ltd ('SXG') to undertake a review of water resources and any potential impacts of mining and processing at the Marda Gold Project ('Project') in the Southern Cross district of Western Australia.

1.1 Aims and Objectives

The primary aims and objectives of this assessment are to ascertain the presence of water resources and to assess any potential impacts and risks mining and processing may have upon surface and ground water resources and particularly, any residual impacts post closure. As a consequence it was the intention to build a conceptual model detailing pre and post mining ground water conditions with the aim to ascertain the presence of pit lakes post mining.

1.2 Scope of Works

The scope of works for this assessment entailed:

- Undertake assessments taking due cognisance of guidance by the Department of Mines and Petroleum (Guidelines for Mining Proposals in Western Australia and for Preparing Mine Closure Plans) and the Department of Water (Operational Policy No. 5.12, Hydrogeological Reporting associated with a Groundwater Well Licence).
- Assess local geological conditions and structures to ascertain the characteristics of aquifers with potential ground water resources that may be impacted upon by mining and beneficiation.
- Review and assess local surface and ground water conditions at the Project based upon geological and hydrogeological data gathered during mineral exploration programs.
- Review regional bore data obtained from the Department of Water.
- Estimation of the dewatering requirements for each pit based upon detailed pit water balances, modelling and pit lake assessments.
- Provide a report including conclusions and recommendations for a mining proposal.

1.3 Earlier Work

This document builds on an assessment of water sources for the Project (Pendragon Environmental Solutions, 2013; Appendix A) which includes a detailed assessment of the drilling testing and sampling of a production bore at Marda including the subsequent analysis of the test and water quality data and recommendations made (KH Morgan, 1994; a copy of this report is appended to the water sources assessment in Appendix A).

This document also considered the findings and/or data gathered during other investigations comprising geological exploration programs, ground water level surveys and water quality sampling that are referenced throughout this document where relevant.

2. Project Description

2.1 Brief Project Description

SXG proposes to construct a conventional carbon in leach (CIL) gold processing facility at Marda treating oxide ore mined from multiple open pits (Figure 2.1). Project details are:

- Project life is 48 months, 6 months construction and 42 months mining and processing.
- Throughput rate is for 720ktpa of ore over the operating life of the Project.
- Water requirements from ground water will be 40m^3/hr during construction and 80m^3/hr during operation (abstraction averages 70m^3/hr and peaks at 86m^3/hr).

The Project includes six discrete gold deposits (Figure 2.2) located within the Marda-Diemals Greenstone Belt, 150km north of Southern Cross. Four of these deposits i.e. Dolly Pot, Dugite, Python and Goldstream, clustered on M77/394, are referred to as Marda Central where the processing plant will be constructed. This tenement is located on DPaW Managed Land P5H/36 (Figure 2.3). The Project also includes deposits at Golden Orb (13km south-west of Marda Central on mining lease M77/962) and at King Brown (16km north-west of Marda Central on mining lease M77/931).

The proposed mine development entails the development of six open pits (refer Table 2.1 and Figures 2.4: Marda Central, 2.5: King Brown and 2.6: Golden Orb). Four of the proposed pits including those at the Dolly Pot, Dugite, Python and Goldstream deposits are inside the proposed Section 5(1)(h) multi-purpose reserve for conservation and mining (refer Section 2.3 below).

Table 2.1: Proposed Open Pits.

Deposit	Location of Pit relative to proposed 5(1)(h) Reserve	Pit Dimensions (m)		
		Depth	Width	Length
King Brown	Outside	60	115	305
Golden Orb	Outside	100	205	540
Marda Central Deposits				
Dolly Pot	Inside	85	165	205
Dugite	Inside	55	130	130
Python	Inside	75	150	320
Goldstream	Inside	45	75	200

2.2 Water Demand/Requirements

Pendragon prepared an assessment of potential ground water sources at the Project (Pendragon Environmental Solutions, 2013; Appendix A). This assessment indicated that there is adequate ground water available in the deeper aquifers for sustainable supplies to the Project. The nearest existing public fresh water supply is located at Bullfinch, 100km south of Marda. SXG does not consider exploitation of surface water resources as a viable potential source of water to the Project.

SXG will source water for the gold processing plant, RO plant and dust suppression from existing and planned bores at Marda, drilled into the main ground water aquifer located between 95m and 150m below ground level (KH Morgan and Associates, 1994 included, in Appendix A). Supplementary sources will include dewatering of the open pits and return water from the Tailings Storage Facility (TSF) for use in the gold processing plant:

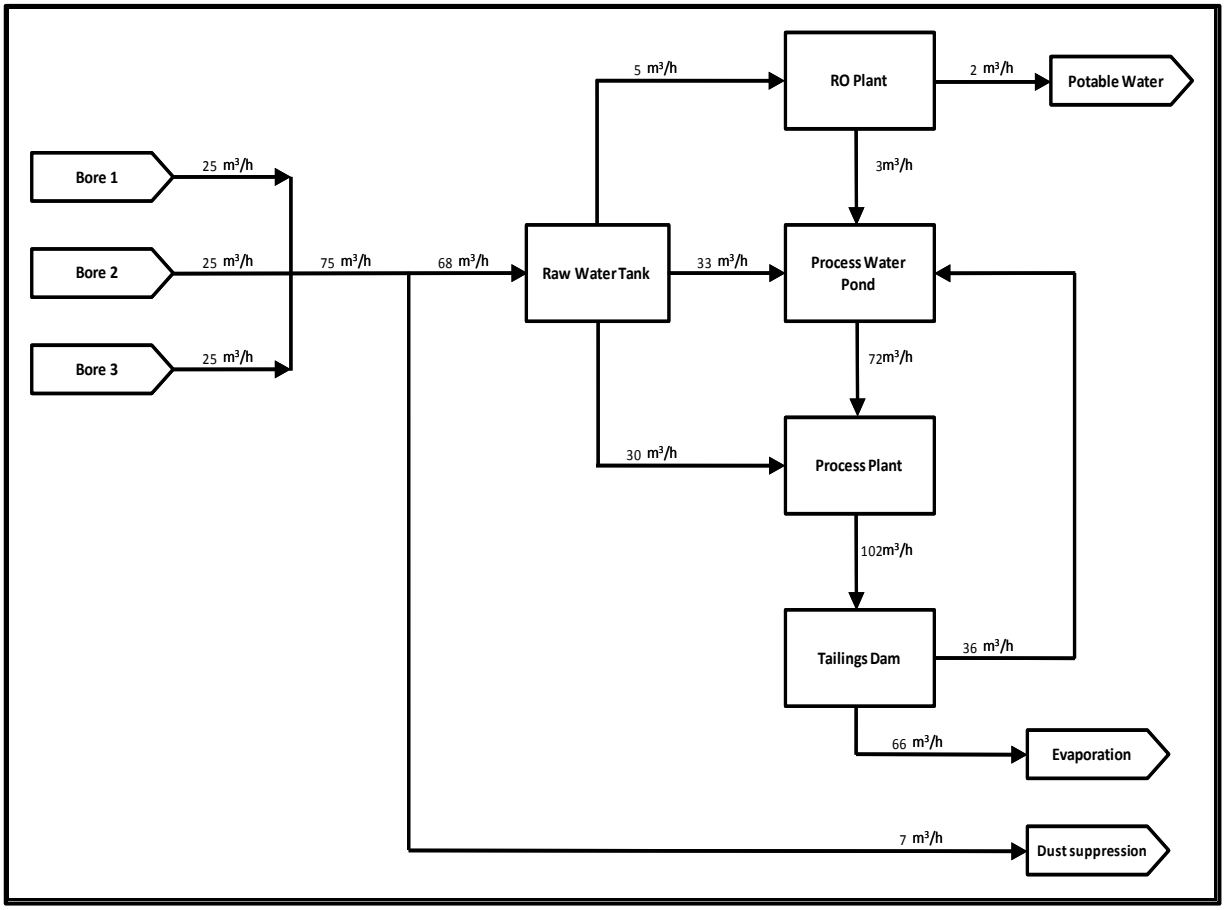

Illustration 1: Schematic Water Balance (SXG, 2013).

Ground water is brackish to saline (refer Section 5.5) and not potable but is suitable for use in gold processing. Untreated ground water will be used for processing whilst water treated using a reverse osmosis plant will be used for potable supplies.

The water requirement is estimated at (SXG, 2013):

Table 2.2: Average Water Requirement.

Maximum Water Abstraction	m^3/hr	86
Average Water Abstraction	m^3/hr	70
Assumptions Raw Water Use		
Construction	m^3/hr	20
Camp	m^3/hr	5
Road Dust Suppression	m^3/hr	7
Operations Fixed	m^3/hr	30
Operations Variable	m^3/hr	33

There is an existing production bore at the Python open pit with a reported sustainable yield of 20m^3/hr (Appendix A). Additional bores with similar capacities will be constructed near the Dolly Open Pit to meet the operational water requirement. The bores are to be equipped with submersible pumps and local diesel generators. These pumps will feed a raw water tank controlled by high/low level switches.

Dewatering of the open pits (excluded from the above water balance, as they do not come until later in

the project life) is to be carried out using portable diesel powered pumps discharging into local sumps and/or evaporation ponds. Anticipated average medium to long term mine influxes and dewatering rates are shown in Table 2.3.

Table 2.3: Anticipated Mine Influxes and Dewatering Rates.

Deposit	Ground Water Level	Pit Depth	Medium to Long Term Flux $Q_{(SEEP/W)}$	Medium to Long Term Flux $Q_{(SEEP/W)}$
	(mbgl)	(m)	(L/s)	(m^3/hr)
King Brown	13.7	52.8	4.5	16.2
Golden Orb	62.5	92.7	0.3	1.1
Marda Central				
Dolly Pot	60.7	81.7	2.9	10.4
Dugite	52.2	56.0	0.1	0.4
Python	64.7	61.5	0.7	2.5
Total:			**3.7**	**13.3**
Total Marda, King Brown and Golden Orb			**8.5**	**30.6**
The final floor of the Goldstream open pit is above the local ground water level.				

Excess dewatering effluent at Marda Central, not required for mining or dust suppression, will be evaporated locally or pumped from the mine pond to the process water pond at the plant.

In the absence of details pertaining to the water bearing capacity, depth and hydraulic parameters of the aquifer at Kings Brown, there is uncertainty as to ground water influx at this open pit. The pit will be 45m deep and the ground water level is at 15m below surface. It is probable that this pit will at least supply sufficient water for dust suppression and that surplus water may be pumped to the process plant at Marda thereby reducing the water demand from bores. Alternatively, excess water will be evaporated using a pond and evaporators if necessary.

The water requirement for dust suppression will be met by ground water influx into the open pits (refer Section 5.4) and the shortfall, if any, by bore water. There will be no discharge into the receiving environment.

2.3 DPaW Conservation Area

The Marda Central tenements are on DPaW Managed Land P5H/36 within an area proposed as a multi-purpose reserve for conservation and mining under Section 5(1)(h) of the Conservation and Land Management Act 1984 (Table 2.3 and Figure 2.3):

Table 2.4: Land Type Description.

Code	Land Type	Category	Management Authority	Description
P5H	5(1)(h) Reserve	Proposal	Department of Parks and Wildlife (DPaW)	Regional Management Plan. A 5(1)(h) Reserve is a reserve index Section 5(1)(h) of the Conservation and Land Management Act of 1984. It is a multi-purpose reserve originally intended by DPaW (previously DEC) to manage pipelines and dams within State forest areas. Since 1988, DMP and DPaW have used this category as an interim device for dealing with important resource areas of WA which also have significant conservation values (e.g. Purnululu, or Bungle Bungle, Reserve adjoining the national park).

The King Brown and Golden Orb tenements are not within the proposed reserve. Whilst the reserve is classified as *proposed*, the land is actively managed by DPaW. For the purpose of assessing and

managing the environmental impacts at the Marda Central tenements from construction to post-closure, it is assumed that the reserve will be implemented with the DPaW as the key stakeholder.

The DPaW advised that they are concerned about pit voids containing water (pit lakes) on land it manages where there is an unacceptable risk to public safety and/or the potential for impacts on biological values that may occur if grazing animals congregate around the water source causing indirect impacts by over grazing. The depth to water in these pits would render it inaccessible to grazing animals. SXG will implement controls to address public safety such as signage, safety bunding and where necessary fencing.

2.4 Department of Water

The Project falls within the Goldfields Groundwater Management Area proclaimed under the Rights in Water and Irrigation Act of 1914. Development and maintenance of a ground water supply and dewatering of open pits require applications to the Department of Water for licences under Sections 26D and 5C of the Act for the taking of water for mine operations. Whilst these applications are subject to approval, they do not constitute a risk to the proposed Project as it is not located within an area where there are many competing users and/or where ground water supplies are in demand or are over-allocated and/or -exploited.

Licences, in terms of Section 26D of the Rights in Water and Irrigation Act of 1914, to construct bores at Marda Central and King Brown were granted in November 2012 (Appendix B):

- CAW175209 Goldfields Deborah Combined Fractured Rock West: Marda Central Tenement M77/394 and King Brown Tenements M77/931 and M77/646.
- CAW176670 Goldfields Deborah Palaeochannel - Fractured Rock: King Brown Tenement M77/931.

  These licences are to be renewed prior to drilling for water supplies as they are generally granted for a period of six months only.

Licences to take water (ground water from bores and dewatering of mine influx into the open pits) in terms of Section 5C of the Rights in Water and Irrigation Act of 1914 will be applied for on completion of bore constructions, hydraulic testing and water quality sampling.

The Marda Central deposits are located approximately 1km north-west of the water reserve R17009 Marda Dam. This historical water feature will not be impacted by the Project (Figure 2.3).

2.5 Environmental Protection Regulations

In terms of Schedule 1, Part 1 of the Environmental Protection Regulations of 1987, dewatering of the open pit at King Brown is classified as:

Table 2.5: Schedule 1 Prescribed Premises.

Category Number	Description of Category	Production or Design Capacity[1]
With particular reference to mine dewatering (note: this list is not all inclusive and excludes the plant, process and TSF):		
6	Mine dewatering: premises on which water is extracted and discharged into the environment to allow mining of ore.	50,000 (tonnes) m^3 of water or more per year

Under Part V of the Environmental Protection Act of 1986, Part 1 of Schedule 1 of the Environmental Protection Regulations (1987) a Works Approval is required for works undertaken on a prescribed

premises during the construction phase and a licence for the operational phase. These approvals, where and if required, will be obtained following lodgement and approval of the Mining Proposal.

3. Climate

3.1 Rainfall and Evaporation

The Project falls within a temperate zone in which the climate is mostly hot and dry. The long-term average temperature at Southern Cross ranges from a monthly maximum of 35ºC to a minimum of 5ºC. Whilst rainfall can occur throughout the year, most rain falls during the winter (May to August; Figure 3.1). Large rainfall may also occur in summer when northwest cyclonic events penetrate inland. The average annual rainfall is 307mm; however the area is known to receive unreliable rainfall and hence annual precipitation may vary between 200mm and 550mm (Table 3.1 and Figure 3.1). The annual evaporation at Marda is 2,195mm exceeding annual rainfall by about seven times.

Table 3.1: Rainfall Data.

Site Details													
Southern Cross Airfield	Number: 012320		1996 to current		Merredin Research Station		Number: 010093		1911 to current				
Latitude: 31.24 °S	Longitude: 119.36 °E		Elevation: 347 m		Latitude: 31.50 °S		Longitude: 118.22° E		Elevation: 318 m				
Nearest Alternative Sites: 012074 Southern Cross (2.7km), 010092 Merredin (105km) and 010093 Merredin Research Station (110km).													
Southern Cross Airfield	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Mean rainfall (mm)	29.6	25.3	35.5	24.7	30.2	28.6	34.6	29.0	22.0	14.0	16.7	17.4	307.6
Highest rainfall (mm)	113.0	73.8	154.4	77.8	91.8	69.0	76.8	76.6	40.8	82.4	39.2	91.4	551.8
Date	2001	2011	1999	1999	1999	2005	2008	2003	2006	2011	1996	2011	1999
Lowest rainfall (mm)	0.0	0.0	0.0	0.0	2.2	7.4	7.8	11.8	11.8	0.4	0.2	0.0	151.4
Date	2005	2002	2007	2001	2000	2006	2005	2006	2002	1996	2007	2008	2010
Highest daily rainfall (mm)	60.0	56.8	66.0	77.0	39.0	21.0	24.0	24.4	14.2	30.2	26.0	36.6	77.0
Merredin Research Station	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Mean rainfall (mm)	14.7	15.6	20.5	22.2	38.1	49.2	47.4	37.8	23.4	16.5	14.3	13.9	313.2
Mean evaporation (mm)	344.1	282.8	251.1	159.0	96.1	63.0	58.9	71.3	111.0	179.8	255.0	322.4	2,194.5

4. Surface Water

The Project area is within the internal drainage division of Western Australia. Surface drainage in this division is directed to the many salt lakes and claypans that occur in the inland of Western Australia. The area is underlain by granite strata of the Yilgarn Craton with Archaean Greenstone intrusions in parallel belts. There are no rivers or major streams. Mallees and scrubs are found on sand plains associated with lateritised uplands, playas and granite outcrops.

4.1 Marda Central

The area has a low relief with dominant *Eucalyptus* species and lesser *Casuarina* woodland on small areas of banded iron formation subcrop (Rapallo, 2012). Surface drainage across the Marda Central area is poorly defined and consists mainly of broad sheet wash following short duration high intensity storms. Occasional shallow, ephemeral drainage channels are present but these are mostly short, originating on rises some 30m above the plains and terminating within a few hundred meters. A few small ephemeral creek beds rise in the area and flow north or north-west towards a chain of unnamed salt lakes or clay pans at Marda Central (Figures 2.2 and 2.4).

The only known surface water in the area is Marda Dam (Figure 4.1), a disused dam previously used to supply water to the old Marda settlement. The dam is fed by a small creek. The Marda Dam is approximately 2km east of the Evanston-Bullfinch road and 0.5km from the closest part of M77/394 (Figure 2.3).

Owing to the low rainfall of the area, coupled with the high rate of evaporation, and runoff characteristics of the area, surface water is unlikely to be a reliable source of water for the Project. Runoff from the mining areas occurs as sheet flow and is unlikely to contain large amounts of silt and sediment which may impact on the receiving downstream environment. Whilst a detailed sediment and erosion plan has not yet been developed, the following objectives, during and post mining, will be met:

- Large rainfall events will be managed by bunds and water collection measures/structures.
- Diversion of clean storm runoff around the areas of disturbance.
- Collection of runoff within the areas of disturbance.
- Treatment of contained runoff by settling of silt and removal of hydrocarbons, where required.
- Discharge treated runoff water to the process water ponds and/or use water for dust suppression.

The shallow, ephemeral drainage channels discharge into low lying plains up to 30m below the rises where they originate. Therefore, flooding of the proposed open pits and related mining infrastructure along the higher elevations, is unlikely.

4.2 King Brown

King Brown (Figures 2.2 and 2.5) is located at the southern end of a small ridge which discharges to the south into a low lying clay pan. Owing to the elevation difference between 5m and 7m between the proposed open pit and the clay pan, flooding of the proposed open pit and related mining infrastructure is unlikely.

4.3 Golden Orb

Golden Orb (Figures 2.2 and 2.6) is situated in undulating terrain which discharges to the south into ephemeral creeks that flow further southwards. The proposed open pit is at least 20m above these streambeds. Flooding of the pit and related mining infrastructure is unlikely.

5. Ground Water

5.1 Geology

The Goldfields region is one of nine regions in Western Australia and is the largest. It is mostly a low and flat plateau of extremely ancient Precambrian rocks which have been stable since long before the Paleozoic. Because of the extreme geological stability and the absence of glaciation since the Carboniferous, the soils are extremely infertile and generally quite saline. In the absence of rivers and major streams any rainfall that is not evaporated or absorbed by the dense rooting systems of the native flora percolates to form brackish to saline ground water.

The Marda Central, King Brown and Golden Orb deposits are located in the Marda-Diemals Greenstone Belt (GSWA Jackson 1:100,000 Sheet).

The geology and structure of the Marda Central Deposits (Figures 5.1, 5.2 and 5.3), King Brown (Figure 5.4) and Golden Orb (Figure 5.5) is well understood through prospect scale geological mapping and extensive RC and diamond drilling at and around each deposit. Geological interpretations were aided by airborne and ground magnetics. The following descriptions are based on extensive drilling coverage by SXG and also draw on past work by Cyprus, Gondwana and Evanston Resources.

5.1.1 Marda Central

Outcrops of bedrock along the Marda trend are variable and sparse over the Dollypot, Dugite and Goldstream deposits (Figures 5.1 and 5.2). Patchy outcrops of Banded Ironstone Formation (BIF) at Python trend approximately west-north-west and are up to 3m in width. Structures with a bearing to the occurrence and movement of ground water comprise deep weathering (up to 100m depth), steeply dipping open folds, shear, faults, brecciation and fracturing (Figure 5.3).

5.1.2 King Brown

Outcrops of bedrock trending west-north-west are variable and sparse and blanketed by ferruginous gravels. Structures with a bearing to the occurrence and movement of ground water comprise weathering (up to 60m depth), steeply dipping open folds, shear, faults, brecciation and fracturing (Figure 5.4).

5.1.3 Golden Orb

Outcrops of bedrock at Golden Orb are blanketed by lateritic duricrusts and ferruginous gravels. Structures with a bearing to the occurrence and movement of ground water trend north-west and comprise deep weathering (up to 90m depth), steeply dipping open folds, shear, faults, brecciation and fracturing (Figure 5.5).

5.2 Acid Mine Drainage

5.2.1 Marda Central

Investigations into the physical and chemical characteristics of soils, sub soils and mine waste

materials from the Marda Central Deposits, with the objectives to determine if any of the soil, subsoil or waste rock material had the potential to produce acid and/or metalliferous drainage and if the available soils were suitable for use in final rehabilitation, were undertaken by Rapallo in 2012. Rapallo concluded that *all the wastes are classifiable as benign. In the unlikely event that any fresh rock waste with visible sulphides be located during mining, it is recommended that fresh waste be buried within the waste rock facility or returned to the pit after completion of mining. No additional test work is required. Apart from the possibility of encountering fresh rock if mining proceeds below currently planned levels, it is safe to predict that no wastes from this project will produce Acid Mine Drainage* (Rapallo, 2013a).

5.2.2 King Brown

With regard to waste characterisation at King Brown Rapallo concluded that *all the wastes are classifiable as benign. In the unlikely event that any fresh rock waste with visible sulphides be located during mining, it is recommended that waste be buried within the waste rock dump or returned to the pit after completion of mining. No additional test work is required* (Rapallo, 2013b).

5.2.3 Golden Orb

With regard to waste characterisation at Golden Orb Rapallo concluded that *all the wastes are classifiable as benign. In the unlikely event that any fresh rock waste with visible sulphides be located during mining, it is recommended that waste be buried within the waste rock dump or returned to the pit after completion of mining. No additional test work is required* (Rapallo, 2013c).

5.3 Hydrogeology

5.3.1 Groundwater Levels and Flow Directions

The Project is located in a relatively flat plain with the occasional BIF ridge protruding from the plain. Figure 5.6 shows a regional profile across the area. The Windarling Ranges lie approximately 20km to the north of Marda Central and the Jackson Ranges lie approximately 2km south of Marda Central. Golden Orb is approximately 8km south of the Jackson Ranges.

An inspection and assessment of ground water level measurements (Table 5.1) from a large number of exploratory boreholes across the Project indicate that ground water levels imitate the regional (Figure 5.6) and local topography. There is no clear discernible trend as the mean local ground water level gradients are small, ranging between 0.31% (0.0031m/m) and 0.39% (0.0039m/m).

Ground water across the region occurs in basins of weathering and local fracture systems, which vary in both vertical and lateral extent, controlled by geological structures, which would suggest compartmentalisation of ground water resources where there is little if any hydraulic connection between the different compartments. As a consequence ground water is likely to move or drain very slowly and may be considered stagnant (reference should be made to Section 5.5 of this document).

Table 5.1: Ground Water Levels across the Marda Gold Project.

Deposit	Ground Water Level			
	Average (mbgl)	Minimum (mAHD)	Maximum (mAHD)	Average (mAHD)
King Brown	13.71	383.56	385.56	384.61

Deposit	Ground Water Level			
	Average (mbgl)	Minimum (mAHD)	Maximum (mAHD)	Average (mAHD)
Golden Orb	62.45	369.64	373.94	372.94
Marda Central (average depth to ground water level: 62.68mbgl)				
Dolly Pot	60.75	382.77	384.29	383.83
Dugite	52.25	385.99	387.03	386.64
Python	64.72	382.84	385.64	384.48
Goldstream	Dry to 67mbgl – 382.35mAHD			

Ground water levels at King Brown are shallow averaging 13.7m below surface. At Marda Central and Golden Orb the average ground water level is deeper than 60m below surface.

5.3.2 Ground Water Levels: Pre and Post Mining

The measured ground water levels and proposed pit dimensions (in accordance with the May 2012 Feasibility Study) appear in Table 5.2. The pit dimensions, depending on economic criteria and the outcomes of additional exploration and resource evaluations may be adjusted. Underground mining below the pits may also occur in future as mineralisation extends along strike to a level below the current pit designs.

Table 5.2: Pit Dimensions and Water Levels.

Deposit	Average Ground Water Level		Pit Dimensions						
			Pit Crest (mAHD)		Pit Floor (mAHD)	Depth		Width (m)	Length (m)
	(mbgl)	(mAHD)	Min	Max		Min	Max		
King Brown	13.71	384.61	395.3	402.7	342.5	52.8	60.2	115.6	304.3
Golden Orb	62.45	372.94	432.7	439.3	340.0	92.7	99.3	204.9	542.5
Marda Central									
Dolly Pot	60.75	383.83	441.7	445.4	360.0	81.7	85.4	165.3	205.7
Dugite	52.25	386.64	438.5	440.2	382.5	56.0	57.7	129.3	129.5
Python	64.72	384.48	446.5	457.0	385.0	61.5	72.0	150.5	321.9
Goldstream	67.00	>382.35	444.9	451.7	405.0	39.9	46.7	74.4	199.1
The levels highlighted in blue indicate that dewatering may be required during mining and that there is a potential for standing water in the open pit at closure.									

Cognisance must be taken that the aquifers across the Project are associated with highly fractured and jointed banded iron formation (BIF) and behave similar to the main aquifer at Python (KH Morgan and Associates, 1994). Bore MPB1, drilled to 126m below surface, at this location has an airlift yield of about 20m^3/hr and is bound by two north-south striking faulting systems joining to the south of the bore. Drilling records indicate that the degree of fracturing increased around the mafic contacts encountered at 95m and between 124m and 126m below surface. Although the records do not indicate the exact locations of the principal water strikes, they report that *the airlift yield encountered during construction continued to increase with depth indicating that deep weathering may contribute to bore yield*. Significant fracturing of the BIF was recorded as deep as 154m. The vertical extent of the aquifer is currently undefined. Thus, cognisance must be taken that the main water strikes during drilling at the Python deposit were between 95m and 126m below surface. Ground water level measurements thus reflect piezometric heads and as such pit lakes are likely to develop only in those pits which will intersect water bearing strata where:

- shallow ground water occur such as at King Brown; and
- pit depths approach 90m, the depth at which first ground water strikes is intersected such as at Dolly Pot and Python.

Post mining water levels are expected to be at levels similar, albeit somewhat below those pre-mining due to mine dewatering and evaporation from the sidewalls and floors of the open pits. Bore testing (KH Morgan and Associates, 1994) indicated that ground water levels did not recover fully within a time similar to abstraction indicating that water displaced by pumping is not replaced immediately due to dewatering of the fracture systems. This also explains why bore yields are decreasing over time. Similar responses in ground level behaviour and influx rates are expected during mining. Where the primary aquifers or water bearing strata will be penetrated during mining, the duration of recovery, or at least 90% of that, will be within a time span similar to mining of the pit, generally less than 18 months.

Where pit influxes exceed the rate of evaporation such as anticipated at Marda Central: Dolly Pot, King Brown and Golden Orb, pit lakes are likely to develop. The likelihood of pit lakes developing was ascertained by means of pit water balances and estimation of influxes by means of modelling (refer Section 5.4.2).

5.3.3 Ground Water Dependent Ecosystems (GDEs)

From a ground water perspective, GDEs are defined as: *natural ecosystems that require access to ground water to meet all or some of their water requirements so as to maintain their ecological functions* (Department of Water SA, 2012). Six types of GDEs are conventionally recognised in Australia:

- **Terrestrial vegetation** that relies on the availability of shallow ground water.
- **Wetlands** such as paperbark swamp forests and mound springs ecosystems.
- **River base flow systems** where ground water discharge provides a base flow component to the river's discharge.
- **Aquifer and cave ecosystems** where life exists independent of sunlight.
- **Terrestrial fauna**, both native and introduced that rely on ground water as a source of drinking water.
- **Estuarine and near shore marine systems**, such as some coastal mangroves, salt marshes and sea grass beds, which rely on the submarine discharge of ground water.

Of these, only terrestrial vegetation and fauna may occur within the Project area. Table 5.3 details the criteria for discerning zones and sites which may fit the definition of a GDE.

Table 5.3: Criteria for Defining Water Dependent Ecosystems.

Environmental Aspect	Criteria	Indicators of Groundwater Dependence
Level 1: Locate zones with potential for groundwater dependence		
Potential for ground water fed systems	Status of inundation, submergence, seeps and springs, ground water aquifers, geology and topography	Soil and surface/ground water surveys indicate water at (inundation, submergence, seeps, springs) or close (dampness) to the surface which vegetation can readily tap into or there is potential for expression of this water to the surface based on geology and topography.

Level 2: Assess specific areas where groundwater dependence potential is high		
Indications of water at inundation, sub-mergence, seeps, springs) or close (dampness) to the surface	Soil moisture Expression of ground water Source of surface water Refer to vegetation criteria	Greater than 15% following at least 7 days of no rain. Shallow ground water levels, extent of ponding or flowing (fre-quency; rainfall relationship). Drainage/topographic characteristics. Surface/ground water quality characteristics. Refer to vegetation structure.
Vegetation Characteristics	Vegetation structure Plant species composition	Structure (large trees) suggests reliance on a long term available water source. Species composition suggests a dependence on a shallow ground water level. Presence of species dependent on (near) permanent water.

These GDEs are areas where groundwater plays a key role both on vegetation dynamics and on soil water balances. The dynamics of these ecosystems, including riparian zones, peatlands, and unsubmerged wetlands, are largely controlled by the soil water content and by the depth to the ground water level.

Marda Central

Since ground water levels at Marda Central occur at depths greater than 52.2m below surface, coupled with a significant water deficit climate, there is no potential for GDEs within this mine tenement.

King Brown

Ground water levels at King Brown ranges between 11.0m and 17.0m below surface averaging 13.7m. Thus it seems that moisture may be present at depths that may support GDEs at this mine tenement. However, an assessment of the depths at which ground water were encountered during exploratory drilling indicated that whilst most samples of drill cuttings were moist, wet samples indicative of ground water were only encountered at depths deeper than 15.0m. It seems therefore that ground water levels are piezometric heads (water levels are above the depths at which ground water were encountered) and are structurally controlled, as is the mineralisation (Figure 5.4), at this location. The ground water quality at this location is saline.

On the basis of the hydrogeological characteristics of the area, it appears unlikely that GDEs would be present at King Brown. A vegetation assessment would be required to confirm that there are no deep rooted vegetation that may access ground water.

Golden Orb

The ground water level at Golden Orb averages 62.5m below surface, coupled with a significant water deficit climate, there is no potential for GDEs within this mine tenement.

5.4 Aquifer Yield

5.4.1 Marda Central

Exploration Groundwater Well Licence 49256 issued on the 10th June 1994 allowed sinking of exploration bores. Drilling and test pumping of MPB1 and an observation bore (at the site of water

exploration bore MEII) was carried out from 16th July 1994 to 2nd August 1994 at the Python prospect located approximately 130km north of Southern Cross in the Yilgarn Mineral Field (KH Morgan and Associates, 1994). Testing included pumping Bore MPB1 at a variable flow rate step drawdown test, followed by a four day constant rate pumping test and four day recovery test. The aquifer hydraulic parameters at Python i.e. transmissivities (T) ranged between 40m^2/d and 59m^2/d with coefficients of storage (S) between 0.0025 and 0.0112 (Table 5.4; KH Morgan and Associates, 1994).
Subsequent data analysis using MLU Aquifer Test Software indicated that transmissivities range between 64 m^2/d and 144m^2/d whilst coefficients of storage varies between 0.03 to 0.20 (Table 5.4; Appendix A; Pendragon Environmental Solutions, 2013). Unlike traditional aquifer test software, MLU is based on a single analytical solution technique for well flow but employs traditional analytical solutions and techniques such as Theis, Hantush, Neuman, Boulton, etc.

Table 5.4: Bore Test Analysis.

Bore ID	Date Assessed	Method	Pumping Rate	K (Hydraulic Conductivity)		T (Transmissivity)		Storativity S [-]
			(L/s)	(m/min)	(m/sec)	(m^2/min)	(m^2/d)	
MPB1	1994	Analytical	5	-	-	0.03	40	0.0025
MPB1	2012	MLU	5	0.0004	0.00001	0.05	64	0.0300
ME11	2012	MLU	5	0.0010	0.00002	0.10	144	0.2000

An aquifer sustainability analysis using the FC Method indicated that the long-term sustainable yield of Bore MPB1 is less than the 5.0L/s found by the 1994 analyses. However, assuming aquifer recharge in the area approximates 5% of MAP, the recommended sustainable yield is 2.7L/s over 24 hours.

For the purposes of this assessment, the aquifers at King Brown and Golden Orb were assumed to possess similar yield characteristics and hydraulic parameters. In general within the Project, dewatering within the cone of dewatering (refer Section 5.4.4 below) will decrease aquifer yields markedly, however, outside the radius of influence aquifer yields will remain at their pre-mining levels.

5.4.2 Mine Influx, Dewatering and Pit Lakes

The yield characteristics and capacities of the aquifers across the Project are expected, based upon the geological composition and fractured nature, to be moderate in the range between 0.5L/s and 5.0L/s.

Earlier first order approximations and estimations indicated that the potential average rate of flux approximate 7.0L/s resulting in a radius of influence around 300m from the crest of the pits. The radii of influence were calculated using the Jacob Equation:

$$s = \frac{2.30.Q}{4.\pi.T}\left(\log\frac{2.25.T.t}{r^2.S}\right)$$

where:

Q: predicted/estimated rate of influx (m^3/d) using the first portion of the Jacob Equation and substituting T (determined from bore test on MPB1) and s = Water Level – Base of Pit.
T: transmissivity (m^2/d).
t: time.
S: storage coefficient [-].
r: radial distance (m).

Q has been estimated from the first part of the Jacob Equation. Estimations indicate that the initial

rate of influx may range between less than 1.0L/s to as high as about 24.0L/s at King Brown (Table 5.5). Consequently, fluxes results in large radial influences to reach a maximum of approximately 800m around the King Brown Pit (Table 5.5 and Figure 5.7). These influences are well within the perimeters of the tenements and the Project is thus anticipated not to impact on aquifer yields and/or ground water levels of any user and/or environment outside their tenements.

Owing to the nature of the fractured rock aquifer, confined to relatively narrow zones and/or compartments, influx into the open pits is likely to commence at relatively large rates but decline rapidly and reach their mean long term rates within 6 months since mining commenced:

Table 5.5: Predicted Radial Influences and Mine Influx.

Deposit	Initial Flux Q_1	Maximum Radial Influence	Ground Water Level	Pit Depth	Medium to Long Term Flux $Q_{(SEEP/W)}$
	(L/s)	(m)	(mbgl)	(m)	(L/s)
King Brown	24	780	13.7	52.8	4.5
Golden Orb	16	740	62.5	92.7	0.3
Marda Central					
Dolly Pot	7	565	60.7	81.7	2.9
Dugite	1	490	52.2	56.0	0.1
Python	1	350	64.7	61.5	0.7
The floor of the Goldstream Open Pit is above the local ground water level.					

The pits are to be dewatered by in-pit sumps and pumps discharging into a pond from where water will be used in the processing plant (Marda Central), for dust suppression (Golden Orb and King Brown) and/or disposed of by means of natural or mechanical evaporation if required (King Brown).

To facilitate mining at King Brown, bores may be required for dewatering in advance of mining. The time to dewater the King Brown pit to a level of 50m below surface with two bores discharging at a rate of 20L/s is estimated at 137 days. Dewatering activities will thus have to commence at least 6 months before mining commences. Once mining commences dewatering may be assisted by in-pit sumps and pumps. Dewatering effluent will be discharged to the evaporation and settlement pond. Excess water not used for mining and dust suppression will be naturally or mechanically evaporated with evaporators.

Ground water influxes during and subsequent to mining, and consequently development of pit lakes, were estimated using pit water balances and modelling employing the SEEP-W software. From the pit water balances (Table 5.6) and models (Figure 5.8) it is evident that:

- Owing to small influxes and large evaporation, permanent pit lakes are unlikely to develop at Goldstream (Figure 5.9), where the pit does not intersect the ground water level, and Python (Figure 5.9) and Dugite (Figure 5.10) where the pit floors are marginally below the ground water level.
- Pit lakes are likely to develop after closure at Dolly Pot (Figure 5.10), King Brown (Figure 5.11) and Golden Orb (Figure 5.12).

The finite element SEEP/W model was used to predict groundwater inflow into the proposed open pits. These models comprised of approximately 725 nodes and 1,202 elements and two distinctive zones: a semi-saturated and a saturated one. The assumed saturated permeability of the aquifer is $1x10^{-5}$m/s whilst the saturated permeability was set at $1x10^{-4}$m/s in accordance with the findings of earlier testing at bores MPB1 and ME11 (KH Morgan and Associates, 1994). The rate of recharge was assumed to be no more than 5%. A two-dimensional simulation was performed under steady state flow conditions at 500 iterations (Table 5.7).

Table 5.6: Pit Water Balances.

Sources or Inputs (kL/a)		Annual Water Balance Average Rainfall: 313mm/a; Evaporation: 2,190mm/a			Losses or Discharges (kL/a)	
Goldstream Open Pit						
Rain	7,199		(Total Pit Surface Area: 2.3ha)		35,259	Evaporation
Influx	0		(Pit Depth/Floor: 39.9m/405.0mAHD)			
		7,199	(Inferred Ground Water Level: >67.0mbgl)	-28,060		Negative water balance; pit floor above ground water level
Python Open Pit						
Rain	12,207		(Total Pit Surface Area: 3.9ha)		59,787	Evaporation
Influx	20,814		(Pit Depth/Floor: 61.5m/385.0mAHD)			Pit floor slightly above inferred ground water level
		33,021	(Inferred Ground Water Level: 64.7mbgl)	-26,766		Negative water balance; pit floor above ground water level
Dugite Open Pit						
Rain	4,069		(Total Pit Surface Area: 1.3ha)		19,929	Evaporation
Influx	946		(Pit Depth/Floor: 56.0m/382.5mAHD)			
		4,038	(Inferred Ground Water Level: 52.2mbgl)	-15,891		Negative water balance - no pit lake.
Dolly Pot Open Pit						
Rain	8,451		(Total Pit Surface Area: 2.7ha)		41,391	Evaporation
Influx	47,304		(Pit Depth/Floor: 81.7m/360.0mAHD)			
		55,755	(Inferred Ground Water Level: 60.7mbgl)	14,364		Pit Lake Water Level: 69.8mgbl - 375.7mAHD
Golden Orb Open Pit						
Rain	17,528		(Total Pit Surface Area: 5.6ha)		85,848	Evaporation
Influx	126,144		(Pit Depth/Floor: 92.7m/340.0mAHD)			
		143,672	(Inferred Ground Water Level: 62.4mbgl)	57,824		Pit Lake Water Level: 68.3mbgl - 371.0mAHD
King Brown Open Pit						
Rain	6,886		(Total Pit Surface Area: 2.2ha)		33,726	Evaporation
Influx	154,526		(Pit Depth/Floor: 52.8m/342.5mAHD)			
		161,412	(Inferred Ground Water Level: 13.7mbgl)	127,686		Pit Lake Water Level: 16.6mbgl - 386.1mAHD

Table 5.7: SEEP/W Model Results.

Parameter	Python	Dugite	Dolly Pot	King Brown	Golden Orb
Initial Water Level (mAHD)	395.0	386.4	383.8	389.1	392.6
Thickness of Saturation (m)	446.5	438.4	441.6	445.0	432.3
Model Bottom Boundary	no-flow				
Pit Bottom Boundary: Fixed Head at (m)	385.0	382.5	360.0	342.5	440.0
Cross Sectional Floor Area (m^2)	2,642	141	281	349	156
Average Flux (L/s)	0.7	0.1	2.9	4.9	0.3
Water Thickness (m)	0.0	0.0	15.7	43.6	31.0
The floor of the Goldstream open pit is above the local ground water level.					

5.5 Water Quality

Samples of water were obtained by bailing after purging the bores (Appendix C, Figures 2.4, 2.5 and 2.6), kept on ice and submitted to ALS Laboratory within a 48 hour sample-to-lab timeframe.

5.5.1 Marda

Ground water qualities across Marda range from relatively fresh to brackish (Table 5.8) and are characterised by circumneutral pHs ranging between 7.0 and 7.9 and electrical conductivities (EC) ranging between 860µS/cm and 10,500µS/cm averaging 4,013µS/cm (Appendix C). The highest ECs at Marda Central occur at Python (Bore SXG-ME011: 10,500µS/cm) and Dolly Pot (Bore SXG-MCR001: 3,590µS/cm).

Major cations and anions are present at large concentrations with the dominant ions: chloride (up to 2,590mg/L); sodium (up to 1,540mg/L); sulfate (up to 632mg/L) and magnesium (up to 251mg/L) typical of brackish environments (Appendix C).

Table 5.8: Total Dissolved Solids and Hardness at Marda.

Bore Number	Total Dissolved Solids (TDS) (mg/L)	Classification	Total Hardness (mg/L $CaCO_3$)	Classification	TDS/EC Ratio
SXG-ME011	6,450	Brackish Water	1,335	Very Hard	0.61
SXG-PYRC064D	2,830	Brackish Water	766	Very Hard	0.64
SXG-MCR001	2,050	Brackish Water	4118	Very Hard	0.57
SXG-MCR002	512	Fresh Water	136	Slightly Hard	0.6
SXG-MCR003	1,270	Brackish Water	191	Moderately Hard	0.61
SXG-MCR004	1,180	Brackish Water	236	Hard	0.57
SXG-DUDD001	3,070	Brackish Water	420	Very Hard	0.67
Water can be classified by the amount of TDS per liter: Fresh water < 1,000 mg/L TDS, Brackish water 1000 to 10,000 mg/L TDS, Saline water 10,000 to 30,000 mg/L TDS and Brine > 30,000 mg/L TDS While a TDS of 5,000 mg/L is the minimum threshold for a water to be considered brine, the typical range is 30,000 to 100,000 mg/L.					

Most of the dissolved trace metals with the exception of barium, lithium, manganese and nickel are below their detection limits (Table 5.9) with sporadic detection of all elements particularly those of arsenic, cobalt, copper, molybdenum and zinc. Manganese, zinc and iron are marginally elevated.

Table 5.9: Dissolved Trace Elements in Ground Water at Marda.

Analyte	Units	Average	Median	Maximum	Minimum
Aluminium	mg/L	0.010	0.010	0.010	<0.010
Arsenic	mg/L	0.030	0.006	0.109	<0.001
Barium	mg/L	0.028	0.028	0.051	0.005
Cobalt	mg/L	0.006	0.002	0.018	<0.001
Copper	mg/L	0.003	0.002	0.008	<0.001
Lithium	mg/L	0.018	0.012	0.066	0.003
Manganese	mg/L	0.316	0.123	1.350	0.029
Molybdenum	mg/L	0.004	0.001	0.009	<0.001
Nickel	mg/L	0.030	0.006	0.140	0.002
Selenium	mg/L	0.010	0.010	0.010	<0.010
Zinc	mg/L	0.362	0.037	1.360	<0.005
Iron	mg/L	0.145	0.145	0.160	<0.050
Note: Beryllium, Cadmium, Chromium, Lead, Silver, Tin, Uranium and Vanadium reported below their limits of reporting.					

5.5.2 King Brown

Ground water qualities at King Brown are saline (Table 5.10) and are characterised by circumneutral pHs ranging between 7.0 and 8.4 and electrical conductivities (EC) ranging between 73,600µS/cm and 118,000µS/cm averaging 93,433µS/cm (Appendix C).

Major cations and anions are present at large concentrations with the dominant ions: chloride (up to 45,800mg/L); sodium (up to 23,900mg/L); sulfate (up to 8,330mg/L) and magnesium (up to 3,650mg/L) typical of saline environments (Appendix C).

Table 5.10: Total Dissolved Solids and Hardness at King Brown.

Bore Number	Total Dissolved Solids (TDS) (mg/L)	Classification	Total Hardness (mg/L $CaCO_3$)	Classification	TDS/EC Ratio
SXG-KBRC052	100,000	Brine	16,727	Very Hard	0.85
SXG-KBRC021	56,200	Brine	8,958	Very Hard	0.76
SXG-KBR060	71,800	Brine	11,880	Very Hard	0.81

Bore Number	Total Dissolved Solids (TDS) (mg/L)	Classification	Total Hardness (mg/L $CaCO_3$)	Classification	TDS/EC Ratio
Water can be classified by the amount of TDS per liter: Fresh water < 1,000 mg/L TDS, Brackish water 1000 to 10,000 mg/L TDS, Saline water 10,000 to 30,000 mg/L TDS and Brine > 30,000 mg/L TDS While a TDS of 5,000 mg/L is the minimum threshold for a water to be considered brine, the typical range is 30,000 to 100,000 mg/L.					

Most of the dissolved trace metals are below their detection limits (Table 5.11). Manganese and iron are elevated.

Table 5.11: Dissolved Trace Elements in Ground Water at King Brown.

Analyte	Units	Average	Median	Maximum	Minimum
Barium	mg/L	0.098	0.120	0.136	0.040
Cadmium	mg/L	0.0026	0.0026	0.0026	<0.0001
Cobalt	mg/L	0.015	0.015	0.015	<0.001
Lithium	mg/L	0.091	0.097	0.098	0.078
Manganese	mg/L	2.834	1.350	7.140	0.012
Nickel	mg/L	0.018	0.018	0.018	<0.001
Iron	mg/L	1.840	1.840	1.840	<0.050
Note: Aluminium, Arsenic, Beryllium, Chromium, Copper, Lead, Molybdenum, Selenium, Silver, Tin, Vanadium and Zinc reported below their limits of reporting.					

5.5.3 Golden Orb

Ground water quality at Golden Orb is saline (Table 5.12) and characterised by a circumneutral pH at 7.3 and electrical conductivity (EC) at 29,900µS/cm (Appendix C).

Major cations and anions are present at large concentrations with the dominant ions: chloride (up to 2,590mg/L); sodium (up to 1,540mg/L); sulfate (up to 632mg/L) and magnesium (up to 251mg/L) typical of saline environments (Appendix C).

Table 5.12: Total Dissolved Solids and Hardness at Golden Orb.

Bore Number	Total Dissolved Solids (TDS) (mg/L)	Classification	Total Hardness (mg/L $CaCO_3$)	Classification	TDS/EC Ratio
SXG-GOR055	17,700	Saline	3,463	Very Hard	0.59
Water can be classified by the amount of TDS per liter: Fresh water < 1,000 mg/L TDS, Brackish water 1000 to 10,000 mg/L TDS, Saline water 10,000 to 30,000 mg/L TDS and Brine > 30,000 mg/L TDS While a TDS of 5,000 mg/L is the minimum threshold for a water to be considered brine, the typical range is 30,000 to 100,000 mg/L.					

Most of the dissolved trace metals are below their detection limits (Table 5.13). Manganese is slightly elevated.

Table 5.13: Dissolved Trace Elements in Ground Water at Golden Orb.

Analyte	Units	Average	Median	Maximum	Minimum
Barium	mg/L	0.025	0.025	0.025	0.025
Cadmium	mg/L	0.0005	0.0005	0.0008	0.0001
Cobalt	mg/L	0.003	0.003	0.005	0.001
Copper	mg/L	0.002	0.002	0.002	0.002
Lithium	mg/L	0.031	0.031	0.0380	0.025
Manganese	mg/L	0.143	0.143	0.224	0.063
Molybdenum	mg/L	0.004	0.004	0.004	<0.001
Nickel	mg/L	0.006	0.006	0.010	0.003
Selenium	mg/L	0.010	0.010	0.010	0.010

Analyte	Units	Average	Median	Maximum	Minimum
Uranium	mg/L	0.002	0.002	0.002	<0.001
Zinc	mg/L	0.016	0.016	0.024	0.008
Note: Aluminium, Arsenic, Beryllium, Chromium, Lead, Silver, Tin, Vanadium and Iron reported below their limits of reporting.					

5.5.4 Physical Chemical Assessment

Ground water, on the basis of concentrations of calcium and magnesium, can be classified as fresh to saline (brine) and slightly to very hard (Tables 5.9, 5.10 and 5.12) indicating elevated concentrations of both calcium and magnesium.

5.5.5 Hydrogeochemical Assessment

Hydrogeochemical processes were evaluated using a Piper Diagram (Figure 5.13). Ground waters, according to their water quality affinity and locations were classified into nine groups (Table 5.14).

Table 5.14: Groundwater Groups for Hydrogeochemical Assessment.

Borehole ID	Group Number
Marda Central	
SXG-ME011	1
SXG-PYRC064D	2
SXG-MCR001	6
SXG-MCR002	7
SXG-MCR003	7
SXG-MCR004	7
SXG-DUDD001	9
King Brown	
SXG-KBRC052	3
SXG-KBRC021	4
SXG-KBR060	5
Golden Orb	
SXG-GOR055	8

A single water type is dominant across the area: a Cl-Na type which is associated with end point (brackish/saline) waters indicative of stagnant ground water receiving little, if any, recharge from rainfall. SXG-MCR002 falls under the Cl-SO_4 type, indicating waters at this location are derived from mixing.

6. Impacts of Mining

6.1 Acid Mine Drainage

All the wastes are classifiable as benign. In the unlikely event that any fresh rock waste with visible sulphides be located during mining, it is recommended that fresh waste be buried within the waste rock facility or returned to the pit after completion of mining. No additional test work is required. Apart from the possibility of encountering fresh rock if mining proceeds below currently planned levels, it is safe to predict that no wastes from this project will produce Acid Mine Drainage (Rapallo, 2013a, b and c).

6.2 Surface Water

Owing to the topographic location and elevations of the proposed open pits and related mine infrastructure coupled with the absence of streams, flooding is unlikely.

Clean storm runoff will be diverted around the areas of disturbance. Rain falling within the perimeters of the open pits, the processing plant and the TSF will be collected, retained, and managed by:

- Bunds and water collection and retaining structures i.e. ponds.
- Treatment of contained runoff by settling of silt and removal of hydrocarbons, where required.
- Discharge treated runoff water to the process water ponds and/or reuse water for dust suppression.

The impacts from rainfall are considered negligible and no special mitigation and/or management measures will be required.

6.3 Ground Water

GDE's are absent at Marda Central and Golden Orb due to deep ground water levels. Whilst GDEs may occur at King Brown where shallower ground water levels prevail, they are unlikely to be present since ground water at this location is structurally controlled and generally encountered in weathered and fractured bedrock deeper than 15m. These observations should be confirmed by a vegetation assessment.

The depth to ground water is paramount in assessing the impact of mining on ground water. Since mining will utilise/exploit ground water resources, impacts on the ground water regime and potential users pertain to:

- Abstraction of ground water at Marda to supply water to the processing plant and camp (treated).
- Infiltration of water from surface impoundments such as the TSF to ground water.
- Dewatering at King Brown and elsewhere if mining intersects the ground water level.
- Pit lakes at closure where mining intersected the ground water level.

6.3.1 Construction

Construction of the Project is unlikely to impact on ground water levels, aquifer yield and/or ground

water quality. Water required for construction earthworks may be sourced from the existing bore at Marda, the proposed new bores at Marda or the proposed bore(s) at King Brown, which is recommended to commence dewatering six months ahead of mining.

6.3.2 Operations

Marda Central

Detailed estimations indicated that drawdowns and the cone of abstraction may extend as far as 550m from the proposed open pits. This is well within the tenement boundaries. The average groundwater level across this tenement approximates 60mbgl and the drawdown as a result of dewatering at the deepest pit (Dolly Pot) will be 21m. This drawdown will not have any impacts on vegetation or other downstream users in the area.

The small foot print and operating the TSF with a minimum water pool and storage in the return water dam to maximise return to the plant (and recycling of water) will result in localised and limited infiltration into the underground. The impact will be limited and is expected to be laterally within close (less than 100m) proximity to the TSF. Infiltration from the TSF is therefore unlikely to impact markedly on the deep ground water levels other than to increase storage in the shallow soils and fractures, and is unlikely to impact on bore and/or aquifer yields. Owing to the elevated salinities of ground water, impacts on water quality, in the absence of acid mine drainage, are considered inconsequential.

Water quality in the aquifer is fresh to brackish and abstraction, dewatering/influx and infiltration at the TSF are unlikely to cause impacts on ground water quality.

King Brown

The impact of dewatering at between 24L/s (initial rate) and 5L/s (after 6 months) is expected to be limited to within 780m from the open pit. This impact, estimated at up to 39m drawdown in the ground water level, may extend beyond the northern boundary of Tenements M77/931 and M77/646. Since this impact is upstream of the open pit and in the absence of other users within the radius of influence, this impact is regarded as inconsequential and of short duration (less than 18 months), which will not require mitigation.

Mine influx water at King Brown will be used for construction earthworks, dust suppression or pumped to Marda Central for use in the process plant, alternatively, disposed of by means of natural or mechanical evaporation.

Golden Orb

The impact of dewatering at between 4L/s (initial rate) and less than 1L/s (after 6 months) is expected to be limited to within 740m from the open pit. This impact, estimated at up to 30m drawdown (from a standing water level of 62m below surface) in the ground water level will extend beyond the eastern perimeter of Tenement M77/962. In the absence of other users within the radius of influence, this impact is regarded as inconsequential and of short duration (less than 18 months) and will not require mitigation.

Mine influx water at Golden Orb will be used for dust suppression.

6.3.3 Closure

Marda Central

A pit lake of up to 15m in depth, is likely to develop after closure at the Dolly Pot open pit. The Goldstream open pit does not intersect the regional ground water level. At the Python and Dugite open pits, deep ground water levels and little influx subject to large evaporation are likely not to cause pit lakes after closure (refer Figures 5.9 and 5.10).

The DPaW advised that they have concerns about pit voids containing water (pit lakes) on land it manages where these may cause unacceptable public liability issues (public safety) and or potential impacts on biological values that may occur if grazing animals congregate causing indirect impacts by over grazing are not relevant due to deep pit lake levels.

Closure designs should address these concerns.

King Brown

A pit lake at King Brown is inevitable due to shallow ground water levels and a deep pit. The closure designs of this pit should take cognisance of this.

Golden Orb

A pit lake at Golden Orb is inevitable due to the depth of this pit. The closure designs of this pit should take cognisance of this.

Summary of Risks, Impacts and Management Measures

The impacts and their risks (methodology may be found in Appendix D) with proposed management measures are summarised in Table 6.1:

Table 6.1: Summary of Impacts and Management Measures.

Issues/Impacts	Potential Risk			Comment/Proposed Control	Residual Risk		
	Consequence	Likelihood	Rank		Consequence	Likelihood	Rank
Exploration for Ground Water Supplies							
Secure supply for mining and processing	3	1 - 2	L - M	Existing high yielding bore. Suitable targets within mining leases. Assessment by drilling, testing and sampling to verify yield, water quality and sustainability.	L		
Mining and Processing							
Acid Mine Drainage							
No anticipated Impacts/risks				None	None		
Surface Water and GDEs							
-				Devise appropriate surface water management (erosion and sediment control) and monitoring plan.	-		
Stream diversion	2	2	L	No diversion required. Separation of clean and dirty water systems.	L		

Issues/Impacts	Potential Risk			Comment/Proposed Control	Residual Risk		
	Consequence	Likelihood	Rank		Consequence	Likelihood	Rank
Deterioration of water quality in small creeks	3	1	L	Sufficient storage capacity; contain dirty runoff. Zero discharge.	L		
Reduction in volume of surface water	3	1	L	Surface water assessment for separating clean and dirty catchments with the view to minimise the latter.	L		
Impact on base flow, increase/decrease flow to/from GDEs, impact on biota	3	1	L	No hydraulic connection between creeks and underlying fractured rock aquifers with deep ground water levels.	L		
Ground Water: Abstraction (Bore Field) and Mining and Processing (Influx and Dewatering Management)							
-				Devise appropriate ground water management and monitoring plans for: ▪ Ground water abstraction from bore fields. ▪ Mine influx and seepage from mine plant and related infrastructure: Open Pits and TSF.	-		
Impact on aquifer yield Impact on ground water level drawdown	3	3	S	Impacts localised and anticipated to be short to medium term. Water quality in general brackish to saline. Influxes and dewatering rates generally low; evaporation large. Ascertain hydraulic characteristics by drilling, testing and sampling. Ground water modelling to set operational controls with the view to manage impacts of abstraction and influx.	L		
Impact on water quality	2	2	L				
Mining and Processing Infrastructure							
-				Devise appropriate ground water management and monitoring plans for mine/process waters.	-		
Open Pits	3	3	S	Impacts localised and anticipated to be short to medium term. Confirm pit lake and geochemical modelling and post closure impacts and provide appropriate mining and rehabilitation and closure criteria.	L		
Seepage from WRDs, TSFs, stockpiles, surface impoundments	3	3	S	Contain by appropriate investigation, engineering design and construction.	L		
Rehabilitation and Closure							
Residual Impacts: Pit Lakes	1	3	L	Mining and processing to be undertaken with the view to minimise residual impacts. Short to medium duration of ground water level return to pre-mining levels. Pit lakes with little, if any migration of pit waters, acting as evaporative sinks. Monitoring and take appropriate corrective action where and if required.	L		
Notes: Rank: S denotes Significant, M Moderate and L Low.							

7. Management and Monitoring

A water monitoring plan is to be implemented. The location of sampling locations, the proposed frequency of water level monitoring and collection of samples, as well as the parameters to be measured and the testing to be undertaken on the water samples by laboratory analysis as well as on-site field testing for internal operational control and management are detailed below:

Table 7.1: Water Monitoring.

Monitoring and Quality		
Responsibility	Manager:	SXG: to be appointed.
	Assisted by:	SXG: to be appointed.
Policy	Initiate and maintain monitoring of the ground water regime (quality and water levels) at appropriate locations throughout construction and thereafter until closure. Minimise the risk of contaminated waters and effluents to leave the mine at any time including during flood events not exceeding a frequency of 1 in 100 years. All water (including rain and storm runoff) is to be treated appropriately and shall not be released into the environment unless such releases can take place under controlled conditions.	
Performance Criteria	To be developed during project implementation: Site specific ambient ground water quality. Site specific trigger values are be developed prior to mining using ambient water qualities from baseline monitoring and reference sites taking due cognisance of the above water quality objectives and guidelines. In addition to the above, water discharged shall have no visible surface films, oils and greases, Total Petroleum Hydrocarbons, litter or suspended matter.	
Implementation Strategy	**General**	The following will be undertaken to facilitate the effective implementation of the management plan: ▪ Provision of site diaries and monitoring proformas will be provided in hard copy and electronic format. ▪ Schedule sampling events appropriately as required.
	General Conduct and Reporting	Samplers shall undertake the following: Liaise with mine and plant managers frequently regarding construction and operations activities and treatment regimes to facilitate appropriate sampling and validation programs. Keep a detailed record of observations and measurements made during sampling events. Baseline or investigative monitoring undertaken during establishment of the bores and then at the end of the current dry season and again at the end of the next wet season. The main purpose of this monitoring is to gather baseline data prior to operations to further characterise the quality of the local groundwater, and most importantly, establish a benchmark for assessing any medium to long term trends and variability in groundwater quality.
Monitoring	**Activity**	Sampling surface water impoundments and ground water monitoring bores and potential sources of contaminants.

Monitoring and Quality		
	Parameters	Rainfall (gauge at each Project area). Rate of flow/discharge (estimate). Depth of water in impoundment. Depth to ground water level. Hydrochemical: General field *in situ* water quality measurements: pH, Temperature, Salinity, Dissolved Oxygen, Oxidation Reduction Potential including observations such as odour, colour, etc.) For analyses by a NATA accredited laboratory: Electrical Conductivity (µS/cm). Total Dissolved Solids (TDS, mg/L). Major anions (Cl, SO_4, CO_3/HCO_3, NO_3-N; mg/L). Major cations (Ca, Mg, Na and K; mg/L). Dissolved metals (Al, As, B, Cd, Cr, Cu, Mn, Ni, Pb, Zn, Fe; µg/L). Nutrients (Total Phosphorus, Ammonia, Nitrite and Nitrate; mg/L).
	Where	Surface water: up- and downstream of mine infrastructure, impoundments at the processing plant and at the TSF. Ground water production and monitoring bores.
	Frequency	**Construction and operations:** Rainfall: daily. Surface water: during and after rain/flow events and/or monthly in impoundments Depth to ground water level: monthly for the first two years to better understand the impacts of wet and dry seasons at the site; quarterly or bi-annually thereafter. Hydro-chemical: ▪ Surface water: during and/or after rain/flow event; impoundments (plant and TSF): monthly or as required. ▪ Ground water: quarterly and or seasonally (bi-annually). **Post Closure:** Depth to ground water level: bi-annually for two years. Hydro-chemical: ▪ Surface water: impoundments, if any: bi-annually. ▪ Ground water: seasonally (bi-annually) for two years.
Compliance	Monitoring data are to be assessed annually to ensure compliance with performance criteria.	
Reporting	The Plant Manager, or nominee, shall record all monitoring results of which a record shall be kept on site for inspection and review by DoW. Tabulations and graphs are to be compiled with brief notes on exceptions; these shall be included in any site audits to be undertaken. The data and information gathered during these monitoring programs are to be used to assess potential impacts of operations on downstream water qualities using comparisons against ambient water qualities and relevant standards and guidelines, trend diagrams, etc. Records and reports, including a final summary, are to be included in the Annual Environmental Review. Where a potential non-conformance event with potential environmental impacts has occurred, the Plant Manager, or nominee, shall notify DoW (by telephone to be followed by facsimile or e-mail within 24 hours) of the nature of the event, the measures implemented to prevent recurrence and any outcomes.	

Monitoring and Quality	
Incident/Failure	Examination of works for evidence of deteriorating water quality.
Corrective Action	Variations by more than 10% trigger further assessment, re-sampling to ascertain repeatability and, if required, site investigations to ascertain cause, impact, remediation and preventative action. Corrective actions will be ascertained and implemented immediately where an identified action or situation has the potential to impact on ground water.
Contingency Plan	At all times during construction and operations, plant, equipment and chemicals are to be operated, handled and maintained in strict accordance with the specifications of manufacturers to ensure that potential non-conformances and hazardous situations are inhibited. Identified controls are to be implemented to ensure immediate response should the need arise.
Complaints	Complaints from the general public and/or neighbours will be treated with respect. The Plant Manager, or nominee, shall maintain a Complaints Register. Complaints will be referred to the appropriate site manager who will direct an appropriate course of action relating to the concern. The Register shall be included in audits and shall record the date and time of the complaint, the name and contact details of the person raising the complaint, the nature of the complaint, the action taken, the details of the person responsible for action and resolution of complaint including actions taken to prevent recurrence. The Plant Manager shall certify each entry on the record.

8. Conclusions and Recommendations

8.1 Conclusions

Surface waters are not considered a source of water to the Project largely due to the ephemeral character of the streams and low rainfall. However, an erosion and sediment control plan will be required to ensure that mining and related activities do not impact on downstream receiving environments. Impacts by rain and/or flooding are considered inconsequential due to the topographic locations of the open pits and mine infrastructure.

Waste characterisations indicated that it is unlikely that acid mine drainage will occur at the Project.

Adequate ground water resources are available to meet the water requirements of the Project. There are no anticipated negative impacts from the water extraction and dewatering activities related to the Project due to the depth to groundwater and the absence of downstream users. The primary impact pertains to the potential for pit lakes to form after closure at Marda Central where the open pits are located within a proposed Section 5(1)(h) Reserve. The DPaW have concerns about the risk to public health from the pit lakes and the risk to overgrazing form congregation of grazing wildlife around the water source.

8.2 Recommendations

8.2.1 Construction

Management should include:

- Develop an Erosion and Sediment Control Plan (ESCP).
- Apply timeously for Section 5C licences to the DoW for taking water for construction and mine operations and undertaking dewatering upon completion of the drilling, testing and sampling programs.
- Ground water modelling to ascertain sustainability of the aquifers and zones of ground water impacts by dewatering and infiltration from the TSF.
- Implement a water monitoring program.
- Commence dewatering at King Brown up to six months prior to mining.

8.2.2 Mining Operations

- Implement the Erosion and Sediment Control Plan (ESCP) and appropriate management and monitoring plans.
- Continuance of water monitoring program
- Further assessments of the sustainability of the production bores should include a re-appraisal of performance following three months of pumping and monitoring. Abstraction bores are to be equipped with 20mm diameter tubes attached to the pump column to allow monitoring of ground water levels. An inline flow meter is required at the pump head to monitor ground water abstraction rates and volumes.
- Monitor and assess infiltration from the TSF and potential impact on ground water levels and water quality. This should be undertaken following geotechnical and detailed hydrogeological

assessments complemented by mass transport modelling.

- Refine pit lake models and water balances as further geological and hydrogeological and monitoring data become available. These will be required to develop appropriate management measures including backfilling of the pits to a level above the standing water to avoid pit lakes if required and to consider/develop other measures to manage the risks identified by the DPaW from pit lakes at closure.

8.2.3 Closure

- Continue monitoring program.
- Monitor pit lakes and assess requirements including backfilling of the pits to a level above the standing water to avoid pit lakes if needed and consider/develop other measures to manage the risks identified by the DPaW from pit lakes at closure.

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Figures

Figure 2.1: Locality.

Figure 2.2: Regional Setting.

Figure 2.3: DEC Conservation Area.

Figure 2.4: Marda Central Deposits.

Figure 2.5: King Brown Deposit.

Figure 2.6: Golden Orb Deposit.

Figure 4.1: Marda Dam.

Figure 5.1: Marda Central Deposits – 1:100,000 DMP Geology.

Figure 5.2: 1:100,000 DMP Geological Legend.

Figure 5.3: Inferred Geological Structures at Marda Central.

Figure 5.4: King Brown Deposit – 1:100,000 DMP Geology.

Figure 5.5: Golden Orb Deposit – 1:100,000 DMP Geology.

Figure 5.6: Regional Topography and Conceptual Ground Water Profile.

Figure 5.7: Radial Influence (Cone) of Dewatering.

Figure 5.8: SEEP/W Models.

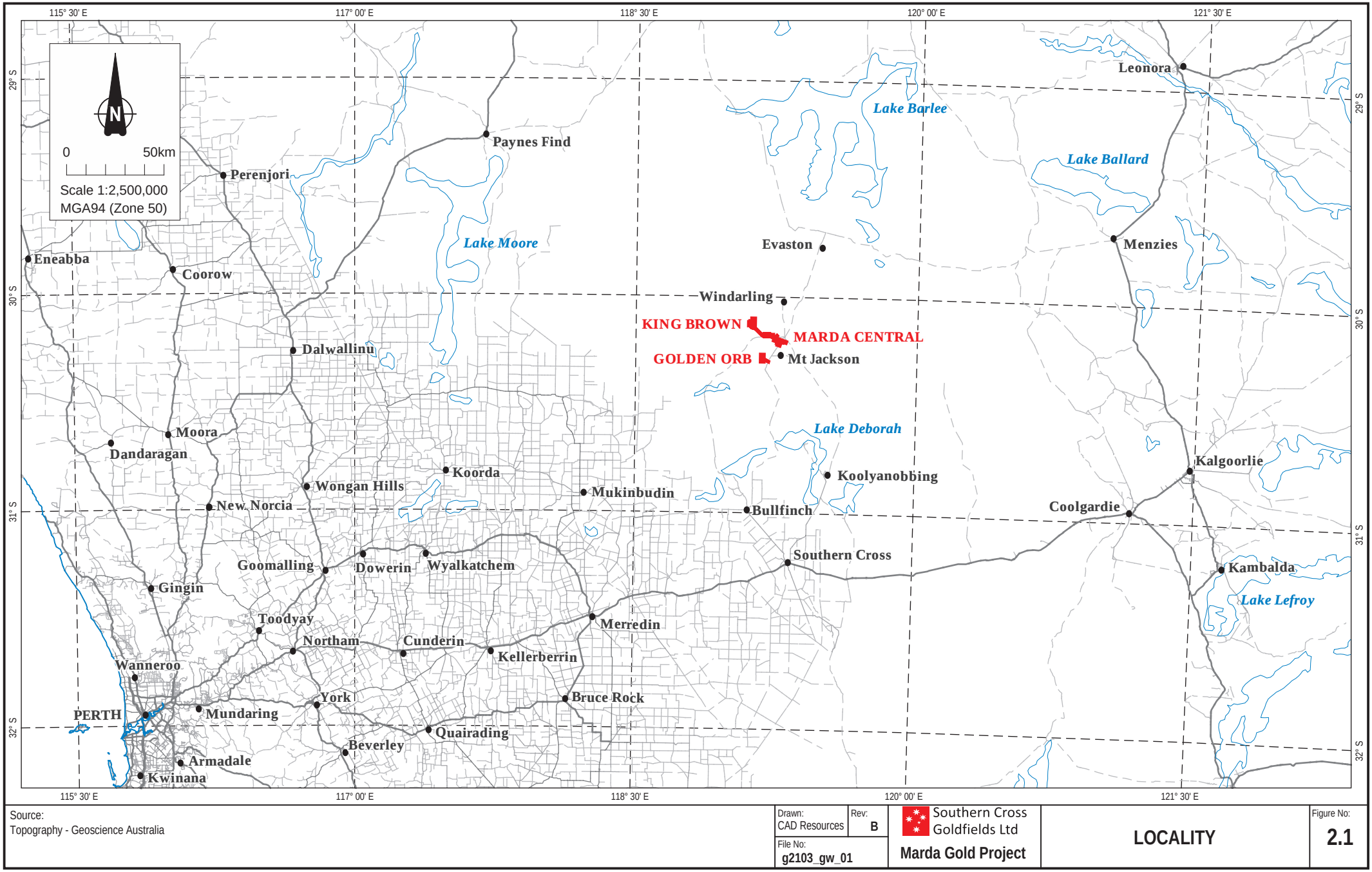
Figure 5.9: Python and Goldstream Profile.

Figure 5.10: Dolly Pot and Dugite Profile.

Figure 5.11: King Brown Profile.

Figure 5.12: Golden Orb Profile.

Figure 5.13: Piper Diagram.



Source:
Topography - Geoscience Australia

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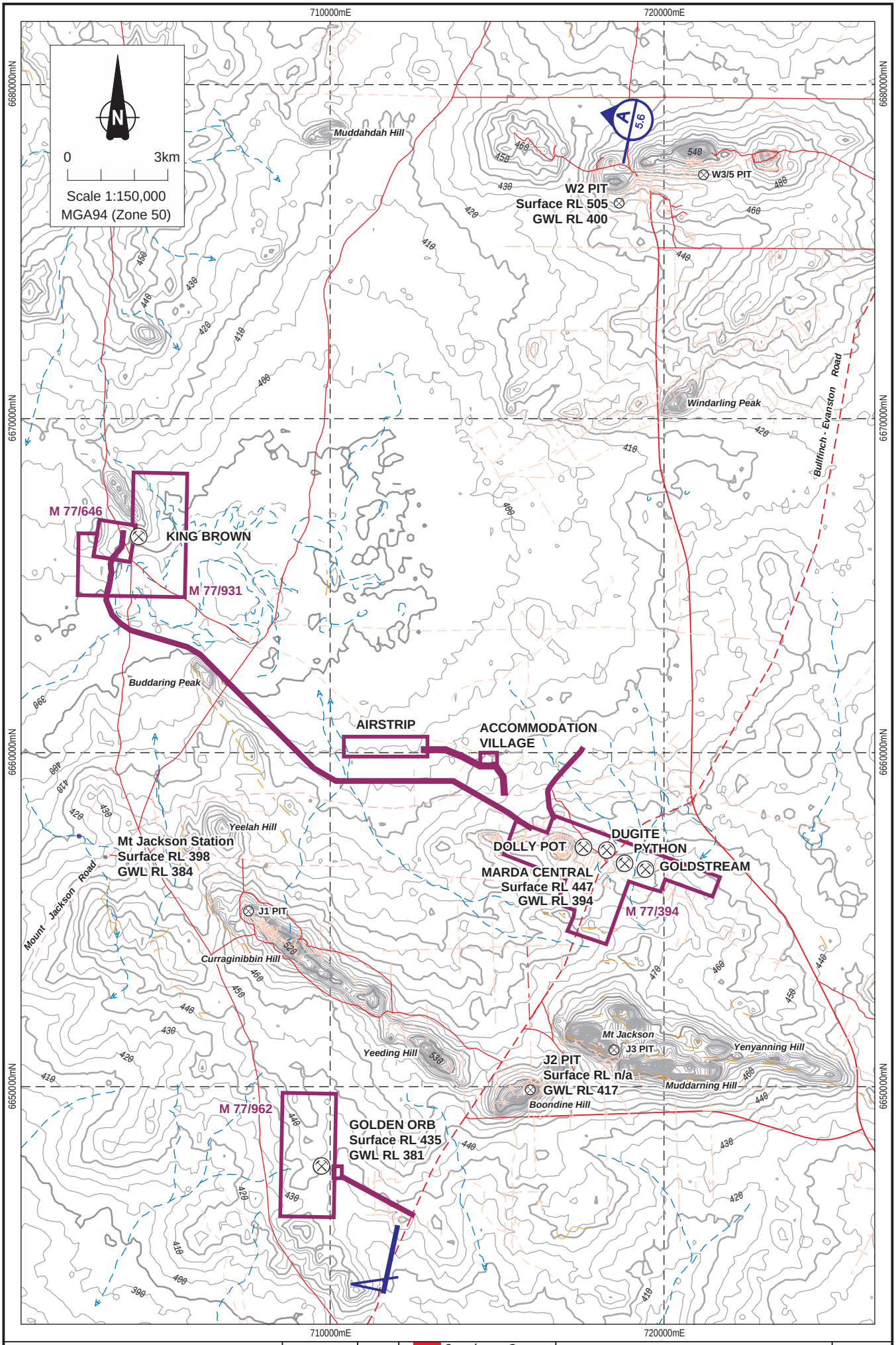
File No: g2103_gw_01		Marda Gold Project	LOCALITY



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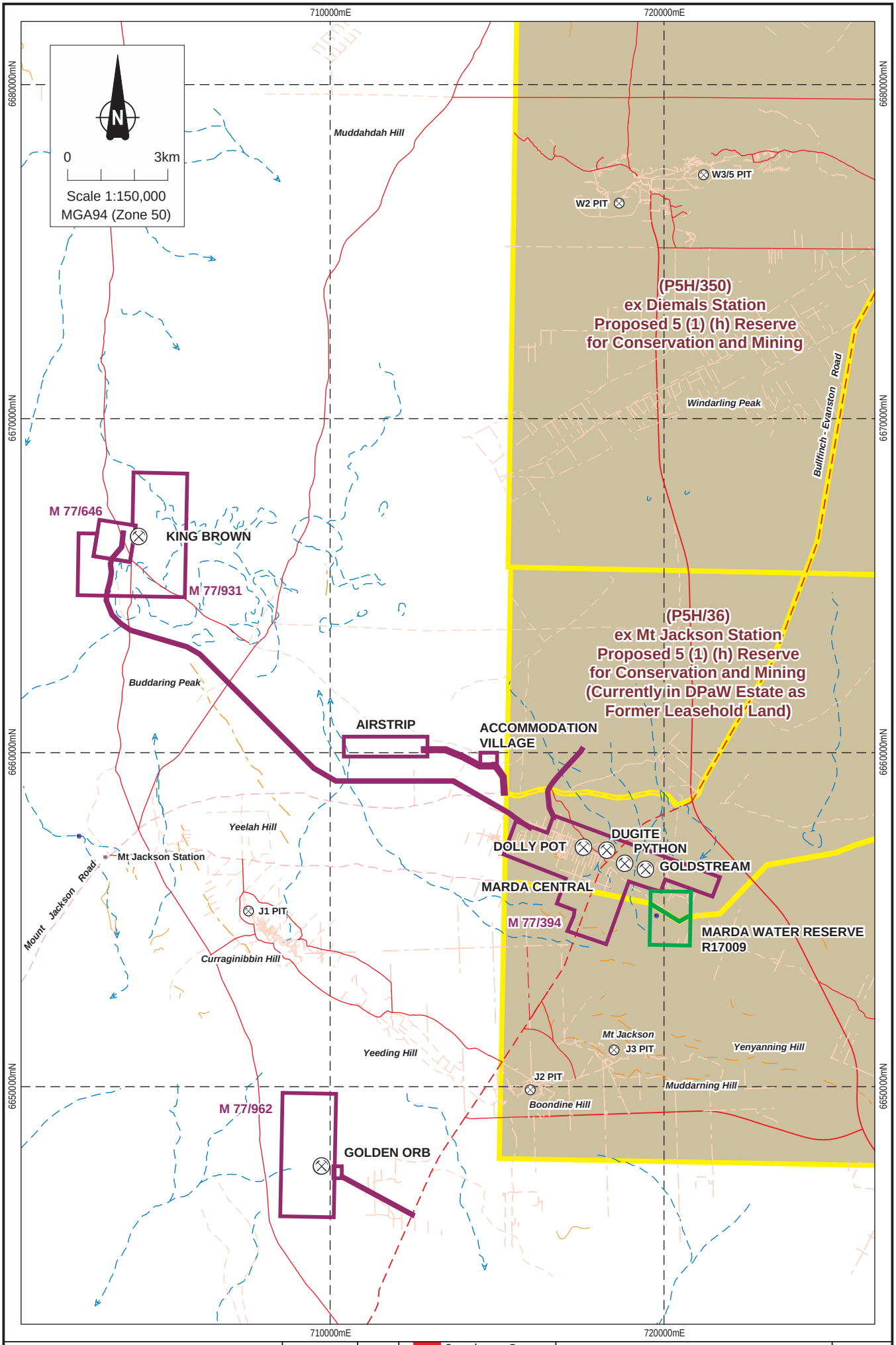
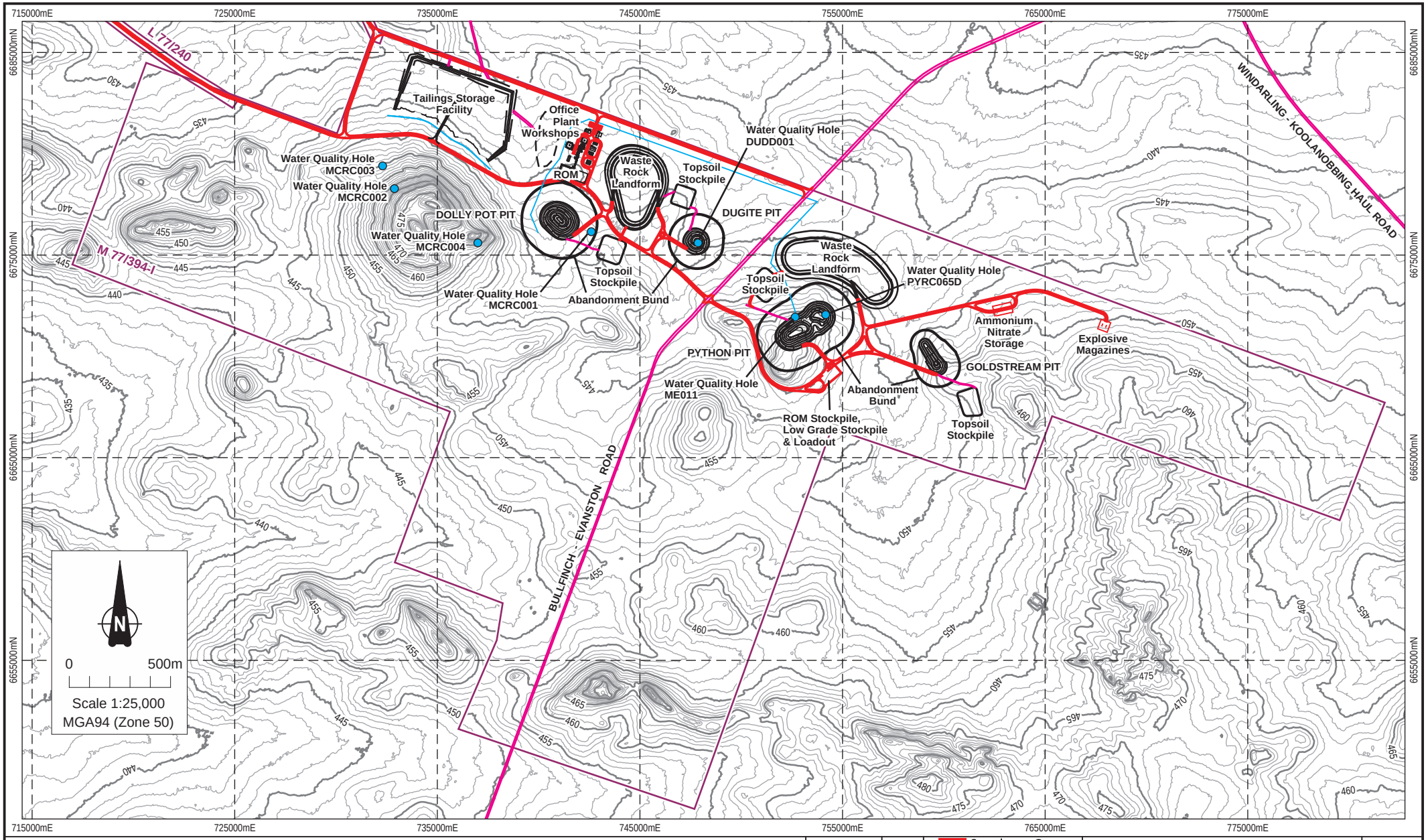


Source: Planimetry - Landgate Relief - SRTM 5m contours DPaW Estate - DPaW	GWL - SXG Tenements - DMP Reserves - Landgate	Drawn: CAD Resources File No: g2103_gw_07	Rev: B	Southern Cross Goldfields Ltd Marda Gold Project	DPaW CONSERVATION AREA	Figure No: 2.3



Source:
Relief - Fugro Spatial Services - 1m contours
Pits - Rockteam
Plant - Como Engineers

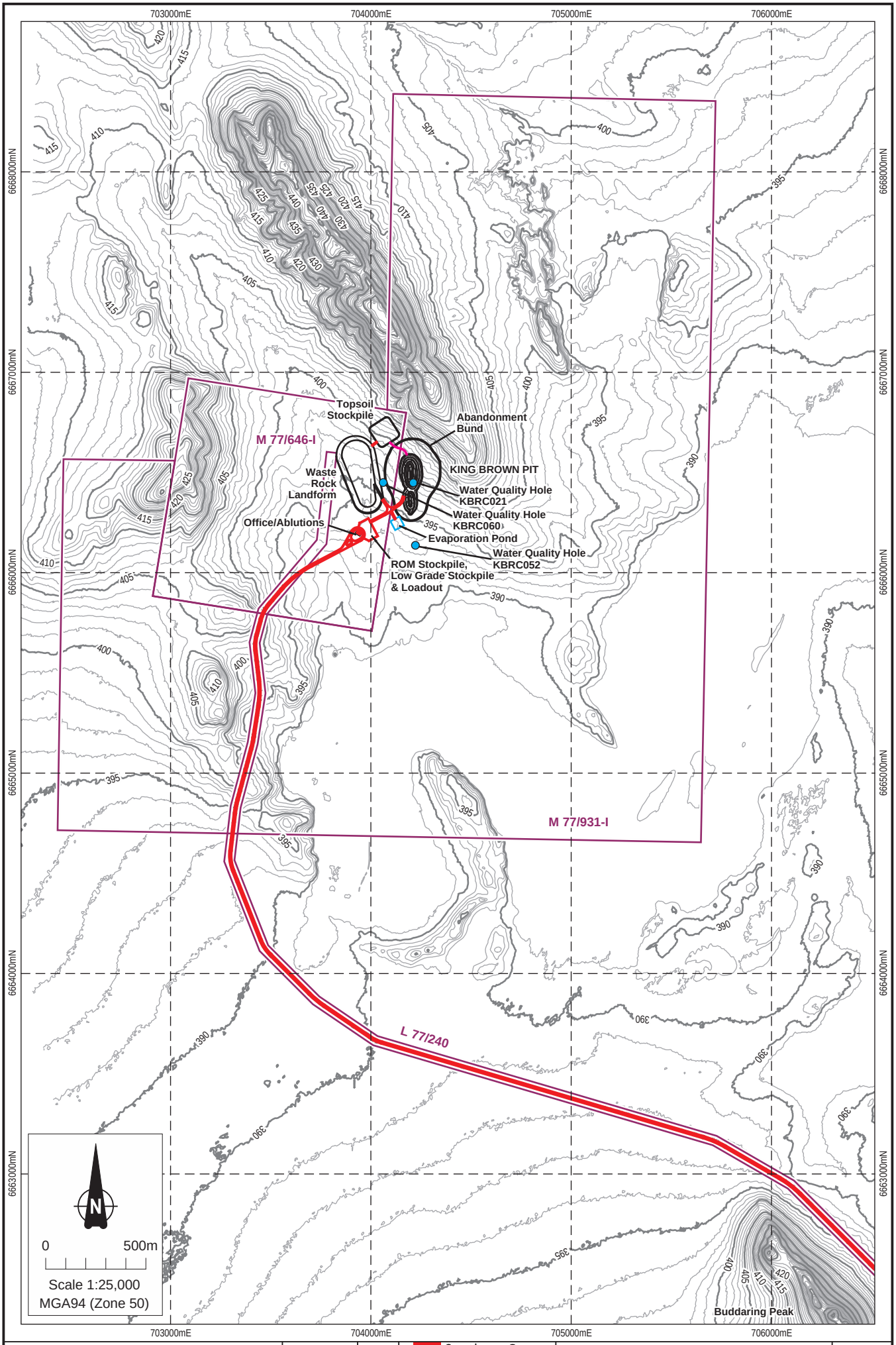
Drawn: CAD Resources	Rev: C
File No: g2103_gw_05_01	

Southern Cross Goldfields Ltd

Marda Gold Project

MARDA CENTRAL DEPOSITS

Figure No: 2.4



Source:
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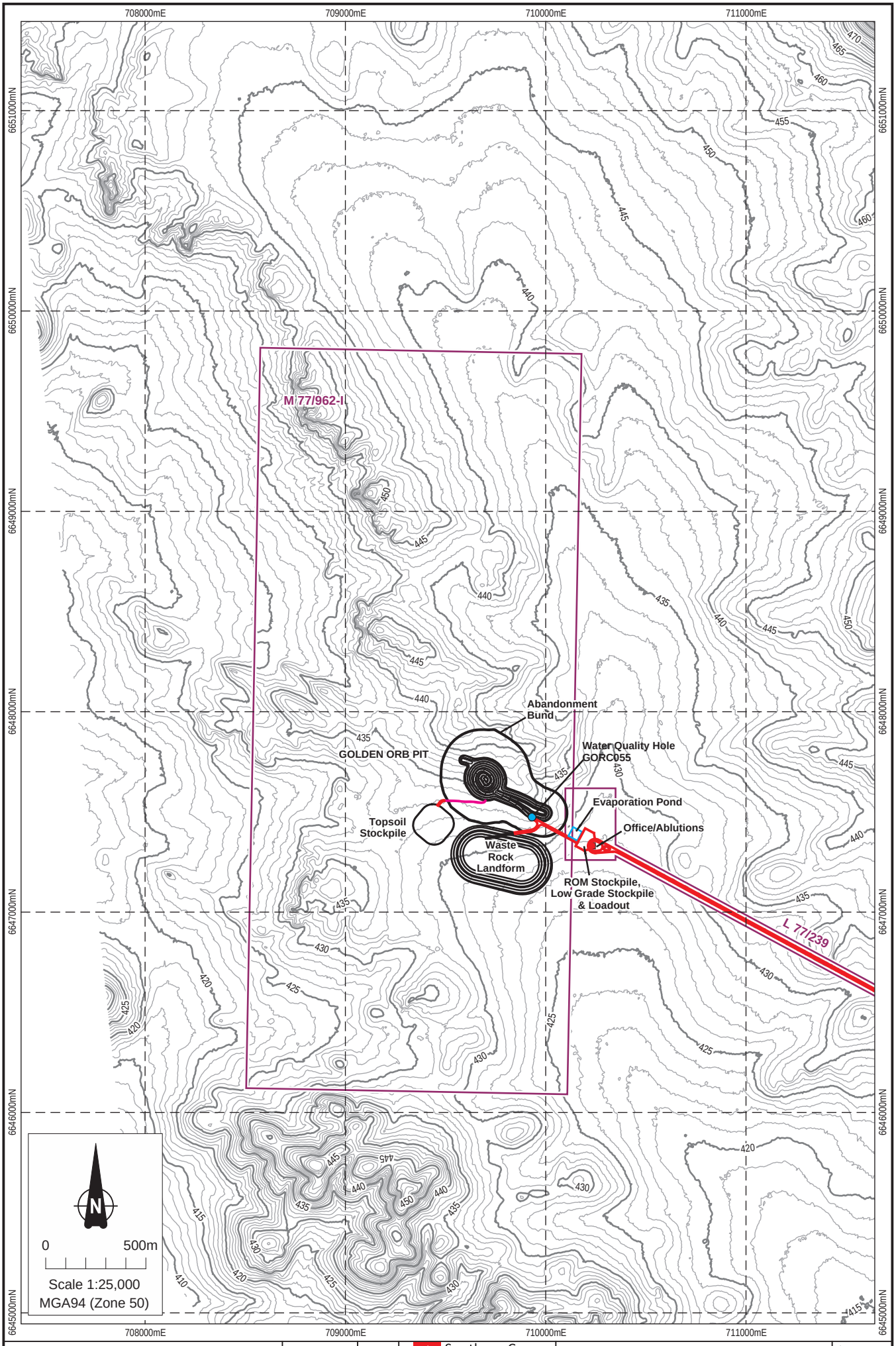
Relief - Fugro Spatial Services - 1m contours
Pits - Rockteam

Drawn: CAD Resources
Rev: C
File No: g2103_gw_05_02

Southern Cross Goldfields Ltd
Marda Gold Project

KING BROWN DEPOSIT

Figure No: 2.5



Source: Planimentry - Landgate Relief - Fugro Spatial Services - 1m contours Pits - Rockteam	Drawn: CAD Resources Rev: B File No: g2103_gw_05_03	Southern Cross Goldfields Ltd Marda Gold Project	GOLDEN ORB DEPOSIT	Figure No: 2.6

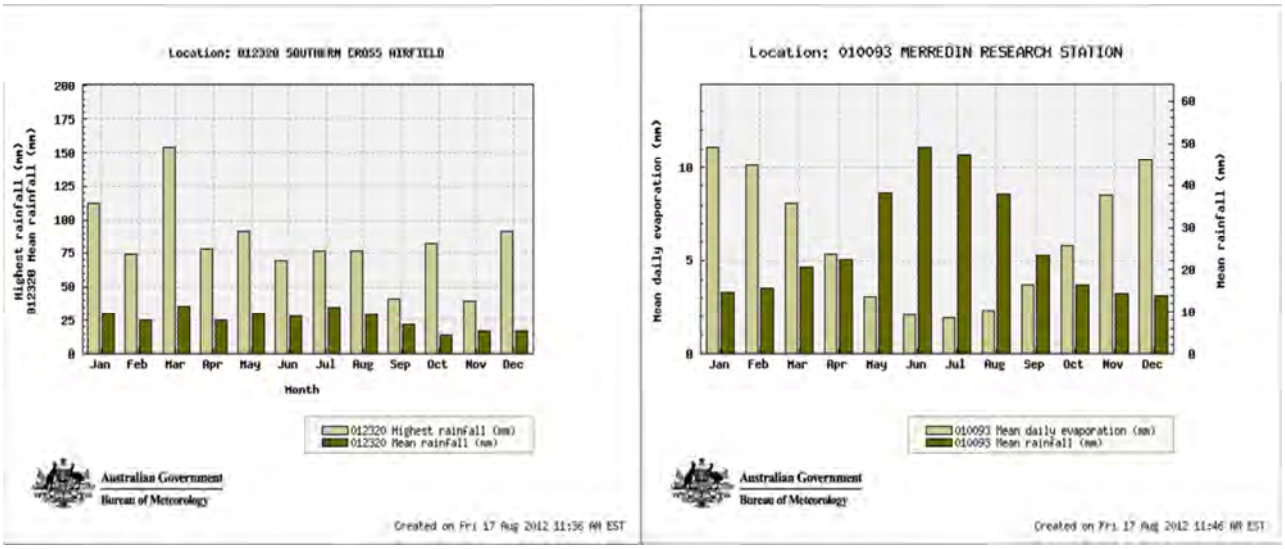
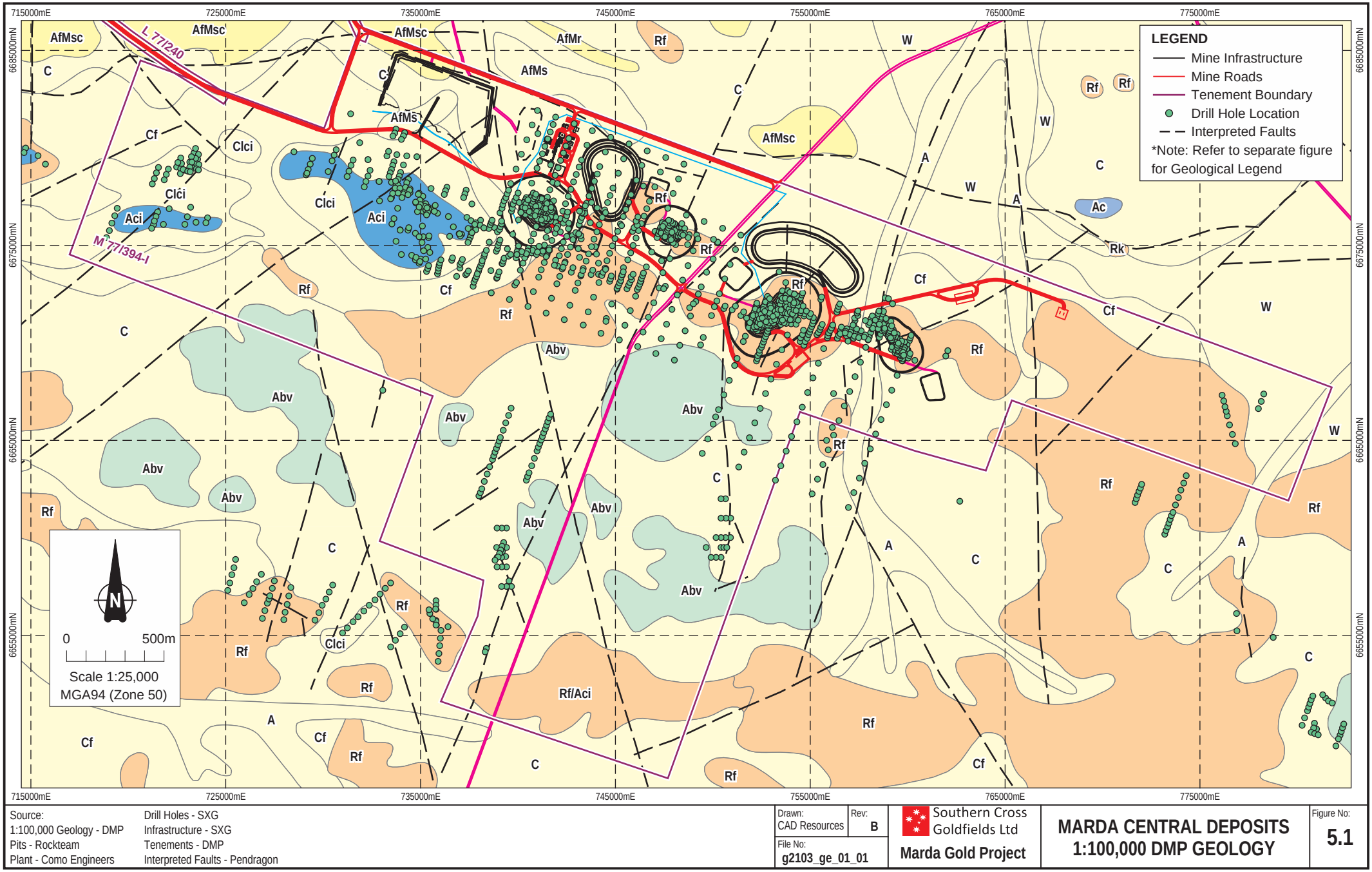


Figure 3.1: Rainfall and Evaporation.

Figure 4.1: Marda Dam.



Source:
1:100,000 Geology - DMP
Pits - Rockteam
Plant - Como Engineers

Drill Holes - SXG
Infrastructure - SXG
Tenements - DMP
Interpreted Faults - Pendragon

Drawn: CAD Resources
Rev: B
File No: g2103_ge_01_01

Southern Cross Goldfields Ltd
Marda Gold Project

MARDA CENTRAL DEPOSITS
1:100,000 DMP GEOLOGY

Figure No: 5.1

Code	Description
A	Clay, silt, sand, and gravel in channels and on floodplains
Ab	Metamorphosed mafic rock, undivided; mainly fine-grained; typically deeply weathered
Abar	Amphibolite; retrogressed to greenschist facies assemblages
Abm	Metamorphosed high-Mg basalt with relict pyroxene-spinifex and/or variolitic textures
Abmf	Strongly foliated high-Mg basalt; locally variolitic; metamorphosed
Abv	Metabasalt; massive to weakly foliated; minor metamorphosed basaltic-andesite
Abx	Metamorphosed mafic-volcanic breccia
Ac	Banded chert with minor banded iron-formation and quartzite; metamorphosed
Aci	Banded iron-formation and minor banded chert; local jaspilite; metamorphosed
AfM	Felsic volcanic and volcaniclastic rock, undivided; typically deeply weathered; metamorphosed
AfMr	Rhyolite; commonly porphyritic; metamorphosed
AfMs	Volcaniclastic and sedimentary rock, undivided; commonly weathered; metamorphosed
AfMsc	Polymictic and rhyolitic oligomictic conglomerate with minor siltstone and sandstone; commonly poorly cemented; metamorphosed
AfMss	Sandstone and minor siltstone with a common volcaniclastic component; metamorphosed
AfMx	Rhyolitic ignimbrite with minor rhyolite flows and volcaniclastic sedimentary rock; metamorphosed
Agmi	MILLARS MONZOGRANITE:quartz-rich monzogranite
Ap	Clay and silt in claypans
As	Metasedimentary rock, undivided; commonly weathered; metamorphosed
Ash	Metashale
Asq	Quartz-rich metasedimentary rock; mainly quartzite
Au	Metamorphosed ultramafic rock, undivided; typically deeply weathered
Aukf	Strongly foliated metakomatiite
Aup	Metamorphosed peridotite; typically serpentinized
Aur	Tremolite-chlorite(-talc) schist
Aux	Pyroxenite; metamorphosed
C	Mixed gravel from different rock types as proximal talus; includes sand and silt; locally ferruginous
Cf	Ferruginous gravel and reworked duricrust
Clci	Talus from banded iron-formation and chert; locally cemented
Ld	Stabilized dune deposits adjacent to playa lakes
Ll	Saline playa lake deposits
Lm	Mixed dune, evaporite, and alluvial deposits adjacent to playa lakes
q	Quartz vein
Rf	Lateritic duricrust; includes iron-cemented reworked products
Rf/Ab	Lateritic duricrust; includes iron-cemented reworked products
Rf/Aci	Lateritic duricrust; includes iron-cemented reworked products
Rf/AfMs	Lateritic duricrust; includes iron-cemented reworked products
Rf/Au	Lateritic duricrust; includes iron-cemented reworked products
Rfc	Lateritic duricrust; ironstone over ridge-forming units
Rgpg	Quartzofeldspathic sand over granitoid rock; sparse granitoid outcrop
Rk	Calcrete
W	Clay, silt, and sand; locally ferruginous
Wf	Sheetwash deposits with abundant ferruginous grit

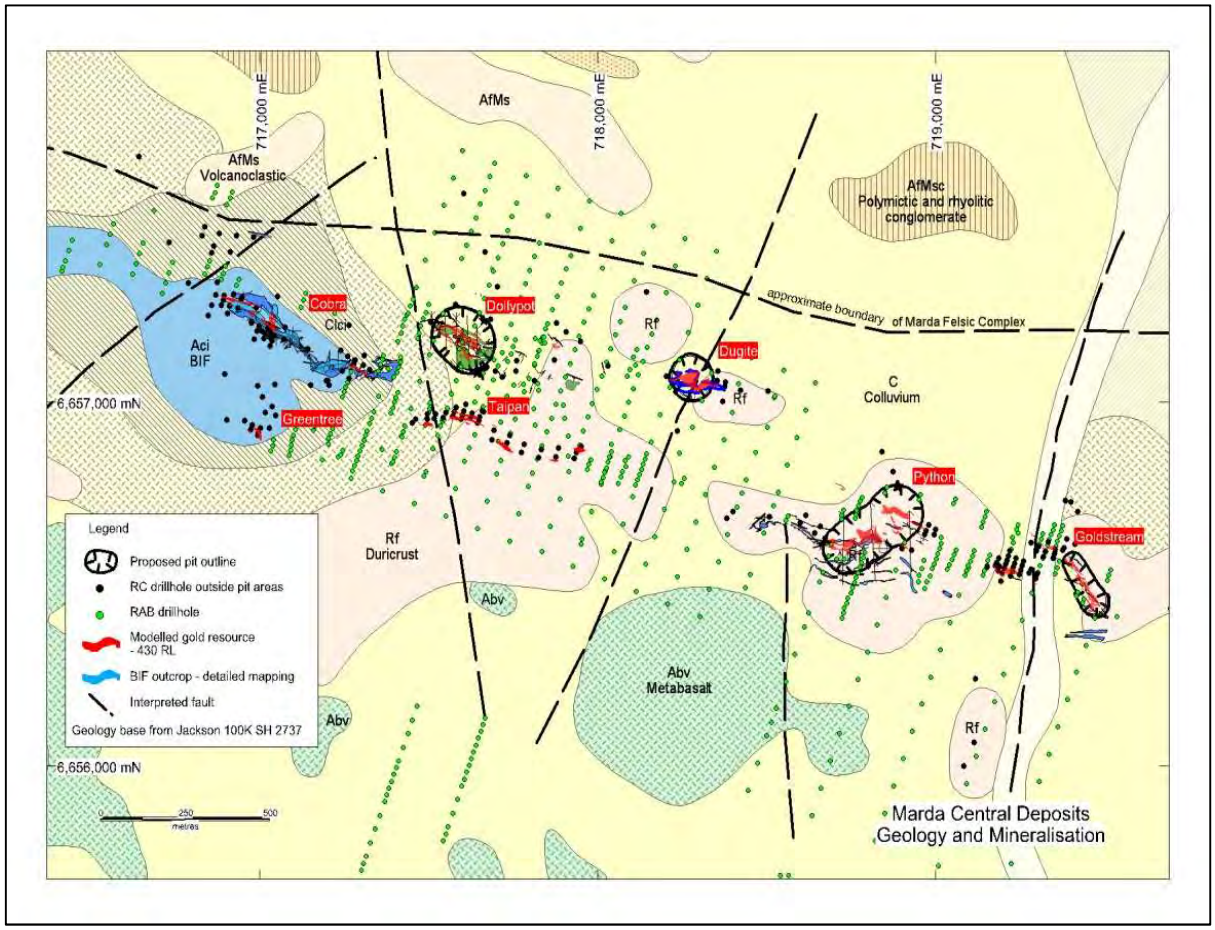
Source:
1:100,000 Geology - DMP

Drawn: CAD Resources
Rev: A
File No: g2103_ge_01_01_Leg

Southern Cross Goldfields Ltd
Marda Gold Project

1:100,000 DMP GEOLOGY LEGEND

Figure No: 5.2



Geology and Primary Structures at Marda Central.

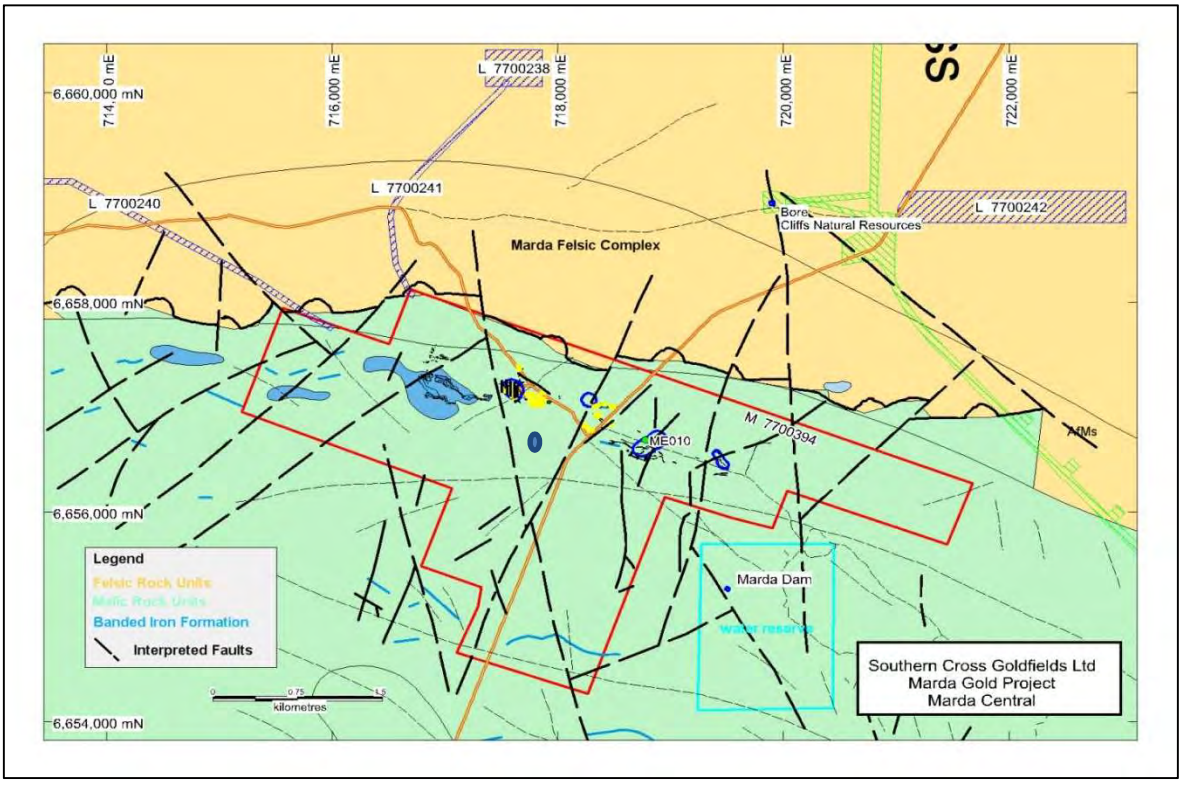
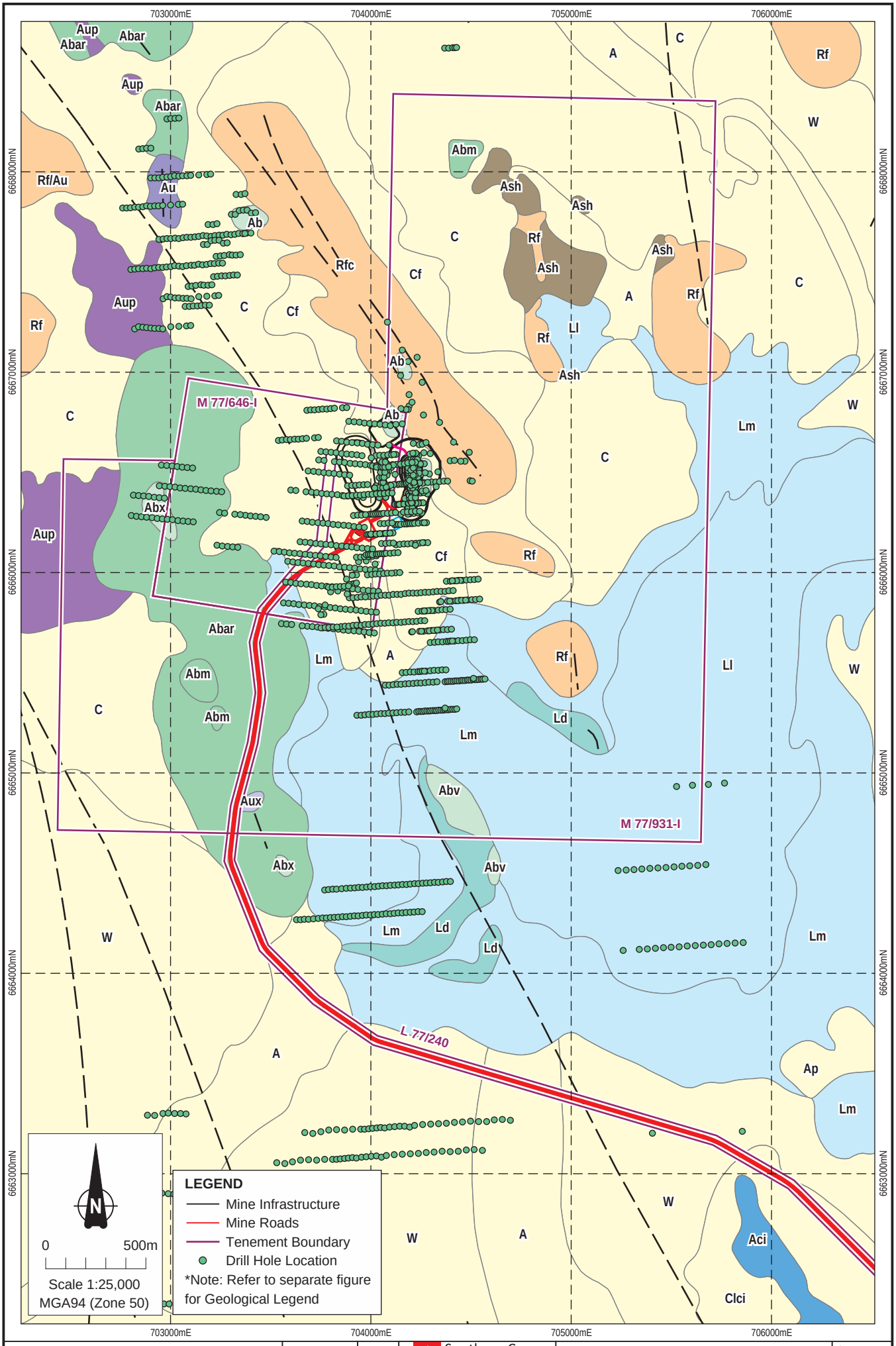


Figure 5.3: Inferred Geological Structures at Marda Central.



Source:
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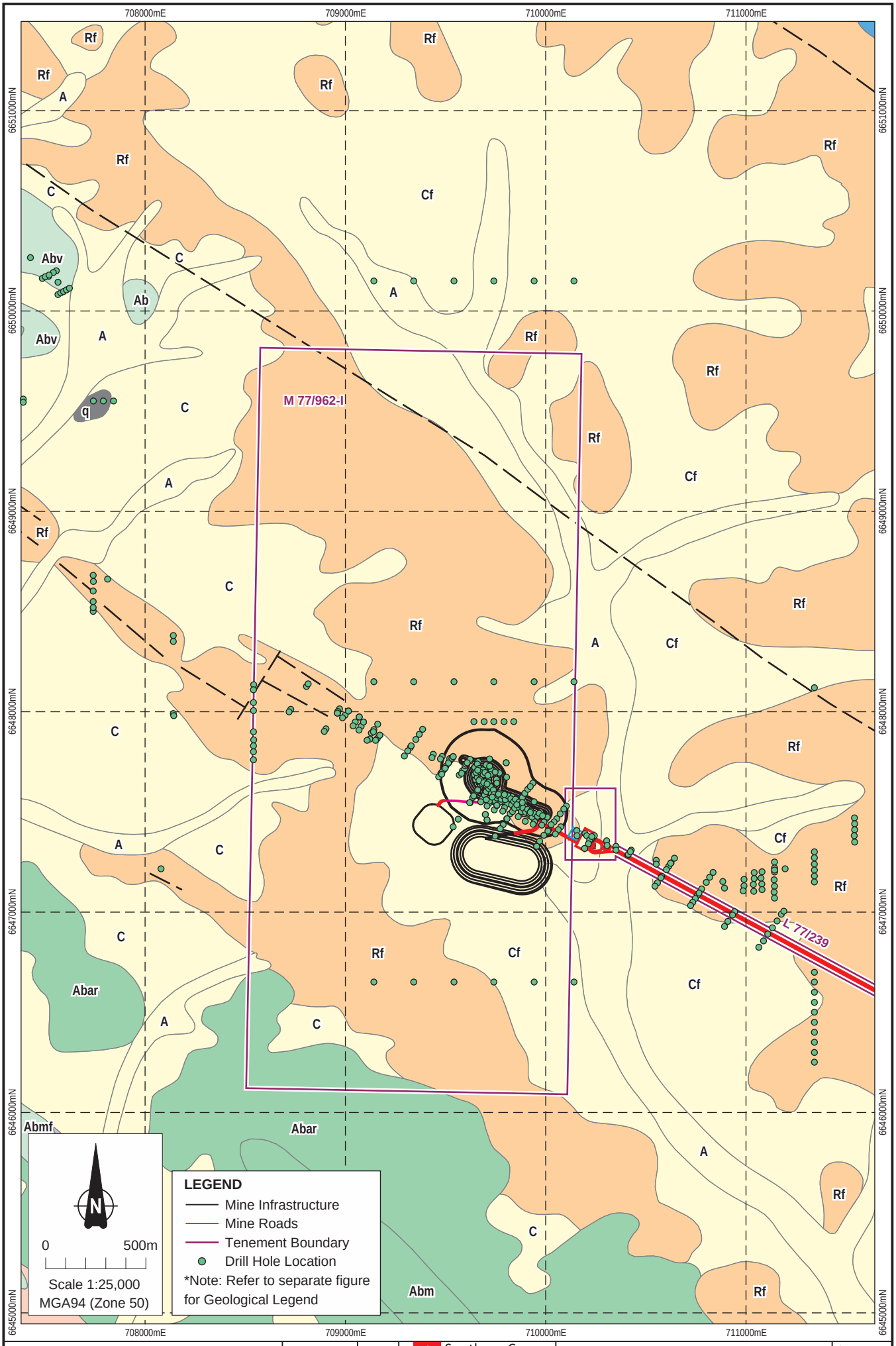
1:100,00 Geology - DMP
Pits - Rockteam
Drill Holes - SXG
Infrastructure - SXG
Tenements - DMP

Drawn: CAD Resources
Rev: A
File No: g2103_ge_01_02

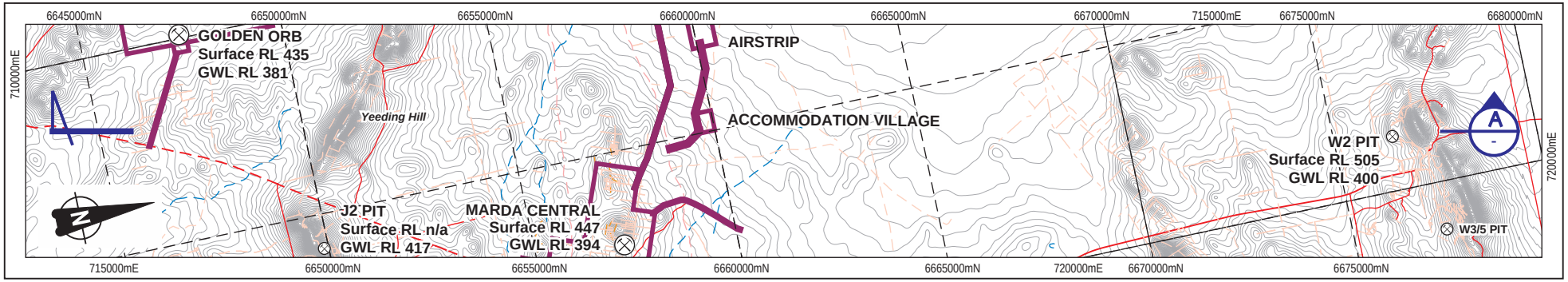
Southern Cross Goldfields Ltd
Marda Gold Project

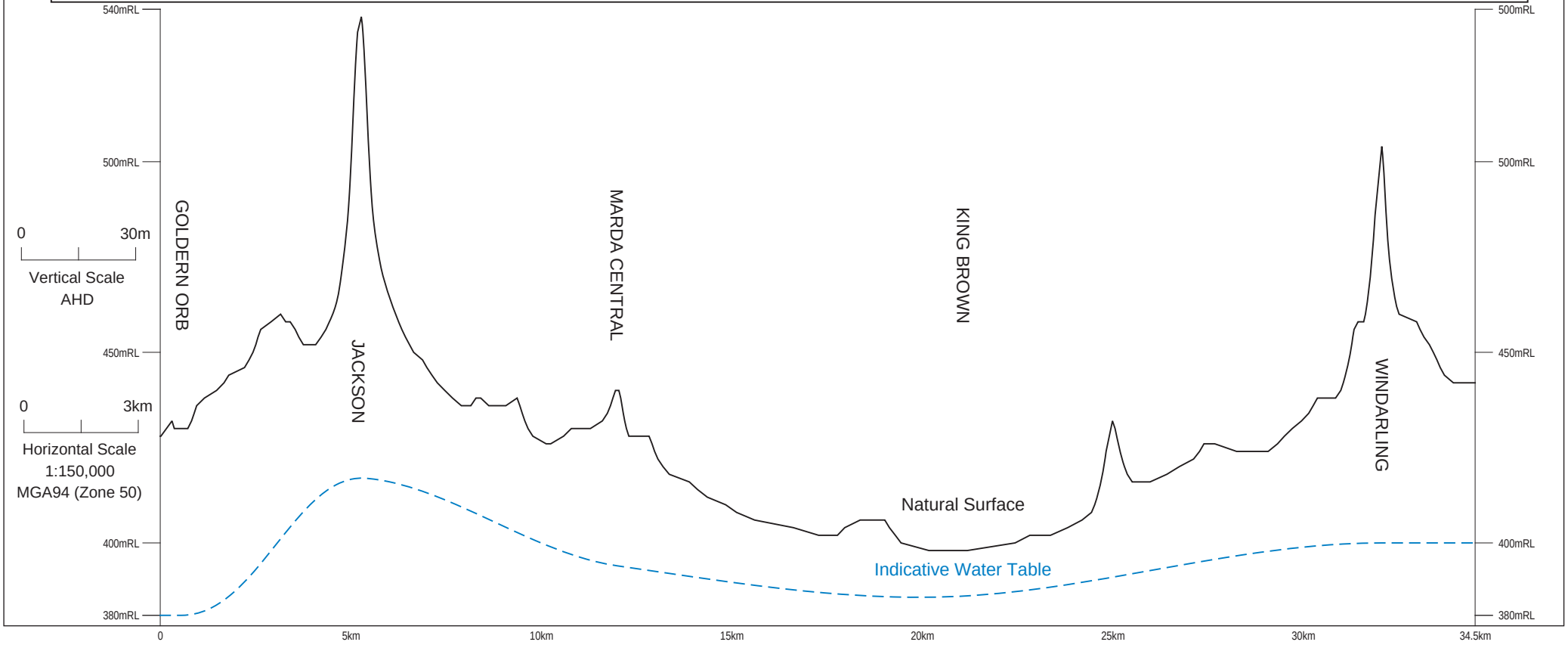
KING BROWN DEPOSIT
1:100,000 DMP GEOLOGY

Figure No: 5.4



Source: Planimentry - Landgate 1:100,000 Geology - DMP Pits - Rockteam	Drill Holes - SXG Infrastructure - SXG Tenements - DMP	Drawn: CAD Resources Rev: A File No: g2103_ge_01_03	Southern Cross Goldfields Ltd Marda Gold Project	GOLDEN ORB DEPOSIT 1:100,000 DMP GEOLOGY	Figure No: 5.5





Source: Tenements - DMP
Planimetry - Landgate
Relief - Landgate (2m contours)
GWL - SXG

Drawn: CAD Resources
Rev: B
File No: g2103_gw_03

Southern Cross Goldfields Ltd
Marda Gold Project

REGIONAL SURFACE & CONCEPTUAL GROUNDWATER PROFILE

Figure No: 5.6

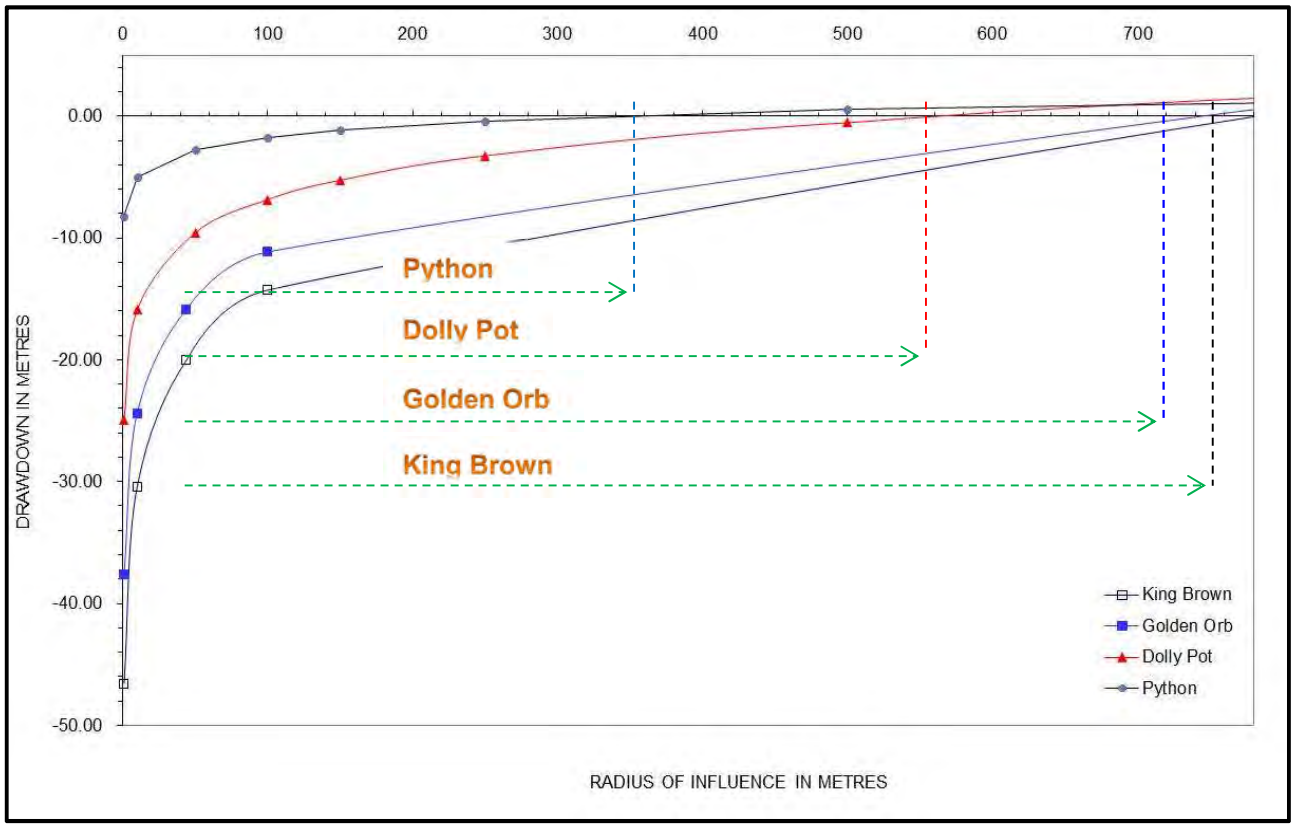
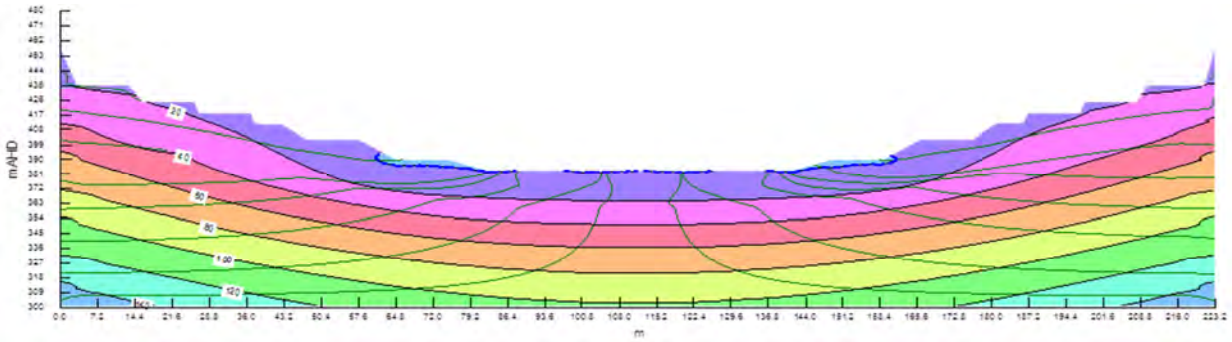
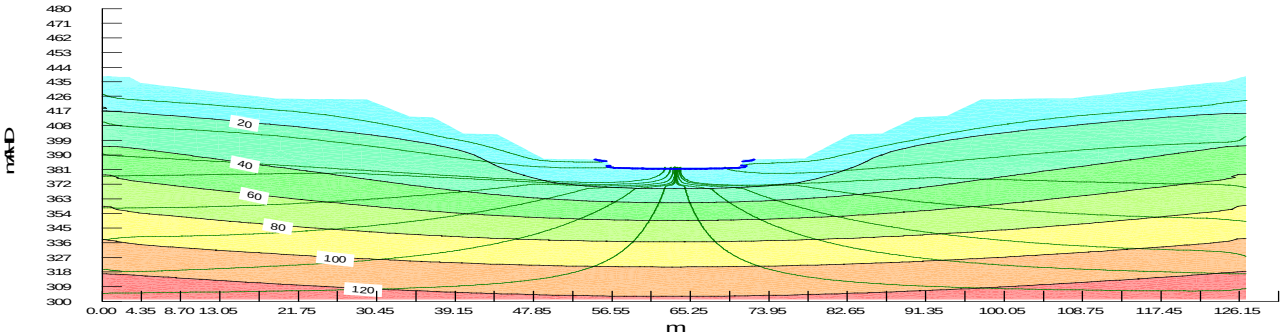


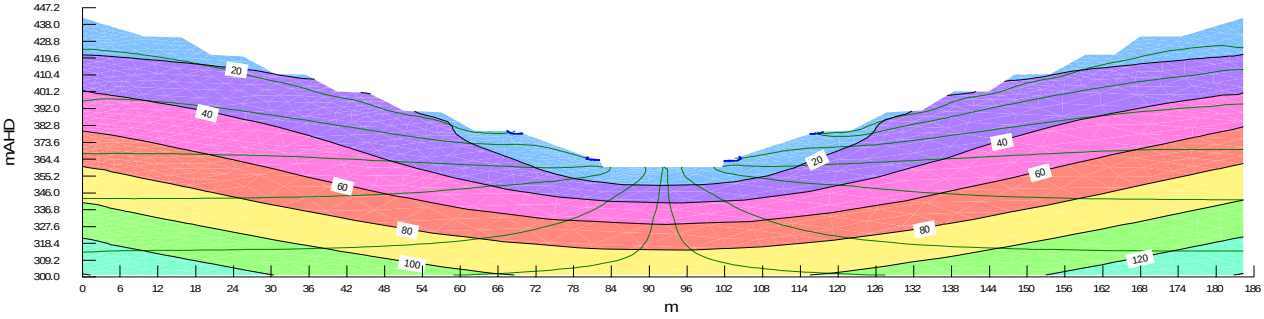
Figure 5.7: Radial Influence (Cone) of Dewatering.



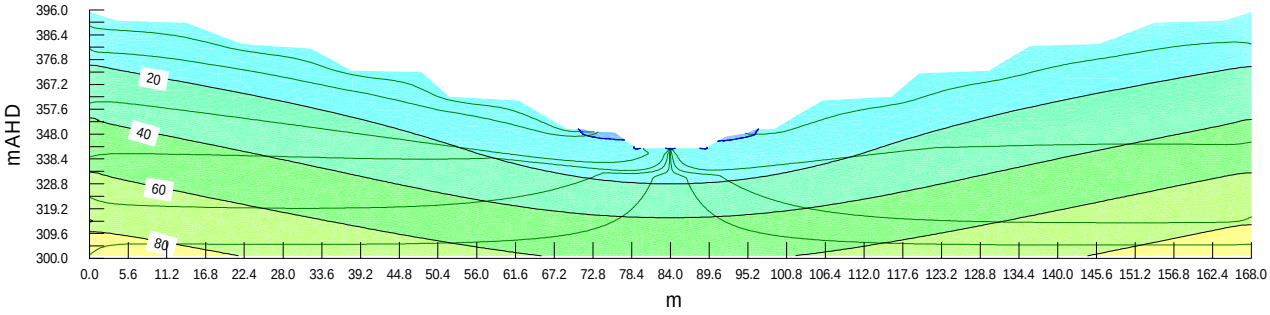
Python Open Pit Model.



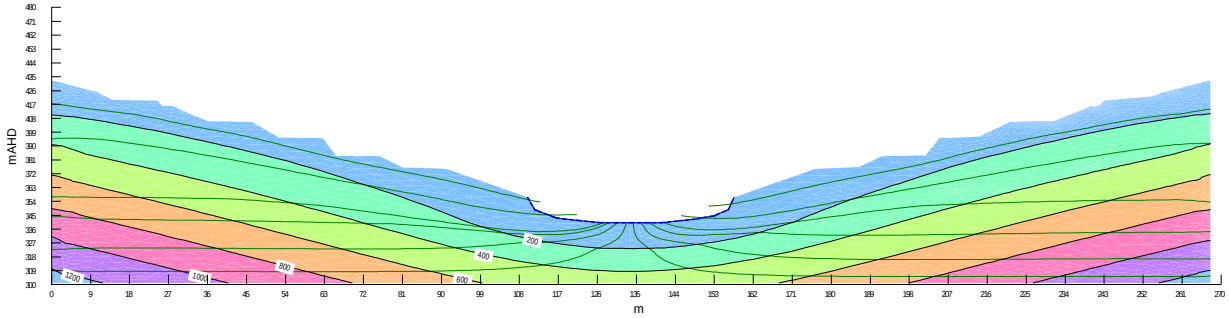
Dugite Open Pit Model.



Dolly Pot Open Pit Model.

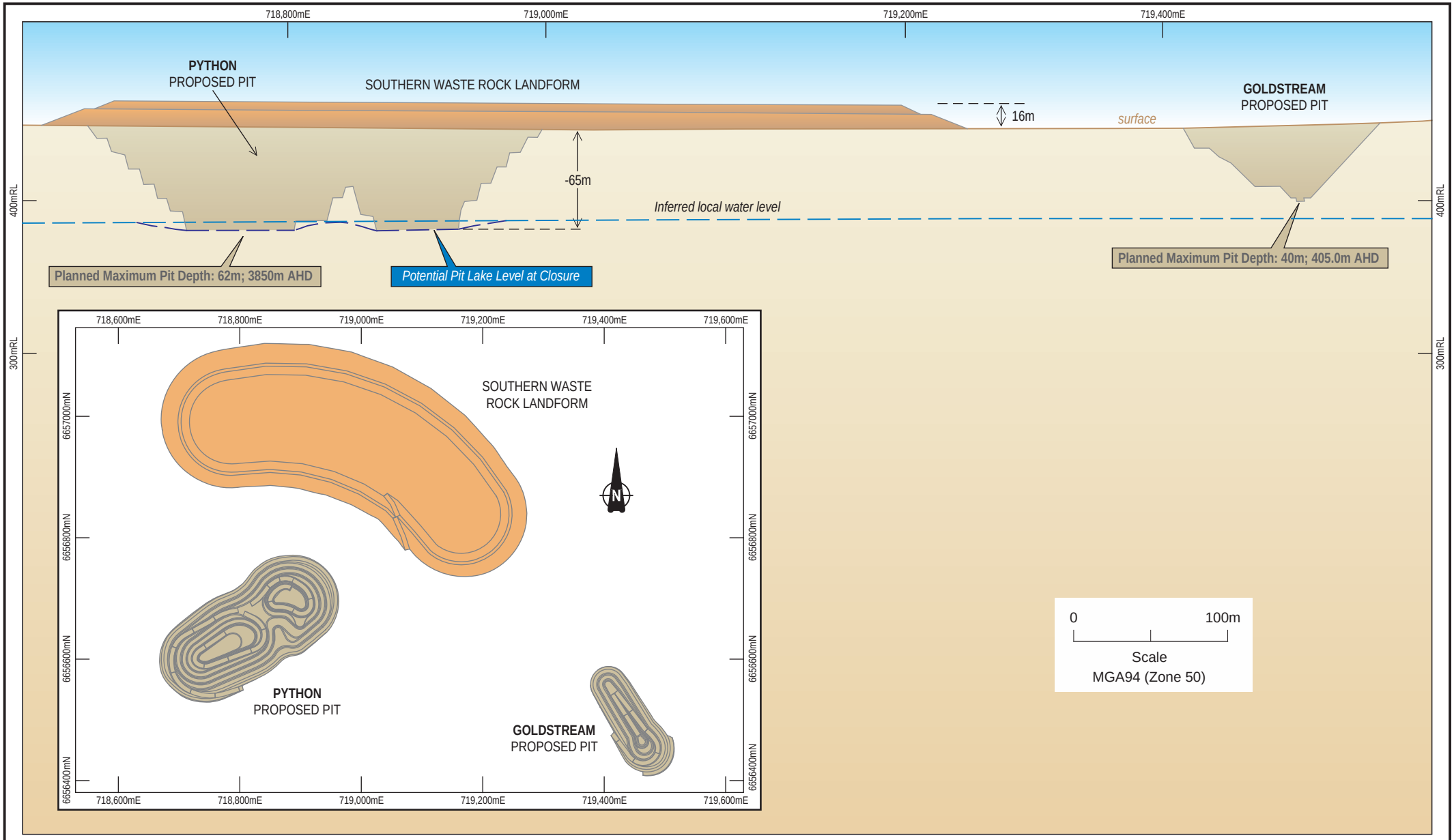


King Brown Open Pit Model.



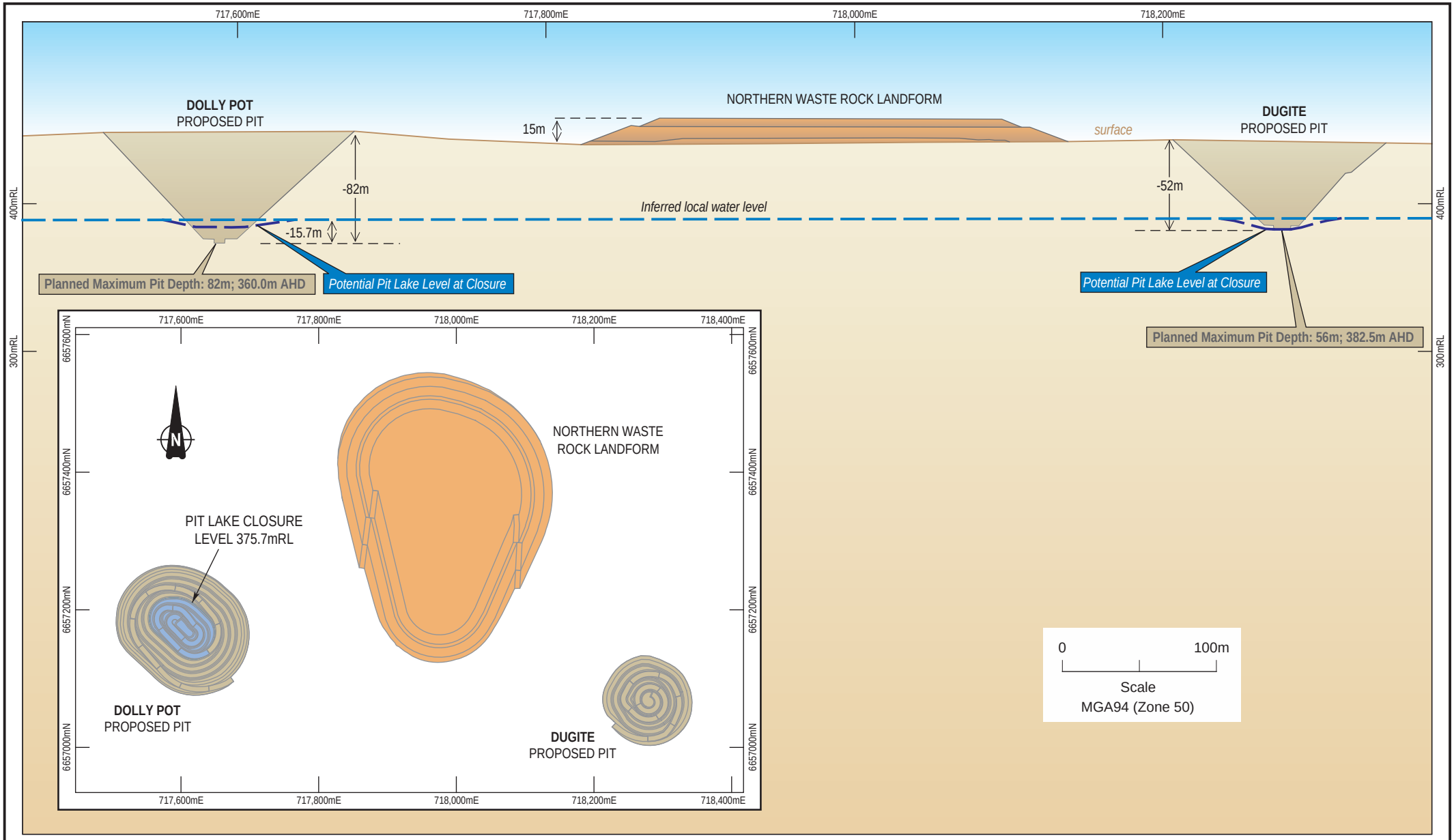
Golden Orb Open Pit Model.

Figure 5.8: SEEP/W Models.



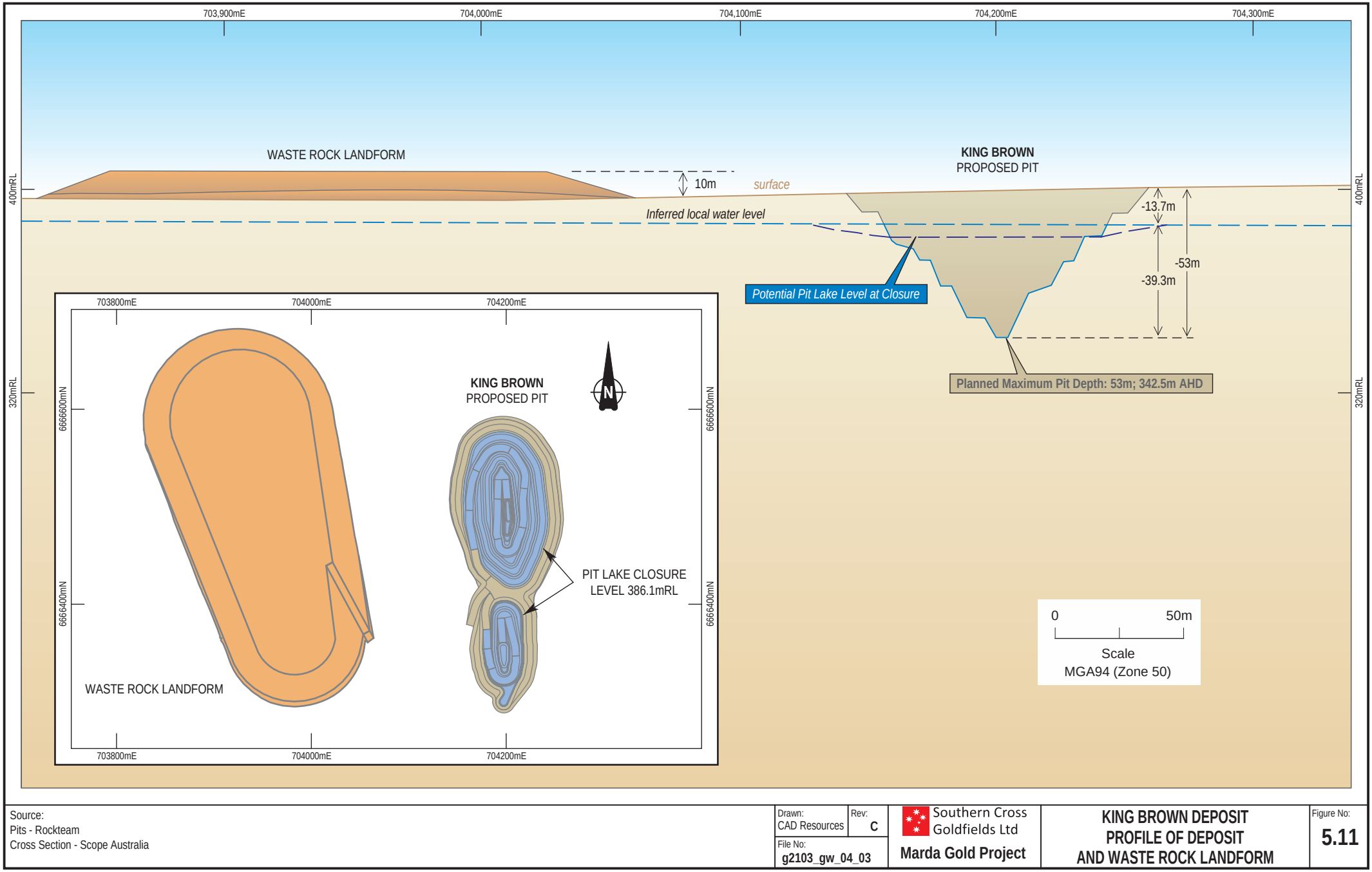
Source:
Pits - Rockteam
Cross Section - Scope Australia

Drawn: CAD Resources	Rev: C	Southern Cross Goldfields Ltd	Figure No: 5.9
File No: g2103_gw_04_02		Marda Gold Project	MARDA CENTRAL DEPOSITS PYTHON & GOLDSTREAM PROFILE OF DEPOSITS AND SOUTHERN WASTE ROCK LANDFORM



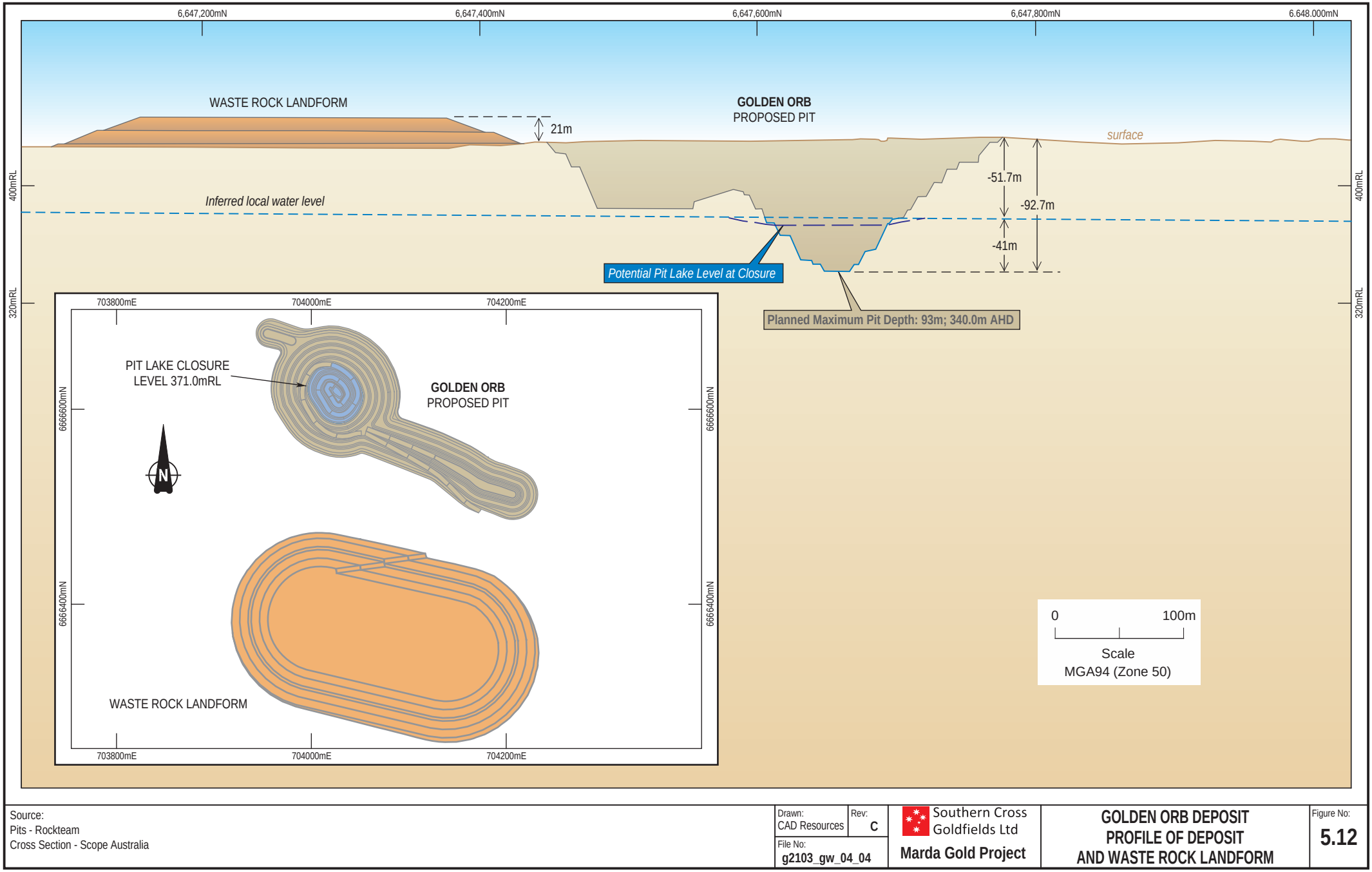
Source:
Pits - Rockteam
Cross Section - Scope Australia

Drawn: CAD Resources	Rev: C	Southern Cross Goldfields Ltd	Figure No: 5.10
File No: g2103_gw_04_01		Marda Gold Project	MARDA CENTRAL DEPOSITS DOLLY POT & DUGITE PROFILE OF DEPOSITS AND NORTHERN WASTE ROCK LANDFORM



Source:
Pits - Rockteam
Cross Section - Scope Australia

Drawn: CAD Resources	Rev: C	Southern Cross Goldfields Ltd	Figure No: 5.11
File No: g2103_gw_04_03		Marda Gold Project	KING BROWN DEPOSIT PROFILE OF DEPOSIT AND WASTE ROCK LANDFORM



Source:
Pits - Rockteam
Cross Section - Scope Australia

Drawn: CAD Resources
Rev: C
File No: g2103_gw_04_04

Southern Cross Goldfields Ltd
Marda Gold Project

GOLDEN ORB DEPOSIT PROFILE OF DEPOSIT AND WASTE ROCK LANDFORM

Figure No: 5.12

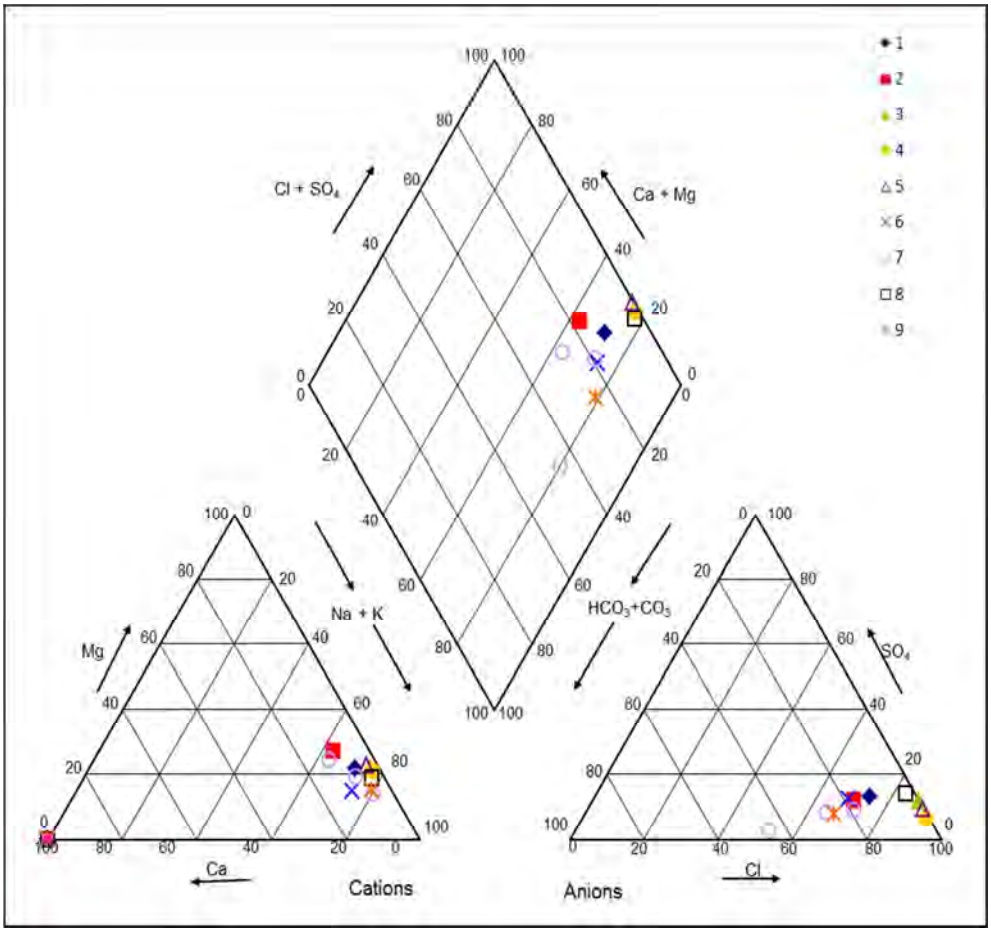


Figure 5.13: Piper Diagram.

Appendices

Appendix A: Water Sources Assessment (including the KH Morgan 1994 report).

Appendix B: Section 26D Licences to Construct Wells.

Appendix C: Ground Water Quality and Laboratory Certificates.

Appendix D: Risk Assessment Methodology.

Appendix A: Water Sources Assessment (including the KH Morgan 1994 report).

Water Sources Assessment

Marda Gold Project

Southern Cross Goldfields Ltd

Revision No 2
November 2013

pendragon environmental solutions
ABN: 92 147 485 416

Leaders in Environmental Practice

Pendragon Environmental Solutions

ABN: 92 147 485 416

Address and Contact Details:

310 Newcastle Street
Northbridge WA 6003
Tel: +61 (8) 9382 8286
Mobile: +61 439 993 933 (Carel)
+61 430 310 085 (Ryan)
email: carel@pendragonenvironmental.com or ryan@pendragonenvironmental.com
Website: www.pendragonenvironmental.com

Report

Title:	Water Sources Assessment Marda Gold Project
File:	PES12006 Southern Cross Goldfields
Author(s):	Edgardo Alarcón León and Carel van der Westhuizen
Client:	Southern Cross Goldfields Ltd
Contact:	Stephen Jones and Tim Dobson
Synopsis:	This document details Water Sources for the Marda Gold Project.

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2	7 November 2013	Edgardo Alarcón León and Carel van der Westhuizen	Ryan Lynch

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Revision No	Date	Approved	Recipient(s)	No of Copies
1	30 August 2012	CvdW	SXG	1
2	7 November 2013	CvdW	SXG	1

Revision

Revision No	Date	Description	Approved
1	30 August 2012	Submission for funding	CvdW
2	7 November 2013	Submission for project/mine approvals	CvdW
Recipients are responsible for eliminating all superseded documents in their possession			

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Appendices

Appendix A: KH Morgan, 1994: Construction, Test Pumping and Hydraulic Analyses.

Executive Summary

Background

Pendragon Environmental Solutions Pty Ltd was engaged by Southern Cross Goldfields Ltd (SXG) to undertake a review of water sources and requirements for the Marda Gold Project in the Southern Cross district of Western Australia and express confidence pertaining to their potential for exploitation.

Objectives

The primary aims and objectives of this investigation are to ascertain the feasibility of water sources for the Marda Gold Project.

Scope of Work

The scope of works for this assessment entailed:

- Assess local geological conditions and structures to ascertain aquifers with a potential for exploitation of groundwater resources.
- Review earlier bore test data.
- Review of the dewatering expectations for each pit particularly King Brown which is the only one expected to have a dewatering requirement.
- Review surface and ground water conditions at the Marda Gold Project.
- Provide SXG with a brief report including conclusions and recommendations pertaining to the potential and sustainability of potential sources of water.
- Compile a work program and estimated costs.
- Prepare and submit a 26D Licence to facilitate exploration for ground water.

Conclusions and Recommendations

Surface waters are considered unreliable and not a source of water to the Marda Gold Project.

Ground water bores in weathered/fractured rock aquifers yielding saline water is considered the most suitable source of water to the project. Several potential drilling sites exist in and around the Marda Gold Project. An application has been lodged to facilitate drilling at two potential targets. This application has since expired and will require renewal prior to bore drilling and testing

There is little doubt that the aquifers will supply the project water requirement.

The following recommendations are to be considered:

- Bore drilling, testing, sampling and assessment including submission of data to DoW.
- Ground water modelling to ascertain long term sustainability of the aquifers.
- Apply timeously for Section 5C licences to the Department of Water for taking water for mine operations and undertaking dewatering of open pit at Kings Brown.
- Further sustainability assessments of production bores should also include a re-appraisal of performance

following three months of pumping and monitoring. Abstraction bores are to be equipped with 20mm diameter tubes attached to the pump column to allow monitoring of ground water levels. An inline flow meter is required at the pump head to monitor ground water extraction.

1. Introduction

Pendragon Environmental Solutions Pty Ltd was engaged by Southern Cross Goldfields Ltd (SXG) to undertake a review of water sources and requirements for the Marda Gold Project in the Southern Cross district of Western Australia, and express confidence pertaining to their potential for exploitation.

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- Prepare and submit a 26D Licence to facilitate exploration for ground water.

2. Water Balance

2.1 Brief Project Description

SXG proposes to construct a conventional carbon in pulp (CIP)/carbon in leach (CIL) gold processing facility at Marda treating oxide and primary ore mined from multiple open pits (Figure 2.1). Project details are:

- Project life is 48 months, 6 months construction and 42 months operations.
- Project throughput is for 720ktpa of ore over the operating life.
- Project water requirements from ground water will be 40m^3/hr during construction and 80m^3/hr during operation (abstraction averages 70m^3/hr and peaks at 86m^3/hr).

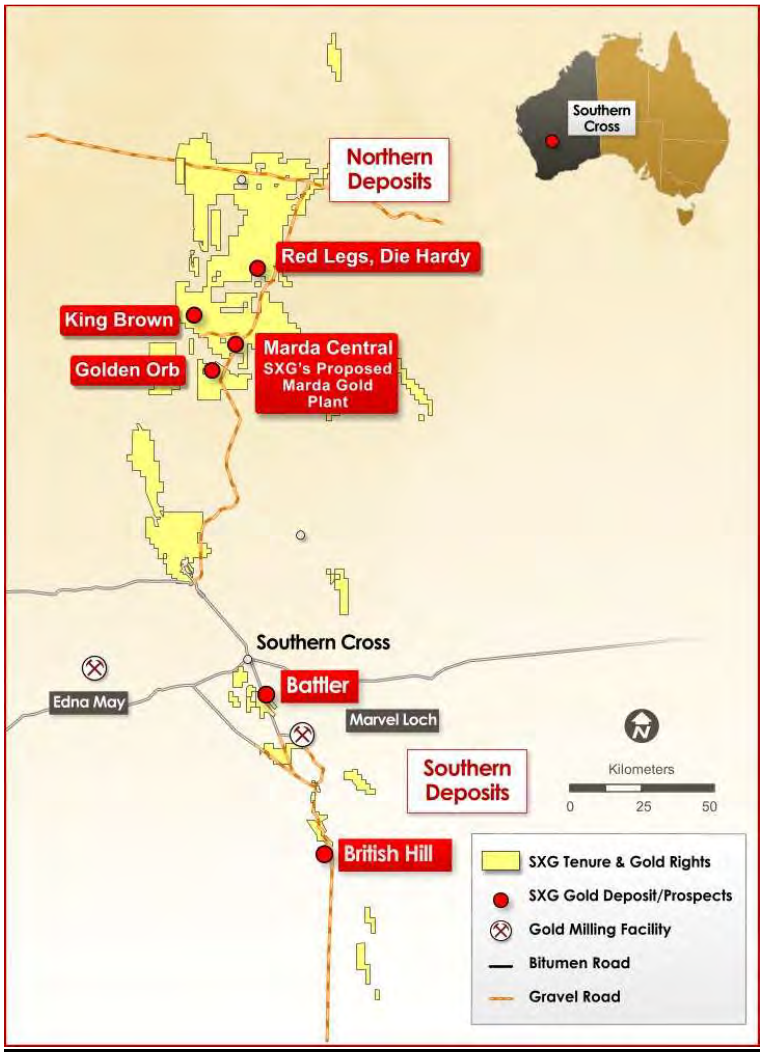

Figure 2.1: Project Location.

SXG has eleven discrete gold deposits (Figure 2.1). Nine of these are located within the Marda-Diemals Greenstone Belt 150km north of Southern Cross referred to as the Northern Deposits. Four of these i.e. Dolly Pot, Dugite, Python and Goldstream are referred to as Marda Central clustered on mining lease M77/394. Marda Central, along with King Brown and Golden Orb comprise the the current project. Golden Orb and King Brown are located 13km southwest and 16km northwest of

Marda Central on mining leases M77/962 and M77/931 respectively. The Cobra, Greentree and Taipan resources, close to Dolly Pot, have not been considered for early production. The Die Hardy and Red Legs deposits are located 29km and 33km northeast of Marda secured by retention licences R77/001 and R77/002. The Battler (M77/1044) and British Hill (M77/1256) resources are located in the Southern Cross Greenstone Belt 13km and 74km south of Southern Cross referred to as the Southern Deposits.

2.2 Climate

The Marda Gold Project falls within in mediterranean climate. The long-term average temperature at Southern Cross ranges from a monthly maximum of 35ºC to a minimum of 5ºC. While rainfall can occur during all months, most rainfall is received during the winter (May-August; Figure 2.2). Significant rainfall can also occur in summer when northwest cyclonic events penetrate inland. The average annual rainfall is 307mm, however the area is known to receive unreliable rainfall, hence annual precipitation can vary between 200mm and 550mm (Table 1 and Figure 2.2).

Table 1: Rainfall Data.

Site Details					
Southern Cross Airfield	Number: 012320	1996 to current	Merredin Research Station	Number: 010093	1911 to current
Latitude: 31.24 ℃	Longitude: 119.36 ℃	Elevation: 347 m	Latitude: 31.50 ℃	Longitude: 118.22°E	Elevation: 318 m
Nearest alternative sites: 012074 Southern Cross (2.7km), 010092 Merredin (105km) and 010093 Merredin Research Station (110km).					

Southern Cross Airfield	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Mean rainfall (mm)	29.6	25.3	35.5	24.7	30.2	28.6	34.6	29.0	22.0	14.0	16.7	17.4	307.6
Highest rainfall (mm)	113.0	73.8	154.4	77.8	91.8	69.0	76.8	76.6	40.8	82.4	39.2	91.4	551.8
Date	2001	2011	1999	1999	1999	2005	2008	2003	2006	2011	1996	2011	1999
Lowest rainfall (mm)	0.0	0.0	0.0	0.0	2.2	7.4	7.8	11.8	11.8	0.4	0.2	0.0	151.4
Date	2005	2002	2007	2001	2000	2006	2005	2006	2002	1996	2007	2008	2010
Highest daily rainfall (mm)	60.0	56.8	66.0	77.0	39.0	21.0	24.0	24.4	14.2	30.2	26.0	36.6	77.0
Merredin Research Station	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Mean rainfall (mm)	14.7	15.6	20.5	22.2	38.1	49.2	47.4	37.8	23.4	16.5	14.3	13.9	313.2
Mean daily evaporation (mm)	11.1	10.1	8.1	5.3	3.1	2.1	1.9	2.3	3.7	5.8	8.5	10.4	6.0

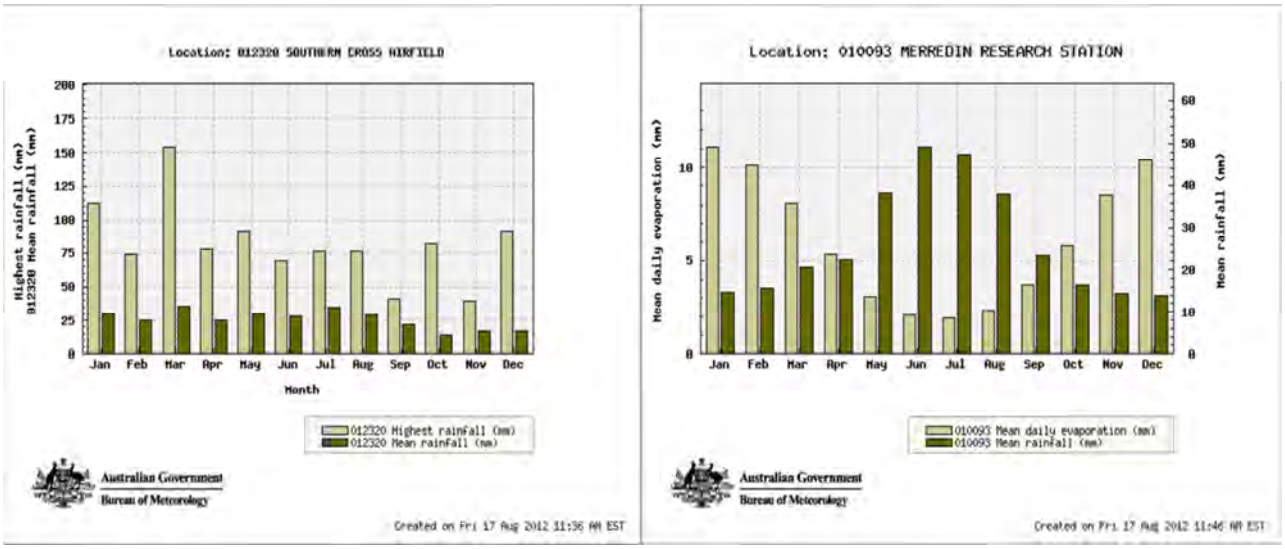

Figure 2.2: Rainfall and Evaporation.

From the above it is evident that the Marda Gold project is located in a water deficit climate in which annual evaporation at 2,190mm exceeds rainfall at 307mm seven times.

2.3 Water Balance

The nearest existing public fresh water supply is located at Bullfinch, 100km south of Marda.

2.3.1 Surface Water

SXG does not consider exploitation of surface water resources as a potential source of water to the Marda Gold Project.

2.3.2 Ground Water

SXG will source water for the project from existing and planned bores at Marda, drilled into the ground water aquifer located approximately 60m below ground level:

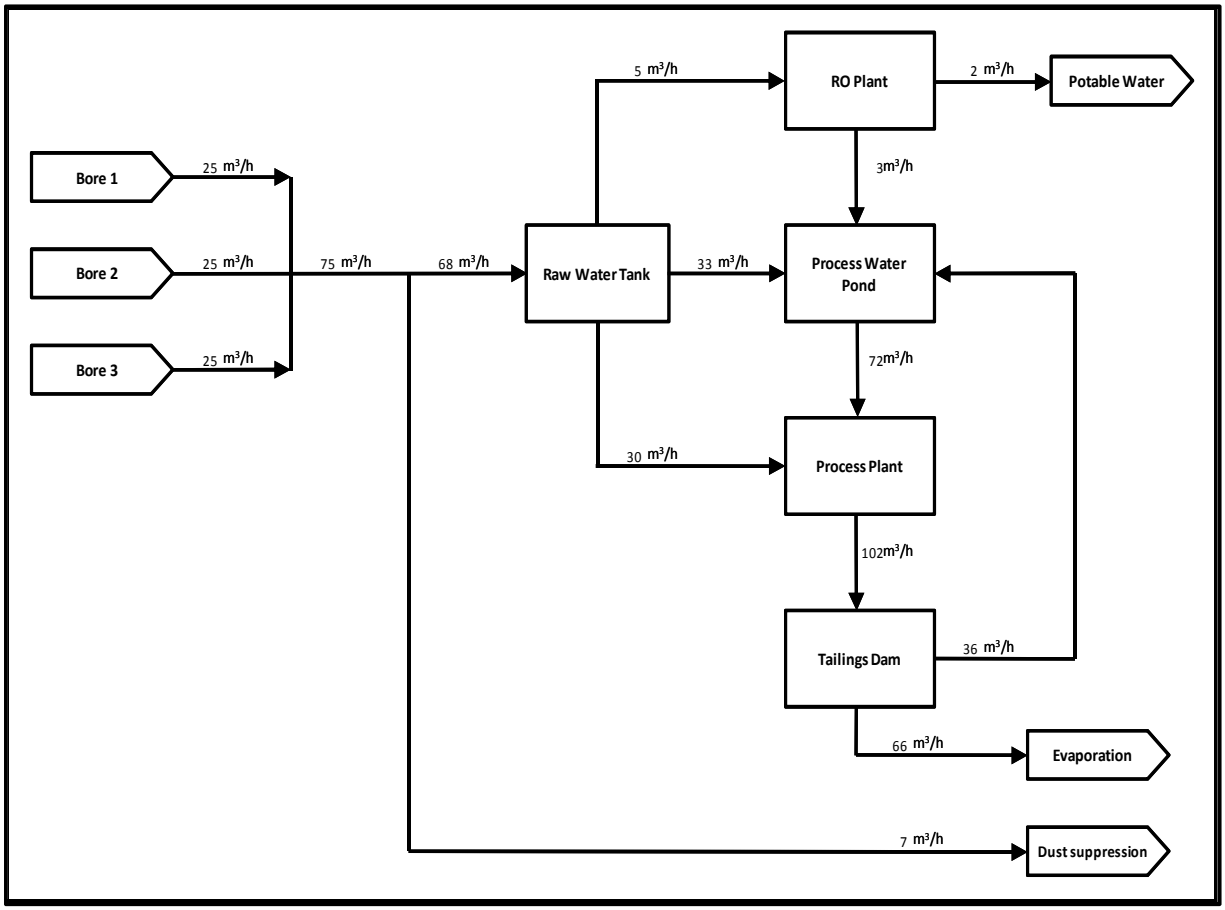

Figure 2.2: Schematic Water Balance (SXG, 2013).

Ground water is brackish to saline and not potable but is suitable for use in gold processing. Untreated ground water will be used for processing whilst water treated using a reverse osmosis plant will be used for potable supplies.

The water balance (SXG, 2013) is estimated at:

Maximum Water Abstraction	m^3/hr	86
Average Water Abstraction	m^3/hr	70
Assumptions Raw Water Use		
Construction	m^3/hr	20
Camp	m^3/hr	5
Road Dust Suppression	m^3/hr	7
Operations Fixed	m^3/hr	30
Operations Variable	m^3/hr	33

There is an existing production bore at the Python Open Pit with a sustainable yield of 20.0m^3/hr. Additional bores with similar capacities will be constructed near the Dolly Open Pit and elsewhere to meet the operational water requirement. The bores are to be equipped with submersible pumps and local diesel generators. These pumps will feed a raw water tank controlled by high/low level switches.

Dewatering of the open pits (excluded from the above water balance) is to be carried out using mobile diesel powered pumps discharging into local ponds. Anticipated average medium to long term mine influxes and dewatering rates amount to:

Table 2: Mine Influxes (Pendragon Environmental Solutions 2013).

Deposit	Ground Water Level	Pit Depth	Medium to Long Term Flux $Q_{(SEEP/W)}$	Medium to Long Term Flux $Q_{(SEEP/W)}$
	(mbgl)	(m)	(L/s)	(m^3/hr)
King Brown	13.7	52.8	4.5	16.2
Golden Orb	62.5	92.7	0.3	1.1
Marda Central				
Dolly Pot	60.7	81.7	2.9	10.4
Dugite	52.2	56.0	0.1	0.4
Python	64.7	61.5	0.7	2.5
		Total:	3.7	13.3
The floor of the Goldstream Open Pit is above the local ground water level.				

Excess dewatering effluent, not required for mining or dust suppression will be pumped from the mine pond to the process water pond at the plant.

In the absence of details pertaining to the water bearing capacity, depth and hydraulic parameters of the aquifer at Kings Brown, there is uncertainty as to ground water influx at this open pit. The pit will be 45m deep and the ground water level is at 15m below surface. It seems thus that this pit will at least supply sufficient water for dust suppression and that surplus water may be tankered to the plant at Marda which would reduce the water demand from bores.

3. Water Sources

3.1 Surface Water

The project area is within the internal drainage division of Western Australia (Beard, 1981). All surface drainage in this division is directed to the many salt lakes and clay pans that occur in the inland of Western Australia.

The surface drainage of the project area is poorly defined and consists mainly of broad sheet wash following short duration high intensity storms. Occasional shallow, ephemeral drainage channels are present but these are mostly short, originating on rises and terminating within a few hundred meters. A few small ephemeral creek beds rise in the project area and flow north or north-west towards a chain of unnamed salt lakes. There are no salt lakes or significant clay pans within the project area itself.

The only known permanent surface water in the area is Marda Dam, a disused dam previously used to supply water to the old Marda settlement. The dam is fed by surface runoff via a small creek. It is fenced off from cattle and larger animals although birds and some small animals would be able to gain access to the water. The Marda Dam is approximately 2km east of the Evanston-Bullfinch road and 0.5km from the closest part of M77/394.

Owing to the low rainfall of the area, coupled with the high rate of evaporation, and runoff characteristics of the area, surface water is unlikely to be a reliable source of water for the Marda Gold Project.

3.2 Ground Water

The Marda Gold Project is located within the Goldfield Groundwater Management Area proclaimed under the Rights in Water and Irrigation Act of 1914 (WA). To develop and maintain a ground water supply and undertake dewatering of open pits will require applications for licences under Section 5C of the Act to the Department of Water for the taking water for mine operations. Whilst these applications are subject to approval, they do not constitute a risk to the proposed project.

3.2.1 Geology

The Marda Central, King Brown, Golden Orb, Die Hardy and Red Legs deposits are located in the Marda-Diemals Greenstone Belt (GSWA Jackson 1:100,000 Sheet). The Battler and British Hill deposits are located in the Southern Cross Greenstone Belt (GSWA Southern Cross 1:250,000 Sheet).

The geology of the Marda Central deposits is well understood through prospect scale geological mapping (White, 1991 and Davis, 1995) and extensive RC and diamond drilling at and around each deposit. Geological interpretations of the setting are aided by airborne and ground magnetics. The following descriptions are based on extensive drilling coverage by SXG and also draw on past work by Cyprus, Gondwana and Evanston Resources.

The Southern Deposits lie within the Southern Cross Greenstone Belt, a tract of slightly to strongly metamorphosed rocks that were initially widespread mafic and ultramafic volcanics, sedimentary rocks

and more restricted felsic volcanics. The margins of the greenstone belt are defined by occurrences of gneissic and granitoid igneous rocks. Contacts between greenstone and granitoid/gneissic provinces are invariably sheared. Structures with a bearing to the occurrence and movement of ground water comprise dykes, breccias, faults, folds and bedding planes.

Outcrops along the Marda trend are variable and sparse over the Dollypot, Dugite and Goldstream deposits. Patchy outcrops of Banded Ironstone Formation (BIF) at Python trend approximately west-north-west and are up to 3m in width. Structures with a bearing to the occurrence and movement of ground water comprise deep weathering (up to 100m depth), steeply dipping open folds, shear, faults, brecciation and fracturing:

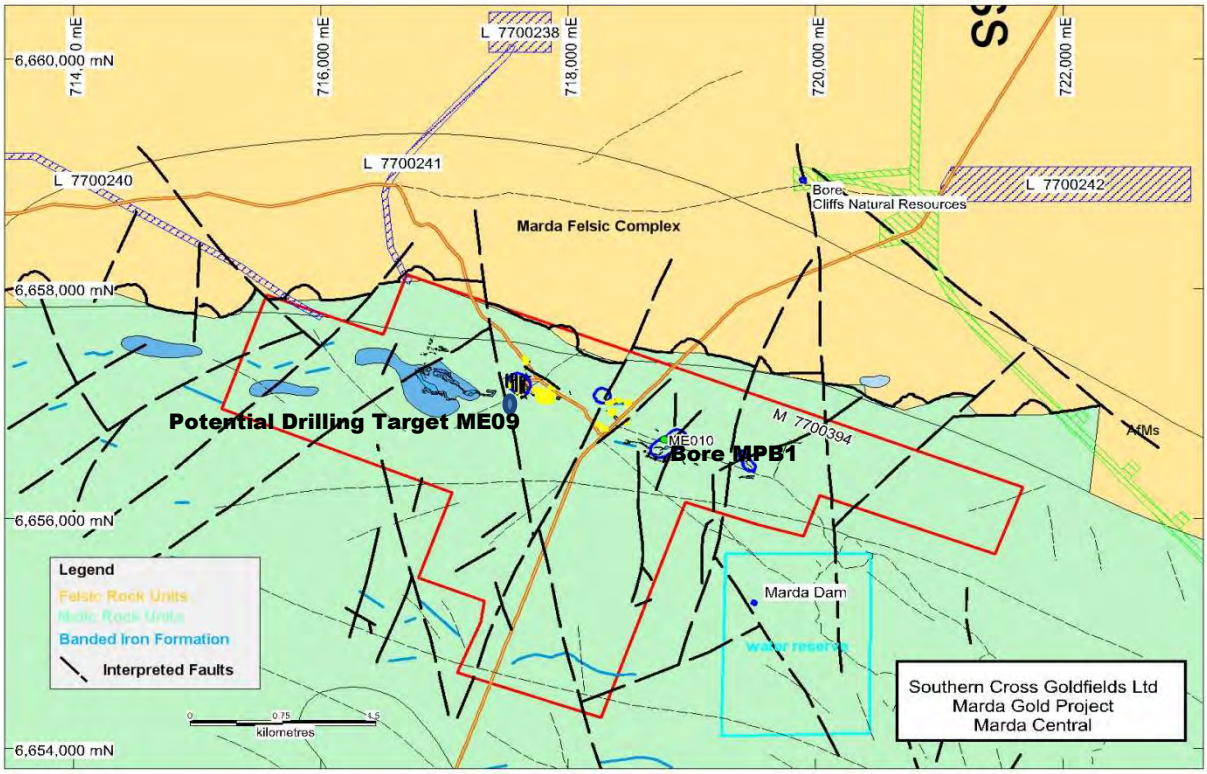

Figure 3.1: Geological Structures at Marda.

3.2.2 Potential Future Drilling Targets

A potential drilling target is indicated on Figure 3.1 at the location of Bore ME9 which has reportedly similar characteristics to Bore MPB1. Intersection of fault, shear and fracture systems are regarded as the targets with the highest potential to yield large sustainable bore yields and with many structures present there are certainly no shortage in future potential drilling targets.

3.2.3 Aquifer System

The main aquifer at Python where Bore MPB1 was constructed, is associated with highly fractured and jointed banded iron formation. Bore MPB1 with a reported airlift yield of approximately 5L/s appears to be bound by two north-south striking faulting systems joining to the south of the bore. The drilling records indicated that the degree of fracturing increased around the mafic contacts encountered at 95m and between 124m and 126m below surface. Although the investigations did not record the exact locations of the principal water strikes, it was reported that the airlift yield

encountered during reaming of the bore continued to increase with depth indicating that deep weathering may contribute to bore yields. Significant fracturing of the banded iron formation was recorded as deep as 154m. The vertical extent of the aquifer is currently undefined.

The standing water level is estimated at approximately 57m below the ground surface. The quality of ground water is brackish to saline.

3.2.4 Bore Testing

Exploration Groundwater Well Licence 49256 issued on the 10th June 1994 allowed sinking of exploration bores. Drilling and test pumping of MPB1 and an observation bore (at the site of water exploration bore MEll) was carried out from 16th July 1994 to 2nd August 1994 at the Python prospect located approximately 130km north of Southern Cross in the Yilgarn Mineral Field (KH Morgan and Associates, 1994). Testing included pumping Bore MPB1 at a variable flow rate step drawdown test, followed by a four day constant rate pumping test and four day recovery test.

The test data were analytically assessed and results reported that the transmissivity (T) of the aquifer at Python ranges between 40m^2/d and 59m^2/d with coefficients of storage (S) between 0.0025 and 0.0112 (Table 3). Subsequent data analysis using MLU Aquifer Test Software indicated that transmissivities range between 64 m^2/d and 150m^2/d whilst coefficients of storage varies between 0.03 to 0.20 (Table 3). Unlike traditional aquifer test software, MLU is based on a single analytical solution technique for well flow but employs traditional analytical solutions and techniques such as Theis, Hantush, Neuman, Boulton, etc.

Table 3: Bore Test Analysis.

Bore ID	Date Assessed	Method	Pumping Rate	K (Hydraulic Conductivity)		T (Transmissivity)		Storativity S [-]
			(L/s)	(m/min)	(m/sec)	(m^2/min)	(m^2/d)	
MPB1	1994	Analytical	5	-	-	0.03	40	0.0025
MPB1	2012	MLU	5	0.0004	0.00001	0.05	65	0.0300
ME11	2012	MLU	5	0.0010	0.00002	0.10	144	0.2000

An aquifer sustainability analysis using the FC Method indicated that the long-term sustainable yield of Bore MPB1 is less than the 5L/s found by the 1994 analyses (Table 4). However, assuming the aquifer recharge in the area approximates 5% of MAP, the recommended sustainable yield is 2.7L/s over 24 hours.

Table 4: Bore Test Analysis using the FC Method.

Method	Sustainable Yield (L/s)	Std. Dev	Early T (m^2/d)		Late T (m^2/d)	S	AD used
Basic FC	0.01	0.00	65		23.8	1.13E-02	7.4
Advanced FC	0.01		65		23.8	1.13E-02	7.4
FC Inflection Point	2.23	0.88					13.1
Cooper-Jacob	0.48	0.31			12.1	9.06E-04	7.4
FC Non-Linear							7.4
Barker	1.94	1.45	K_f =	100	S_s =	1.60E-04	7.4
Average Q_{Sust} (L/s)	**0.93**	**1.07**	b =	0.41	Fractal dimension n =	2.07	

It is evident that more than one bore will be required to meet the project water demand. At least two more bores should be constructed to limit abstraction to no longer than 12 hours per day (less than 720 minutes per day to remain within the straight line sections of the drawdown curves in Figure 3.2) and to facilitate rotation of abstraction to allow sufficient time for recovery and recharge of the ground water regime. Taking cognisance of these objectives, it will be possible to exceed the recommended long term sustainable bore yields taking cognisance of the short expected life of the project, however, this should be re-assessed based upon short-term testing coupled with production monitoring data after about three months.

The primary differences between the two interpretations lies in the interpretation methodologies and interpretation of the significance of the steep decline in the dewatering curve at the end of the bore test (red line in Figure 3.2) indicative of a barrier boundary that would limit both sustainable yield and duration of abstraction over the medium to long term.

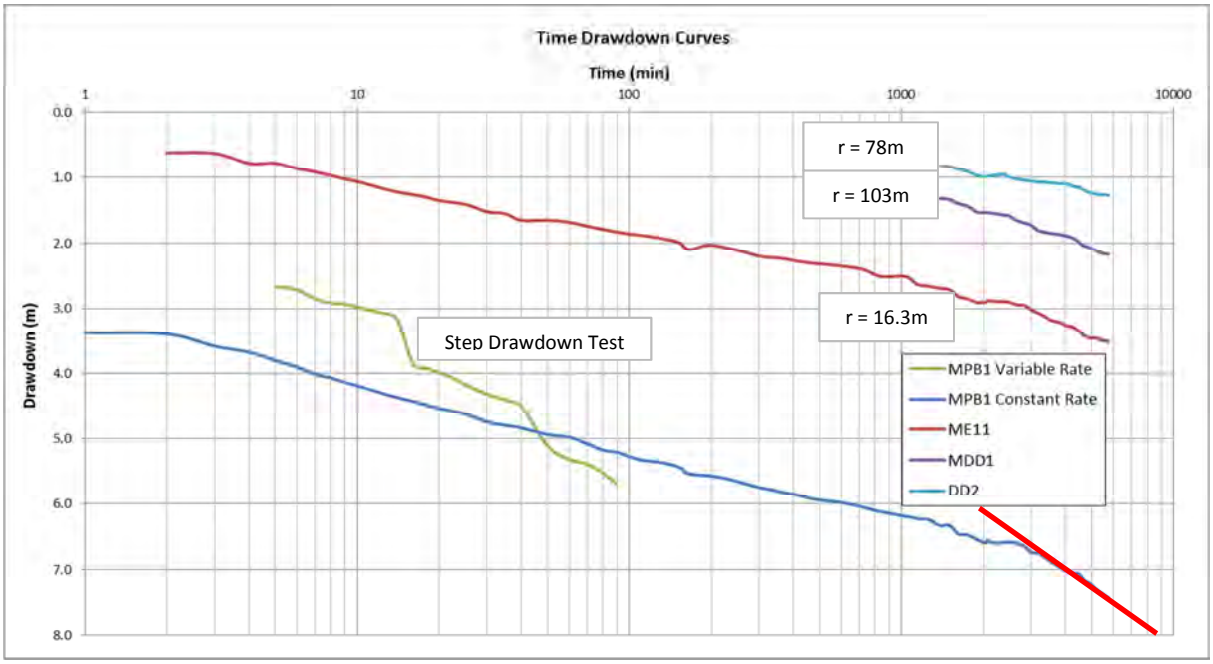

Figure 3.2: Bore MPB1 Drawdown Curve.

K H Morgan and Associates, August 1994, stated that *analysis of the test pumping program has been calculated using the Jacobs form of the Theis equation and variations pertaining to 11 leaky aquifer conditions. Recovery and distance drawdown analysis utilised the least squares method applied to the Theis equation. The data has been subject to both computerised and manual interpretation for comparative results. Storage effects and delayed yield effects were also considered in the manual analysis. A summary of hydraulic parameters are summarised in Tables 2 and 3:*

TABLE 2

SUMMARY OF HYDRAULIC PARAMETERS

Bore Number	Pumping Test		Recovery Test
	Transmissivity (kd) (m^2d^{-1})	Storativity (S)	Transmissivity (kd) (m^2d^{-1})
MPB1	40	-	49
ME11	44	0.0157	43
DD1	41	0.0025	-
DD2	50	0.0112	-

TABLE 3

DISTANCE DRAWDOWN ANALYSIS SUMMARY

Pumping Duration (mins)	Drawdown Bore Number and Radial Distance				Transmissivity (kd) (m^2d^{-1})	Storage Co-efficient (S)
	MPB1 r:0m	ME11 r:16.3m	DD1 r:103m	DD2 r:78m		
1380	6.33	2.7	1.32	0.82	59	0.00283
3000	6.74	3.02	1.73	1.04	58	0.00367
5760	7.44	3.51	2.17	1.26	55	0.00444

Using Figure 3.2 and the Jacob Equation:

$$s = h_o - h = \frac{Q}{4\pi T} \ln\left(\frac{2.25Tt}{r^2S}\right) = \frac{2.3Q}{4\pi T} \log\left(\frac{2.25Tt}{r^2S}\right)$$

where:

- Drawdown $s = h_o - h$ is the difference between the static (SWL) and pumping (PWL) water levels.
- Static Water Level [SWL] (h_o) is the equilibrium water level before pumping commences.
- Pumping Water Level [PWL] (h) is the water level during pumping.
- Well Yield (Q) is the volume of water pumped per unit time t.
- Transmissivity (T = Kb) is the rate of flow through a vertical strip of aquifer (thickness b) of unit width under a unit hydraulic gradient.
- Storage Coefficient (S = Sy + Ssb) is storage change per unit volume of aquifer per unit change in head.
- Radius of Influence (r) for a well is the maximum horizontal extent of the cone of depression when the well is in equilibrium with inflows.

the T and S values in Tables 2 and 3 could not be attained and it seems that the Morgan estimates did not employ unit log-cycle change in drawdown s. Estimations using the above equation with unit log-cycle drawdowns obtained from the curves in Figure 3.2 (the test data as reported and used by Morgan) yield T and S values:

Bore	Early t<100min T (m^2/d)	Middle t<1,000min T (m^2/d)	Late t>2,500min T (m^2/d)	S
MPB1	73	84	29	-
ME11	99	122	40	0.01 to 0.001
MDD1	-	-	47	0.001
DD2	-	-	100	0.004

The slight increase in the middle T values suggests leaky conditions whilst the marked decrease in late T values result from barrier boundaries that restrict flow and replacement of the water drawn from storage resulting in dewatering of the aquifer. The differences in the slopes of the drawdown curves in the different observation bores suggest heterogeneity in the aquifer typical of weathered and fractured rock aquifers.

Using the T and S values in Tables 2 and 3, Morgan calculated the theoretical sustainable pumping rate based on two years continuous pumping to be in the order of 40kL/hr, however recommended a more realistic sustainable pumping rate of 20kL/hr during the early stages of pumping causing a drawdown of 16m (to 73m below ground surface) after one year continuous pumping of bore MPB1.

4. Impacts of Mining on Ground Water

Impacts on the ground water regime and potential users pertain to:

- Abstraction of ground water at Marda to supply water to the processing plant and camp (treated).
- Infiltration of water from the tailings dam.
- Dewatering of open pits.

4.1 Ground Water Level

4.1.1 Ground Water Dependent Ecosystems (GDEs)

GDEs are areas where groundwater plays a key role on both vegetation dynamics and soil water balances. These areas are of particular interest for several reasons including their relatively high richness both in animal and plant species and their ability to sequester and store carbon (Mitsch and Gosselink, 2000).

GDEs are defined as: *natural ecosystems that require access to ground water to meet all or some of their water requirements so as to maintain their ecological functions*. Six types of GDEs are conventionally recognised in Australia:

- **Terrestrial vegetation** that relies on the availability of shallow ground water.
- **Wetlands** such as paperbark swamp forests and mound springs ecosystems.
- **River base flow systems** where ground water discharge provides a base flow component to the river's discharge.
- **Aquifer and cave ecosystems** where life exists independent of sunlight.
- **Terrestrial fauna**, both native and introduced that rely on ground water as a source of drinking water.
- **Estuarine and near shore marine systems**, such as some coastal mangroves, salt marshes and sea grass beds, which rely on the submarine discharge of ground water.

Of these, only terrestrial vegetation and fauna may occur within the project area. Table 5 details the criteria for discerning zones and sites which may fit the definition of a GDE.

Table 5: Criteria for Defining Water Dependent Ecosystems.

Environmental Aspect	Criteria	Indicators of Groundwater Dependence
Level 1: Locate zones with potential for groundwater dependence		
Potential for ground water fed systems	Status of inundation, submergence, seeps and springs, ground water aquifers, geology and topography	Soil and surface/ground water surveys indicate water at (inundation, submergence, seeps, springs) or close (dampness) to the surface which vegetation can readily tap into or there is potential for expression of this water to the surface based on geology and topography.
Level 2: Assess specific areas where groundwater dependence potential is high		
Indications of water at inundation, sub-mergence, seeps, springs) or close (dampness) to the surface	Soil moisture Expression of ground water Source of surface water Refer to vegetation criteria	Greater than 15% following at least 7 days of no rain. Shallow ground water levels, extent of ponding or flowing (fre-quency; rainfall relationship). Drainage/topographic characteristics. Surface/ground water quality characteristics. Refer to vegetation structure.

Vegetation Characteristics	Vegetation structure Plant species composition	Structure (large trees) suggests reliance on a long term available water source. Species composition suggests a dependence on a shallow ground water level. Presence of species dependent on (near) permanent water.

Since ground water levels are deep at depths greater than 50m below surface coupled with a significant water deficit climate, there is no potential for GDEs within the mine tenements.

4.1.2 Abstraction of Ground Water at Marda

Bore testing at MBP1 indicated that drawdowns and the cone of abstraction may extend as far as 300m. This is well within the tenement boundaries.

4.1.3 Infiltration from Tailings Storage Facility (TSF)

Since the TSF will be the first/primary source of water to be complemented by bore water and/or rain/influx into the open pits, the tailings dam will be operated with a minimum water pool and storage in the return water dam to maximise return to the plant and recycling of water. Infiltration into the underground will thus be limited and is expected to be laterally within close (less than 100m) proximity to the dam.

4.1.4 Dewatering at Kings Brown

Influx and dewatering at the open pits are likely to have an impact, i.e. radii of influences of up to 800m (Pendragon Environmental Solutions, 2013). This impact, estimated at up to 5m drawdown in the ground water level, may extend beyond the boundaries of Tenements M7700931 and M7700646. In the absence of other users within the radii of influence, this impact is regarded as low and of short duration (less than 18 months) which will not require any mitigation measures.

4.2 Aquifer Yield

4.2.1 Abstraction of Ground Water at Marda

Aquifer yield outside the mine tenement will not be impacted.

4.2.2 Infiltration from Tailings Dam Complex

Infiltration, other than to increase storage in the shallow soils and fractures, are unlikely to impact on bore and/or aquifer yields.

4.2.3 Dewatering at Kings Brown

If any, a slight decrease in bore yields within the zone of influence may be expected. The impact is regarded as low and of short duration and no mitigation measures are required.

4.3 Water Quality

Water quality in the aquifer is brackish to saline and abstraction, dewatering/influx and infiltration at the TSF are unlikely to cause impacts on ground water quality.

5. Work Program and Cost Estimates

5.1 26D Licence Application

Renewed applications for a 26D Licence (Appendix A) to facilitate further exploration for ground water supplies is to be lodged with the Department of Water (DoW). It is anticipated that approval (renewal of existing but expired licences) will be granted in two weeks following application.

5.2 Work Program

The work program includes:

Table 6: Work Program.

#	Activity	Duration (weeks)
1	Test and sample Bore MPB1.	1
2	Establish, drill, test and sample two bores at ME9 Dolly Pot and elsewhere to meet water requirement. Potential targets exist approximately 1.3km west of Bore MPB1. Preliminary minimum spacing intervals between potential production bores should be no less than 500m.	3
3	Undertake drilling, testing and sampling at Kings Brown. Two exploration bores at Kings Brown to assess aquifer characteristics and hydraulic parameters and assess influx/dewatering requirements particularly if pre-mining dewatering will be required.	2
4	Assess and model data to ascertain long term sustainability of the aquifers and set abstraction and dewatering rates, limits and requirements.	4
5	Lodge Report and Licences with the Department of Water: ▪ 5C abstraction licences for Marda Central. ▪ 5C dewatering licence for Kings Brown.	2
6	Implement: ▪ Abstraction bore field at Central Marda. ▪ Dewatering bore field at Kings Brown.	 4 6

Bores are to be constructed to the following specifications:

- The bores will be drilled at 275mm diameter to a depth of between 6m and 10m after which solid steel casing will be placed and grouted in place with cement.
- Drilling will continue at 200mm until the main aquifer is intersected, anticipated at between 90m and 125m below surface.
- Upon completion, 150mm solid (to 6m above where water was encountered) and slotted (between where water was encountered and the final depth of the bore) PVC casings will be inserted. The annulus between the screens and bore wall will be filled (gravel pack) with clean washed gravel (>3mm) to 1m above of the screen and then bentonite will be placed to about 1m above the gravel.
- The annulus between the casing and bore wall above the bentonite seal will be filled (gravel pack) with clean washed gravel (>3mm) and/or backfilled with clean drill cuttings.
- All bores will be completed with a concrete plinth (1m by 1m by 1m deep) and lockable cover to an elevation some 1m above ground level to prevent surface water entering the bore.
- Bores will be developed subsequently by airlift until the water is clean and free of fines.

Estimations of the long term sustainability of the bore, hydrogeological characterizations of the aquifer and assessing impacts of ground water exploitation require information pertaining to:

- Ground water levels and their behaviour.
- Hydraulic parameters, i.e. storativity S (how much water the aquifer stores) and transmissivity T

(rate of ground water movement) of the aquifer.

- Type of aquifer systems, i.e. unconfined, semi-confined, confined, leaky, etc.
- Water quality parameters.

To obtain the above information, bore testing and sampling will be undertaken. To calculate the hydraulic parameters of the aquifers require that water be pumped out from the bore whilst the water level drawdown is measured. This information in turn is both analytically assessed and fed into aquifer test software to calculate sustainable yields (required for classification of the aquifer in terms of yield and potential) and the S- and T-values (required to assess potential impacts on downstream users).

Bore testing will comprise:

- Where the bore airlift yields are low (less than 0.2L/s), testing with a slug method will be preferred. It entails inserting slug water whilst a probe measures the behaviour, i.e. recession, of the water level.
- Step drawdown tests with a test pump installed. This method will commence at a small rate and pumping rate increased at select time intervals until the bore is pumped dry. This information is analysed to determine an optimum flow rate for a constant rate test.
- A constant rate test over a period of no less than 24 hours to examine water level behaviour over the longer term and calculate the aquifer hydraulic parameters. In the case of bore is pumped dry in short period of time, a slug test method will also be undertaking to characterise the bore.

Water level drawdowns and recoveries (water level measurements once the pump is shut down) in both the pumping and observation bores will be measured at select time intervals.

Water quality determination will include:

- Collection of samples during pump testing as follows:
  - One at the start of the test.
  - One at half way of the test.
  - One at the end of the test.
- Samples of water for detailed laboratory analysis will be obtained at the conclusion of pump out tests once the water has reached equilibrium.

5.3 Cost Estimates

Preliminary approximate cost estimates appear below:

Table 7: Preliminary Cost Estimates.

Item	Activity	Estimated Costs ($)
1	Test and sample Bore MPB1.	$36,400
2	Establish, drill, test and sample two bores at ME9 Dolly Pot and elsewhere to meet water requirement. Potential targets exist approximately 1.3km west of Bore MPB1. Preliminary minimum spacing intervals between potential production bores should be no less than 500m.	$223,200
3	Undertake drilling, testing and sampling at Kings Brown. Two exploration bores at Kings Brown to assess aquifer characteristics and hydraulic parameters and assess influx/dewatering requirements particularly if pre-mining dewatering will be required.	$238,200
4	Assess and model data to ascertain long term sustainability of the aquifers and set abstraction and dewatering rates, limits and requirements.	
5	Lodge Report and Licences with the Department of Water: ▪ 5C abstraction licences for Marda Central.	$15,000

Item	Activity	Estimated Costs ($)
	▪ 5C dewatering licence for Kings Brown.	
6	Implement: ▪ Abstraction bore field at Central Marda. ▪ Dewatering bore field at Kings Brown.	Cannot be reliably costed yet. Allowances: $80,000
	Total Estimated Cost (excluding GST):	**$592,800**
Estimated costs include consultants and contractors.		

6. Conclusions and Recommendations

6.1 Conclusions

Surface waters are considered unreliable and not a source of water to the Marda Gold Project.

Ground water bores in weathered/fractured rock aquifers yielding saline water is considered the most suitable source of water to the project. Several potential drilling sites exist in and around the Marda Gold Project. An application has been lodged to facilitate drilling at two potential targets. This application has since expired and will require renewal prior to bore drilling and testing

There is little doubt that the aquifers will supply the project water requirement.

6.2 Recommendations

6.2.1 Pre-Mining Operations

- Bore drilling, testing, sampling and assessment including submission of data to DoW.
- Ground water modelling to ascertain long term sustainability of the aquifers.
- Apply timeously for Section 5C licences to the Department of Water for taking water for mine operations and undertaking dewatering of open pit at Kings Brown.

6.2.2 Mining Operations

- Further sustainability assessments of production bores should also include a re-appraisal of performance following three months of pumping and monitoring. Abstraction bores are to be equipped with 20mm diameter tubes attached to the pump column to allow monitoring of ground water levels. An inline flow meter is required at the pump head to monitor ground water extraction.

References

K H Morgan and Associates, August 1994: Construction, Test Pumping and Hydraulic Analysis of Bore MPB1, Marda Project. Gondwana Resources NL.

Pendragon Environmental Solutions, 2013: *Surface and Ground Water Assessment, Mining Proposal, Tenements Marda: M77/394, King Brown: M77/931 and M77/646 and Golden Orb: M77/962.*

Southern Cross Goldfields Ltd, 2012: *Marda Gold Project: Surface and Groundwater Brief.*

Southern Cross Goldfields Ltd, 2013: *Marda Gold Project: Water Abstraction Estimate.*

Appendix A: KH Morgan, 1994: Construction, Test Pumping and Hydraulic Analyses.

PROJECT 807

CONSTRUCTION, TEST PUMPING AND HYDRAULIC ANALYSIS

PRODUCTION BORE MPB1

MARDA PROJECT

GONDWANA RESOURCES NL

26TH AUGUST, 1994

CONSULTING GEOLOGISTS
- GROUNDWATER
- EXPLORATION
- MINING
- ENVIRONMENT

K.H. Morgan and Associates

Unit 10/4 Queen Street
Bentley WA 6102

Telephone 356 5455
Facsimile 351 9853

PLATES

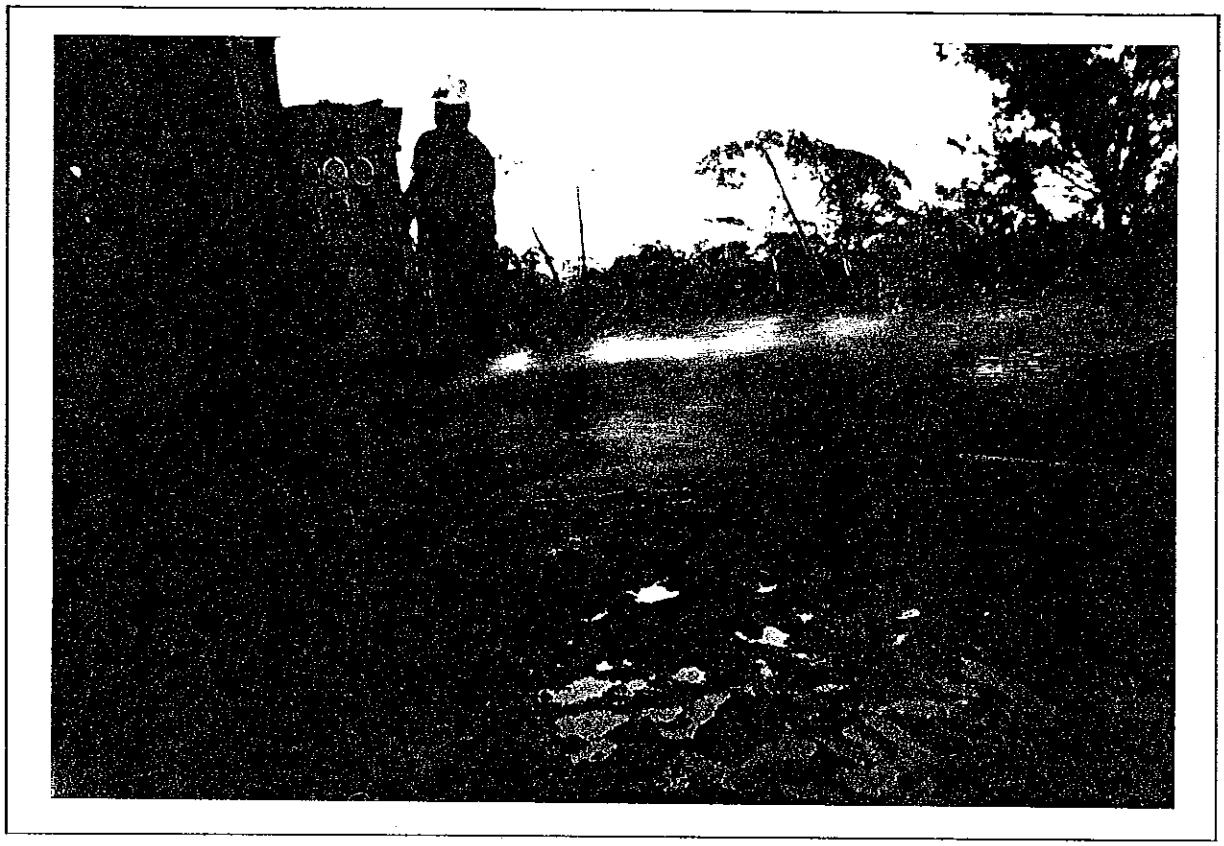

Plate 1: Groundwater jetting from the 260 millimetre diameter borehole during reaming

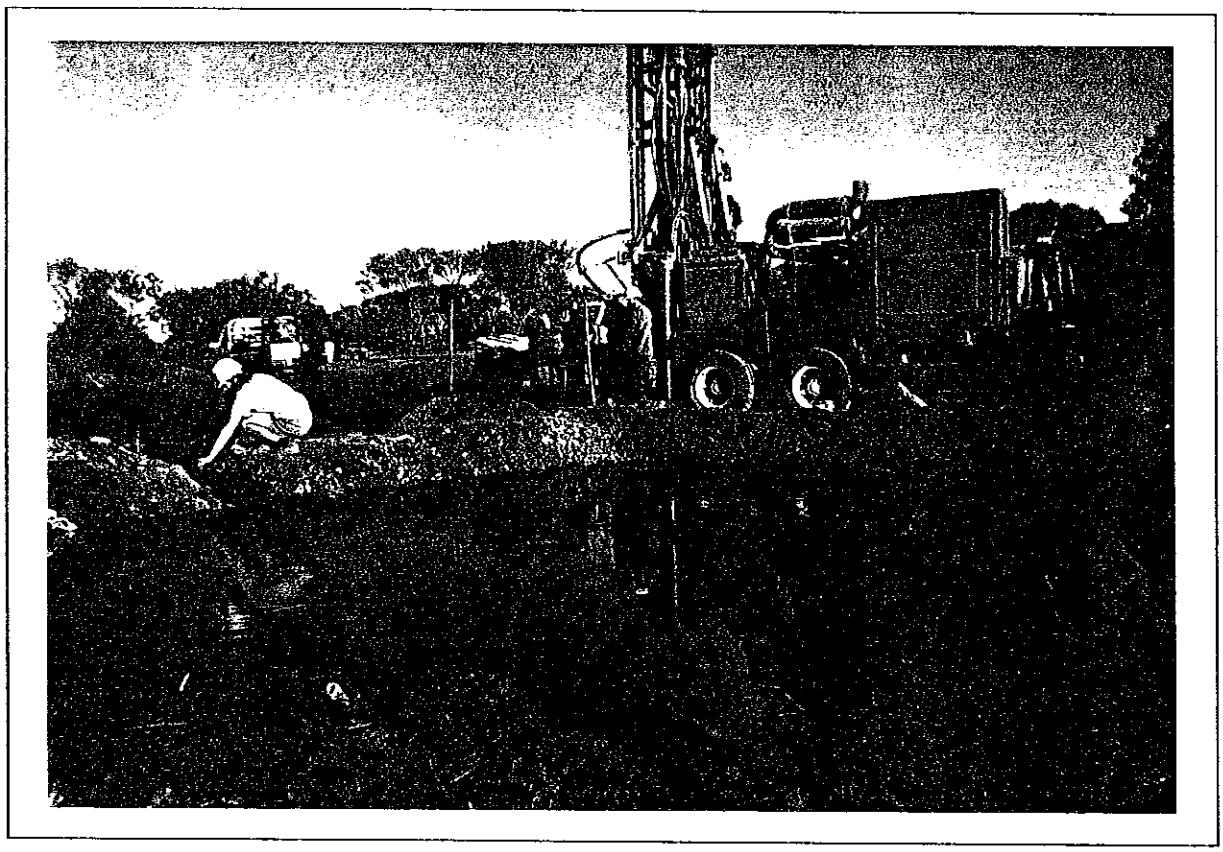

Plate 2: Measuring groundwater yields using a 90° vee notch weir. Flows up to 50 kilolitres per hour were recorded during borehole reaming and airlift flow testing

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3.	TEST PUMPING PROGRAMME	3.
4.	HYDRAULIC ANALYSIS	4.
4.1	Step Drawdown Test	4.
4.2	Constant Rate Pump Test	4.
4.3	Recovery Test	5.
4.4	Distance Drawdown Analysis	5.
5.	HYDROGEOLOGY	6.
6.	GROUNDWATER QUALITY	7.
7.	DRAWDOWN TRENDS AND PREDICTIONS	8.
8.	BOREFIELD EXPANSION	8.
9.	GROUNDWATER MONITORING MEASUREMENTS	8.
10.	CONCLUSIONS	9.
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8. PRODUCTION BORE MPB1 RECOVERY CURVE

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10. DISTANCE DRAWDOWN ANALYSIS, 1380 MINUTES PUMPING DURATION

11. DISTANCE DRAWDOWN ANALYSIS, 3000 MINUTES PUMPING DURATION

12. DISTANCE DRAWDOWN ANALYSIS, 5760 MINUTES PUMPING DURATION

PLATES

PLATE 1 GROUNDWATER JETTING FROM THE 260 MILLIMETRE DIAMETER BOREHOLE DURING REAMING

PLATE 2 MEASURING GROUNDWATER YIELDS USING A 90° VEE NOTCH WEIR. FLOWS UP TO 50 KILOLITRES PER HOUR WERE RECORDED DURING BOREHOLE REAMING AND AIRLIFT FLOW TESTING

APPENDICES

APPENDIX 1 DRILL LOGS

APPENDIX 2 PUMP TEST DATA

APPENDIX 3 CHEMICAL ANALYSIS CERTIFICATE

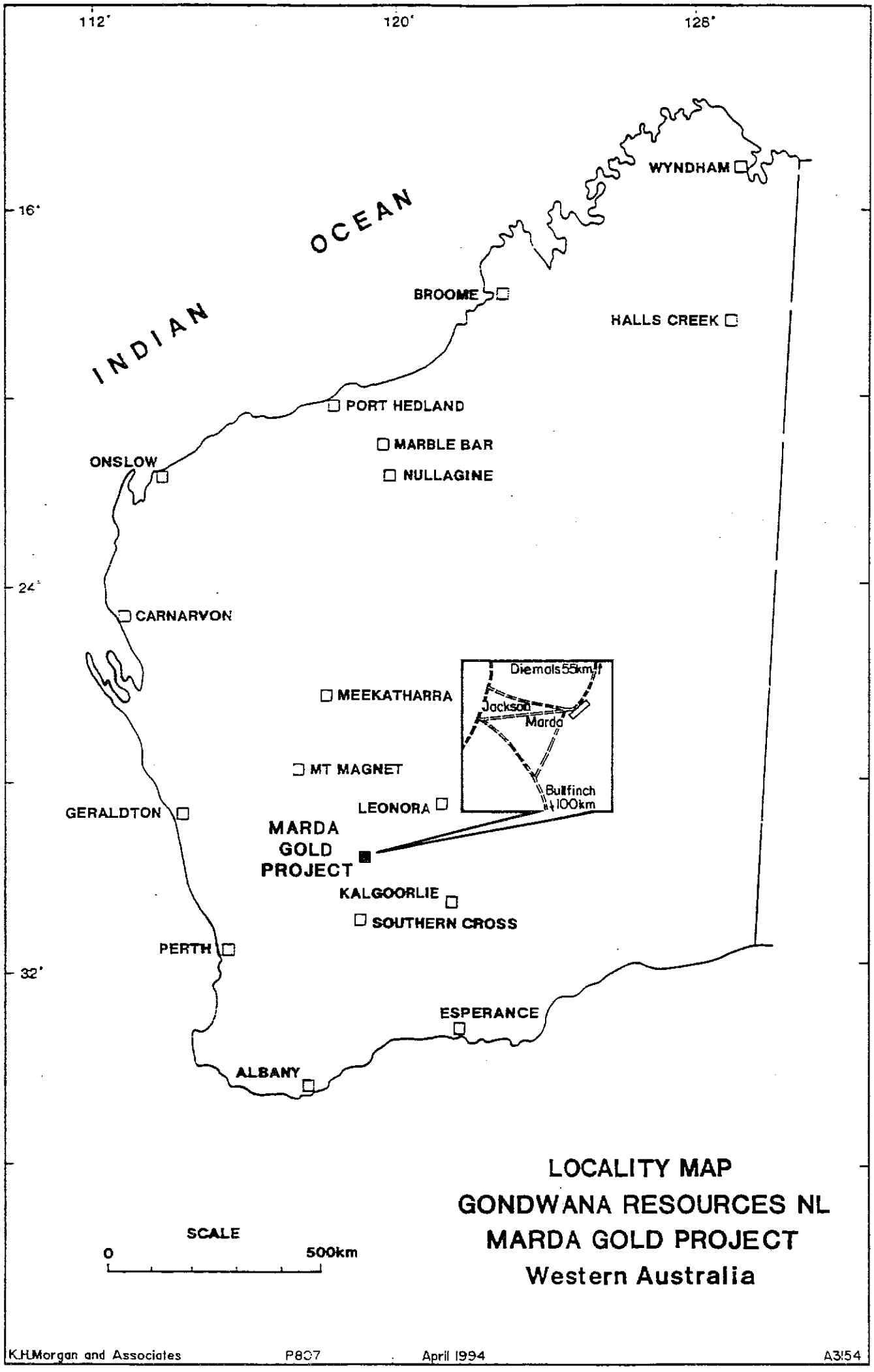
112°
120°
128°
16°
24°
32°
INDIAN OCEAN
WYNDHAM
BROOME
HALLS CREEK
PORT HEDLAND
MARBLE BAR
NULLAGINE
ONSLOW
CARNARVON
MEEKATHARRA
MT MAGNET
GERALDTON
LEONORA
MARDA GOLD PROJECT
KALGOORLIE
SOUTHERN CROSS
PERTH
ESPERANCE
ALBANY
Diemals 55km
Jackson
Marda
Bullfinch 100km
SCALE
0
500km
LOCALITY MAP
GONDWANA RESOURCES NL
MARDA GOLD PROJECT
Western Australia
K.H.Morgan and Associates
P807
April 1994
A3154

FIGURE 1

CONSTRUCTION, TEST PUMPING AND HYDRAULIC ANALYSIS
PRODUCTION BORE MPB1, MARDA PROJECT
GONDWANA RESOURCES NL

1. INTRODUCTION

The following work was carried out from 16th July 1994 to 2nd August 1994 at the Python prospect of the Marda project located approximately 130 kilometres north of Southern cross in the Yilgarn Mineral Field (Figures 1 and 2.1). The work comprised:

* drilling
  - the construction of production bore MPB1 at the site of water exploratory hole ME11;
  - the construction of an observation bore at the site of water exploration hole ME11 (Figure 2.2).
* test pumping
  - variable flow rate step drawdown test;
  - four day constant rate pumping test;
  - four day recovery test.

The main aims of this report are:

* to provide bore construction methods and completion details for production bore MPB1 and observation bore ME11;
* summarise the test pumping programme conducted on MPB1;
* present the test pumping results numerically and graphically;
* provide a hydraulic analysis of the data;
* supply the recommended sustainable pumping rate, drawdown trends and predictions based on the analysis;
* provide recommendations on monitoring and Water Authority of Western Australia licensing requirements.

2. DRILLING AND BORE CONSTRUCTION

Geological drill logs for production bore MPB1 and observation bore ME11 are provided in Appendix 1. Bore construction diagrams for the bores are presented in Figures 3.1 and 3.2.

Bore MPB1 was constructed at the site of the reverse circulation water exploratory hole ME10 using both mud rotary and conventional percussion drilling methods.

Dunlop Drilling of Southern Cross supplied an Ingersoll Rand T4 drillrig equipped with a 350 psi 1050 cfm compressor and a 350 cfm 750 psi auxiliary compressor. A trailer mounted 6x4 Gardiner Denver pump was utilised for mud drilling purposes.

A 300 millimetre diameter hole was drilled with a rolla bit to a depth of 44 metres using mud-rotary techniques. This hole was cased to a depth of 42 metres with 273 millimetre outer diameter (4.8mm wall) steel casing. The base of the steel casing was fixed with approximately 200 litres of cement slurry.

The steel surface casing was required to prevent the unstable weathered zone from washing out and collapsing during hole reaming. The cemented surface casing seals off clays and fines, reducing the possibility of bore siltation and slot blockage during the operational life of the bore.

Percussion hammer drilling methods were employed from 44 to 127 metres for the 256 millimetre diameter hole. A three metre long stabilizer followed the percussion hammer.

Groundwater airlifted from the bore during reaming was directed into adjacent sumps (Plate 1). Regular flow monitoring was conducted during reaming by measuring water levels from a 90° vee notch weir situated between the two sumps (Plate 2).

At the completion of hole reaming the drill rods and hammer were removed and the hole was cased to 126 metres with 179 millimetre outer diameter (157mm id) ABS bore casing.

Bore casing was slotted from 90 to 126 metres. The slotted interval comprised four rows down the casing of 100 millimetre by 2 millimetre horizontal slots with a slot spacing of 10 millimetres. An ABS end capping is attached.

The polyurethane ABS casing was selected for this bore for the following reasons.

* Strength: this material is suitable for inpit dewatering bores and can tolerate nearby blasting. High strength materials were required for this bore due to its depth and the blocky jointed nature of the banded iron formation.

* Threaded flush joints: flush joints allow a reduced diameter hole. Flared bell joints are not present as in pvc casing. The threaded casing allows fast installation of the casing, this was preferred due to the unstable nature of the jointed rocks that comprise the aquifer. Drilling costs were significantly reduced due to the fast installation of the threaded bore casing.

* Weight: This high strength low weight material was suited to this programme, casing could be unloaded and moved into place around the drill rig without the use of forklifts or cranes.

Following the installation of bore casing the annulus between the hole and the casing was packed with 4m³ of 3.2 to 6.4 millimetres diameter graded, washed gravel.

The hole was airlift developed for approximately four hours until the water was clear and free of fine gravel and silt.

A circular cement block was set around the bore casing at the ground surface.

The observation bore constructed at the site of water exploration hole ME11 was drilled using reverse circulation methods.

This hole was drilled to a depth of 133 metres using a 145 millimetres diameter hammer. The hole was cased using 32 millimetre diameter class 9 pvc. A two metre 155 millimetre diameter pvc surface collar was emplaced. Bore casing was slotted from 73 to 133 metres.

Observation bore ME11 was completed at the surface with a cement block.

Completion details of production bore MPB1 and observation bore ME11 are provided in Table 1.

TABLE 1

BORE COMPLETION DETAILS

Bore Number	Surface Casing		Bore Casing		Gravel Pack (m^3)	Drilling Methods	Slotted Interval (m)	Airlift Yield ($m^3 h^{-1}$)
	Depth (m)	Diameter (mm)	Depth (m)	Diameter (mm)				
MPB1	42	273	126	179	4	mud rotary conventional percussion	90 - 126	25
ME11	155	150	133	32	2	reverse circulation	73 - 133	4*

*restricted reverse circulation yield

3. TEST PUMPING PROGRAMME

The test pumping programme was conducted on production bore MPB1, regular monitoring of the pumping bore, observation bore ME11 and mineral exploration holes DD1 and DD2 were maintained during the test.

The test pumping programme comprised:

(a) variable rate step drawdown test (90 minutes);

(b) constant rate pumping test (5760 minutes);

(c) recovery test (5000 minutes).

Computer printouts of all readings and computerised analysis results are presented in Appendix 2.

Graphs for all drawdown and pumping recovery readings plotted against elapsed time and residual time are present in Figures 4 to 9. Graphs plotted for drawdown against radial distance at specific times are provided in Figures 10 to 12.

The test pumping programme was conducted under the supervision of KH Morgan and associates using equipment supplied by Goldfields Pumping Service.

A Grundfos SP27-12 was selected for the test. The pump inlet was set at 98 metres below the ground surface. Flow rates were measured by a flow metre installed in the borehead configuration, these flow rates were checked by monitoring the vee notch weir emplaced between the drilling sumps.

Groundwater was discharged into the local drainage tracts and flowed away from the bore at a sufficient rate to eliminate any recirculation effects.

4. HYDRAULIC ANALYSIS

Analysis of the test pumping programme has been calculated using the Jacobs form of the Theis equation and variations pertaining to "leaky aquifer" conditions. Recovery and distance / drawdown analysis utilised the least squares method applied to the Theis equation. The data has been subject to both computerised and manual interpretation for comparative results. Storage effects and delayed yield effects were also considered in the manual analysis. A summary of hydraulic parameters are summarised in Tables 2 and 3.

4.1 Step Drawdown Test

The variable rate step drawdown test was conducted over 90 minutes. The bore was pumped at three rates: $12m^3h^{-1}$, $15m^3h^{-1}$ and $18m^3h^{-1}$.

Figure 4.1 clearly demonstrates that the water level in the bore is responsive to the groundwater extraction rate.

4.2 Constant Rate Pump Test

This test commenced on 25th July 1994. Regular monitoring occurred for four days. Drawdown readings plotted against elapsed time are presented in Figures 4 to 7. Computerised analysis along with pump test data is provided in Appendix 2.

TABLE 2

SUMMARY OF HYDRAULIC PARAMETERS

Bore Number	Pumping Test		Recovery Test
	Transmissivity (kd) (m^2d^{-1})	Storativity (S)	Transmissivity (kd) (m^2d^{-1})
MPB1	40	-	49
ME11	44	0.0157	43
DD1	41	0.0025	-
DD2	50	0.0112	-

TABLE 3

DISTANCE DRAWDOWN ANALYSIS SUMMARY

Pumping Duration (mins)	Drawdown				Transmissivity (kd) (m^2d^{-1})	Storage Co-efficient (S)
	Bore Number and Radial Distance					
	MPB1 r:0m	ME11 r:16.3m	DD1 r:103m	DD2 r:78m		
1380	6.33	2.7	1.32	0.82	59	0.00283
3000	6.74	3.02	1.73	1.04	58	0.00367
5760	7.44	3.51	2.17	1.26	55	0.00444

5. HYDROGEOLOGY

The main aquifer at the Python prospect is associated with highly fractured and jointed banded iron formation. The degree of fracturing is increased around the mafic contacts encountered at 95 metres and 124 to 126 metres.

The airlift yield encountered during hole reaming continued to increase with depth. Significant fracture of the banded iron formation was recorded as deep as 154 metres in the reverse circulation exploration hole. The vertical extent of the aquifer is undefined.

The standing water level recorded prior to the commencement of the test pumping programme was 59.05 metres in bore MPB1. The true standing water level is estimated to be approximately 57 metres below the ground surface.

Test pumping results and detailed analysis indicates that the aquifer has high groundwater storage potential of saline groundwater.

6. GROUNDWATER QUALITY

A detailed groundwater chemical analysis certificate is provided in Appendix 3.

The total dissolved solids (tds) calculated by gravimetric methods is 10,200 parts per million with a pH of 7.6.

Table 4 presents six total dissolved solids values recorded during the pumping test.

TABLE 4

BORE MPB1 PROGRESSIVE SALINITY DATA

Elapsed time of pumping (minutes)	10	720	1440	2880	4320	5760
(hours)	-	12	24	48	72	96
Total dissolved solids (ppm)	11410	11430	11120	11150	11110	11130

The tds readings presented in Table 4 have been calculated using electrical conductivity methods. A slight variation in tds values is apparent between the analysis certificate and Table 4. This is attributed to the different analytical methods used. The tds of 10,200 ppm value acquired using gravimetric methods is more accurate.

Table 4 indicates that minor fluctuations have occurred during the 96 hour pump test. An overall trend of salinity decrease has been observed. This trend is not expected to continue. The predicted salinity value variation pattern will be one of slight fluctuations during groundwater extraction. Regular water sampling at three monthly intervals is required to test for the tds value long term trends.

7. DRAWDOWN TRENDS AND RECOMMENDED THEORETICAL SUSTAINABLE PUMPING

Table 5 provides six and twelve months theoretical drawdown projections at the Python project.

TABLE 5

SIX AND TWELVE MONTH THEORETICAL DRAWDOWN PROJECTION SUMMARY

Bore Number	Standing Water Level (m)	Water Level Projection (m)	
		Six Month	Twelve Month
MPB1	57	71	73
ME11	57	66	68
DD1	59	65	67
DD2	57	64	65

The theoretical sustainable pumping rate based on two years continuous pumping has been calculated to be in the order of 40 kilolitres per hour, however a more realistic sustainable pumping rate of 20 kilolitres per hour is recommended during the early stages of pumping. This sustainable pumping rate can be reviewed and adjusted using drawdown information and extraction volume monitoring data following one months continuous pumping.

8. BOREFIELD EXPANSION

A re-appraisal of the bores performance is recommended following one to three months of continuous pumping and regular monitoring. This assessment will be combined with the recent pump test analysis and will provide key information regarding long term sustainable extraction from the bore.

At least one additional production bore is recommended for backup purposes.

The minimum spacial distance between production bores targeting the banded iron formation aquifer is 500 metres, based on the recent test pumping analysis.

Water exploration drillhole ME9 (Figure 2.1) was drilled at the Dolly Pot prospect, located approximately 1.3 kilometres west of bore MPB1. This exploratory hole has defined a potential bore site that encountered similar lithologies and airlift yields as exploratory hole ME10 that was converted to the production bore MPB1.

9. GROUNDWATER MONITORING REQUIREMENTS

The pumping bore MPB1 should be equipped with a 20 millimetre diameter tube attached to the riser pipe in the bore to allow a monitoring probe to check water levels. An inline flow meter is required in the borehead configuration to monitor groundwater extraction volumes.

Water levels in all observation bores and the pumping bore along with groundwater extraction volumes are to be recorded at least monthly, however weekly readings are suggested in the first month following bore commissioning.

Groundwater salinities are to be recorded from each bore at least every three months. A full chemical analysis, similar to the certificate presented in Appendix 3 is required annually.

A borefield monitoring report must be compiled annually to satisfy the Water Authority of Western Australia's licensing requirements. This report will display water levels, groundwater extraction, tds values and climatic information graphically and will comment on the effects of pumping on a local and regional scale in the area.

10. CONCLUSIONS

* Production bore MPB1 and observation bore ME11 were constructed by Dunlop Drilling during a recent groundwater drilling programme.

* A test pumping programme has been conducted on bore MPB1. The test pumping programme comprised: a variable rate step drawdown test; a constant rate pumping test and a recovery test.

* The transmissivity range of the aquifer at the Python prospect is between $40m^2d^{-1}$ and $59m^2d^{-1}$.

* The initial storage co-efficient calculation ranges between 0.0025 and 0.0112.

* The production and observation bores intersect fractured banded iron formation and mafic lithologies. The aquifer extends from 95 metres downwards. Significant rock fracturing was encountered at 154 metres.

* The total dissolved solid content measured by gravimetric methods is 10,200 ppm.

* No overall increase in salinity value was measured during the test pumping programme.

* A drawdown of 7.44 metres (66.45m below ground surface) was achieved in bore MPB1 after four days of continuous pumping at the rate of 18 kilolitres per hour (432 kl/day).

* A drawdown of 16 metres (73m below ground surface) is predicted after one years continuous pumping of bore MPB1 at a rate of 20 kilolitres per hour.

11. RECOMMENDATIONS

* A sustainable pumping rate of 20 kilolitres per hour (480 kl/day) is suggested during the initial stages of pumping.

* At least one additional production bore is recommended for backup and supply purposes during ore processing.

* Water exploration drillhole ME9 is a suitable bore site for development if required.

* The groundwater monitoring programme contained in Section 9 must be strictly maintained for licensing purposes and is required for borefield performance assessment.

* A re-appraisal of bore performance based on monitoring data should be conducted following one to three months continuous pumping.

12. REFERENCES

- Work Proposal Groundwater Supply Investigations for Gondwana Resources NL, dated 21st April 1994: KH Morgan and Associates

- Report on Groundwater Exploration at the Marda Project for Gondwana Resources NL, dated 1st June 1994: KH Morgan and Associates

SJ DOYLE BSc MAIG

KH MORGAN BSc FAusIMM MMICA MAIG FGAA

26th August, 1994

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FIGURES

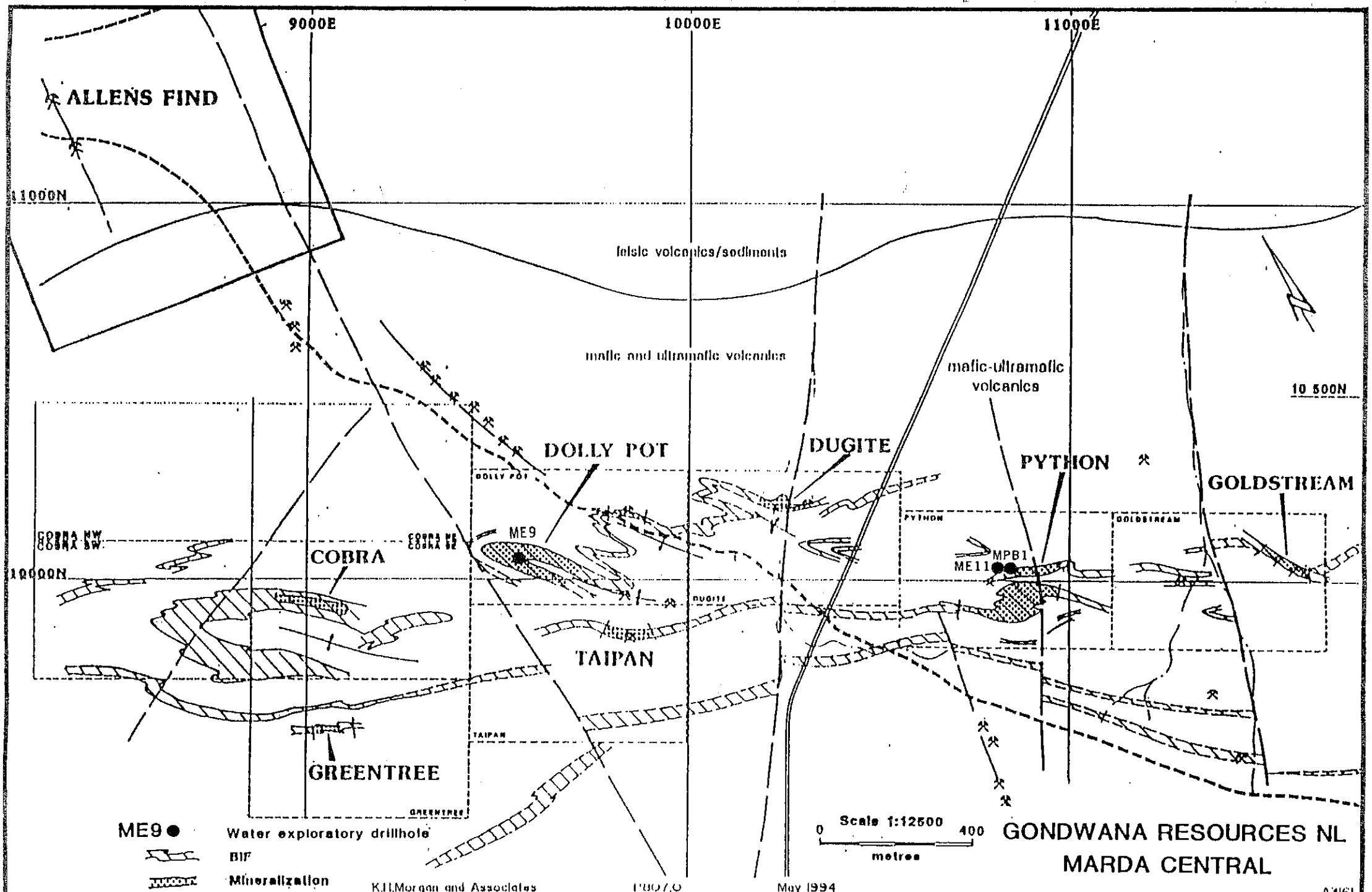
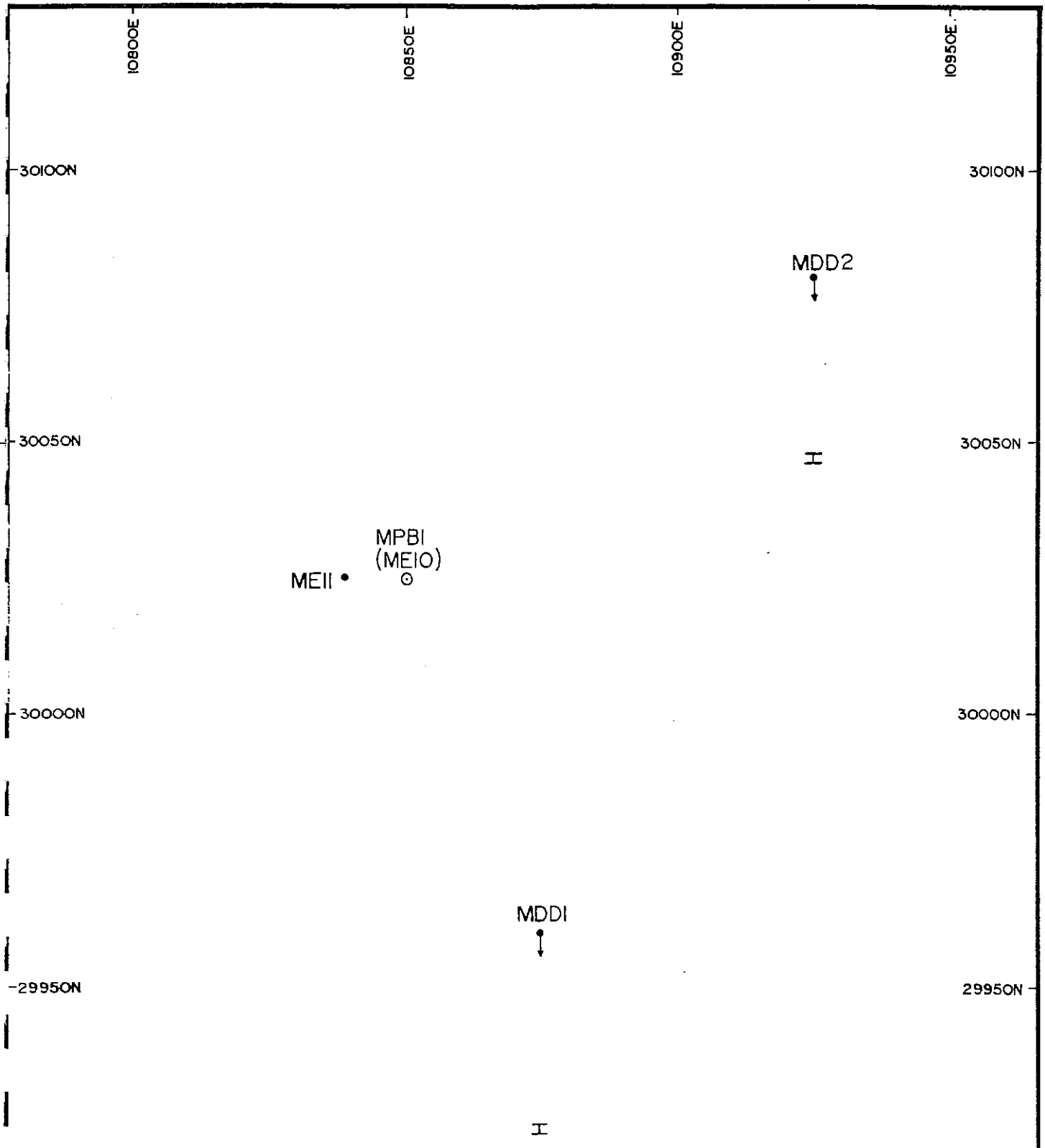

9000E
10000E
11000E
ALLENS FIND
11000N
felsic volcanics/sediments
mafic and ultramafic volcanics
mafic-ultramafic volcanics
10 500N
DOLLY POT
DUGITE
PYTHON
GOLDSTREAM
COBRA NW
COBRA SW
COBRA NE
COBRA SE
COBRA
ME9
MPB1
ME11
10000N
TAIPAN
GREENTREE
ME9 ● Water exploratory drillhole
BIF
Mineralization
Scale 1:12500
0
400
metres
GONDWANA RESOURCES NL
MARDA CENTRAL
K.J.Morgan and Associates
May 1994
A3161

FIGURE 2.1



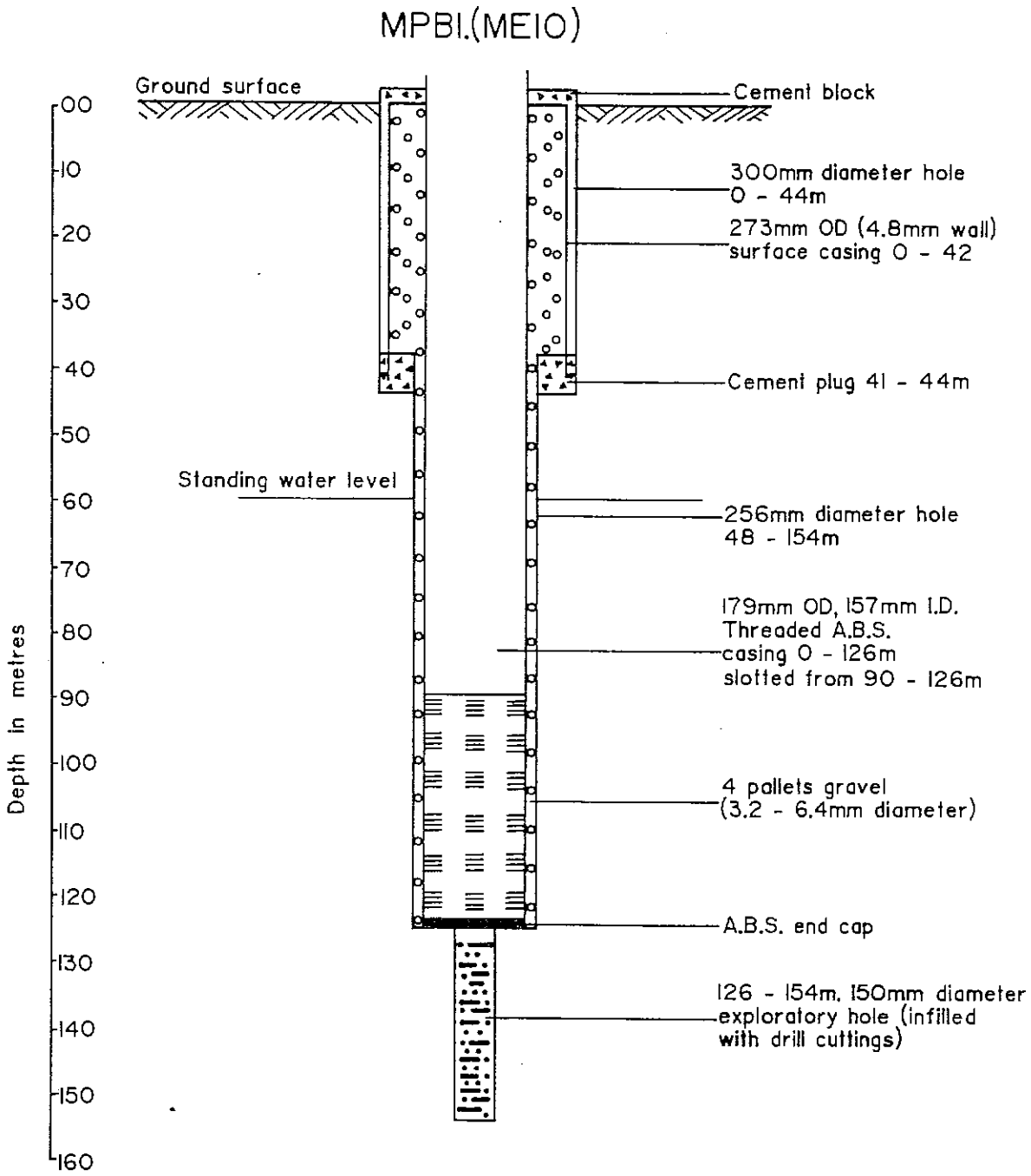
REFERENCE

- ⊙ MPBI Production bore
- • MEII Water exploratory 140CE cased observation bore
- MDDI Cased diamond drill hole 60° declination
- Drawdown response zone from declined hole

GONDWANA RESOURCES NL
BORE LOCATION DIAGRAM
PYTHON PROSPECT

K.H.Morgan and Associates P807 Aug 1994 A3215

FIGURE 2.2



GONDWANA RESOURCES NL

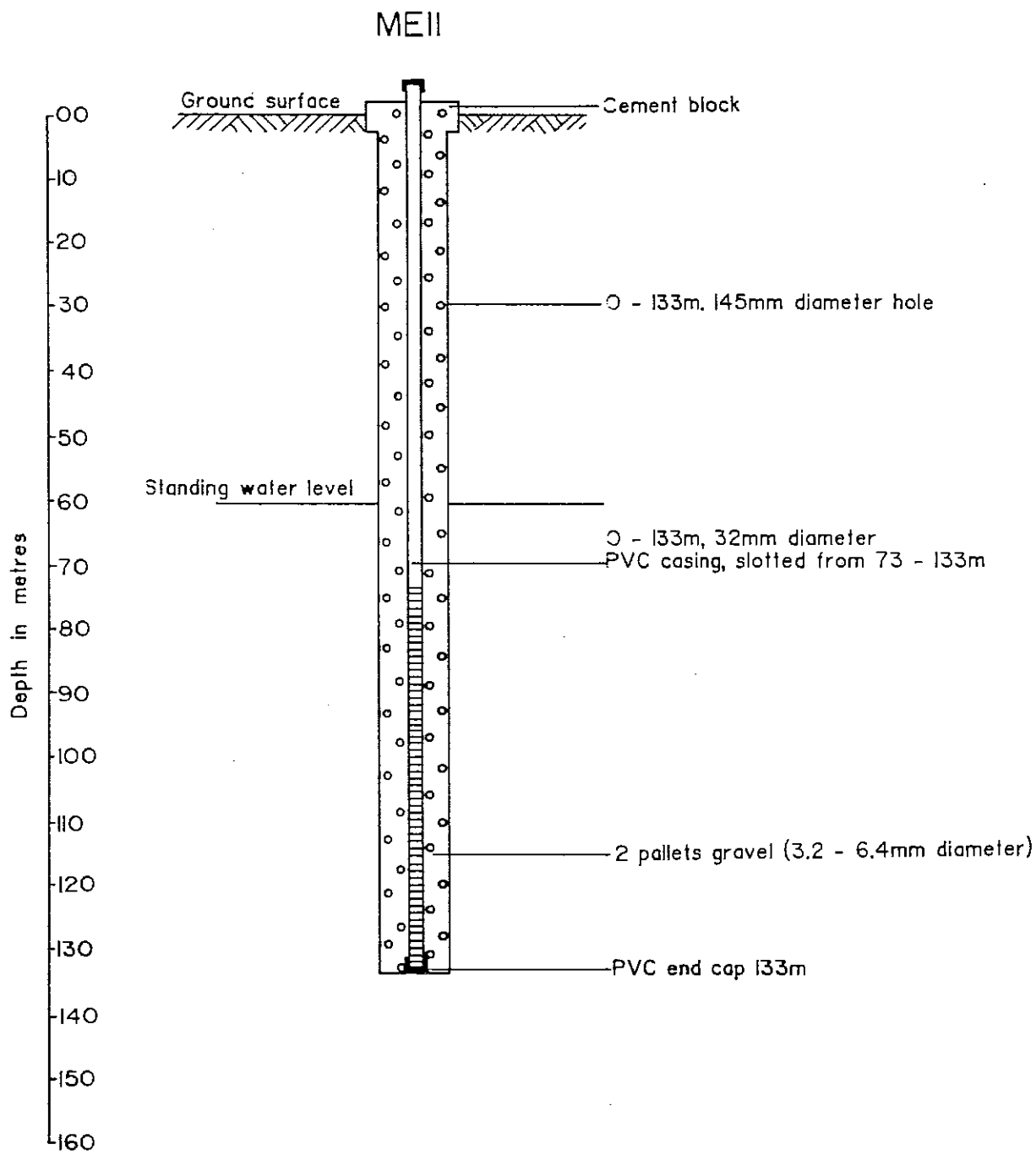
PRODUCTION BORE

CONSTRUCTION DETAILS

MPB1

K.H.Morgan and Associates P807 Aug 1994 A3216

FIGURE 3.1

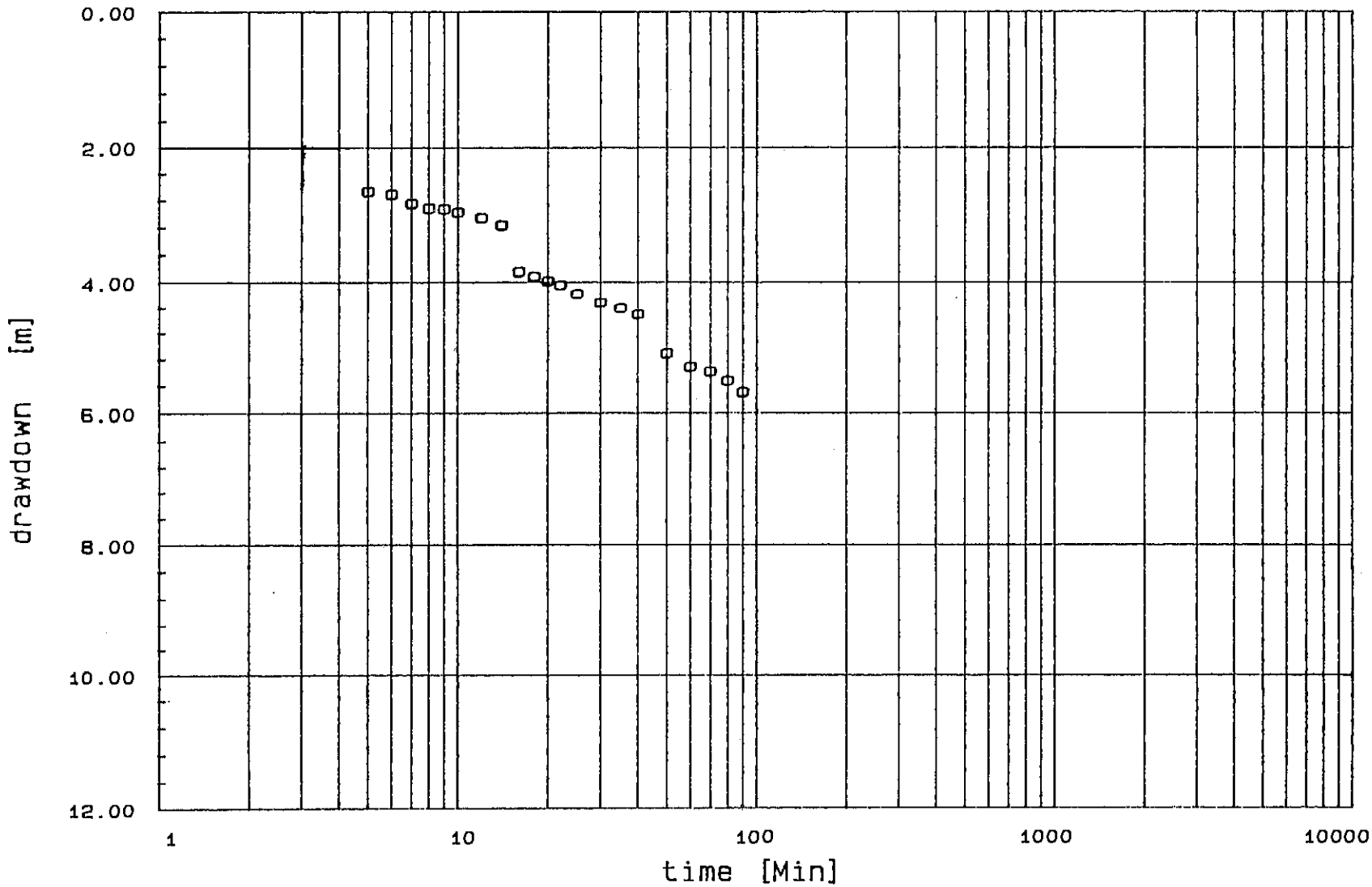


GONDWANA RESOURCES NL
OBSERVATION BORE
CONSTRUCTION DETAILS
ME11

FIGURE 3.2

BORE MPB1: STEP DRAWDOWN TEST (12, 15 & 18 KILOLITRES/HOUR)

GONDWANA RESOURCES NL. MARDA PROJECT



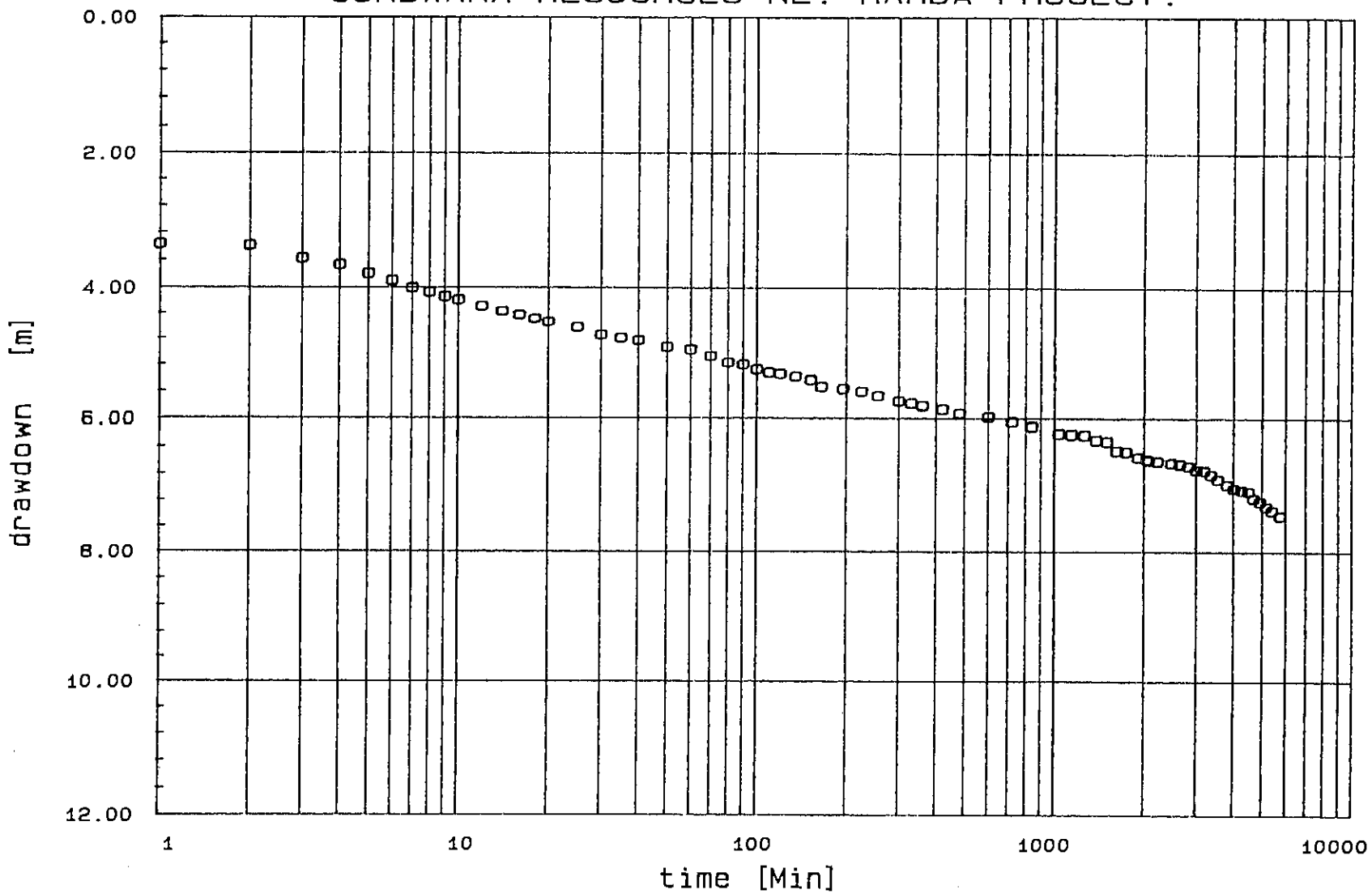
PUMPING RATE = 432 Cub.M./day.
START OF TEST ON 25.7.94

PROJECT NO. 807
KH MORGAN and ASSOCIATES
FIGURE 4.1

CP869

PRODUCTION BORE MPB1: DRAWDOWN v ELAPSED TIME

GONDWANA RESOURCES NL. MARDA PROJECT.

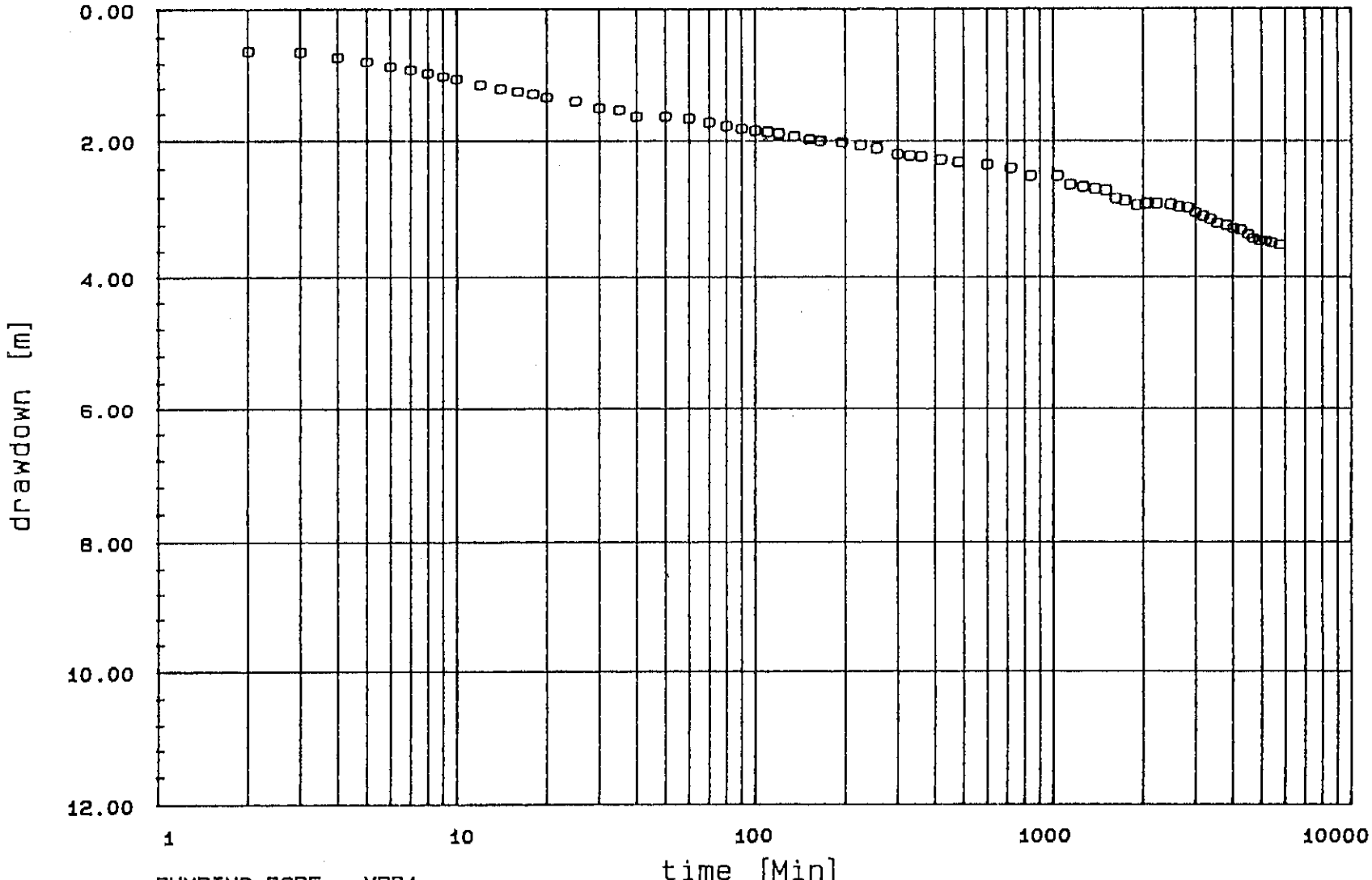


PUMPING RATE = 432 Cub.M./day.
START OF TEST ON 25.7.94

PROJECT NO. 807
KH MORGAN and ASSOCIATES
FIGURE 4.2

OBSERVATION BORE ME11: DRAWDOWN v ELAPSED TIME

GONDWANA RESOURCES NL. MARDA PROJECT.



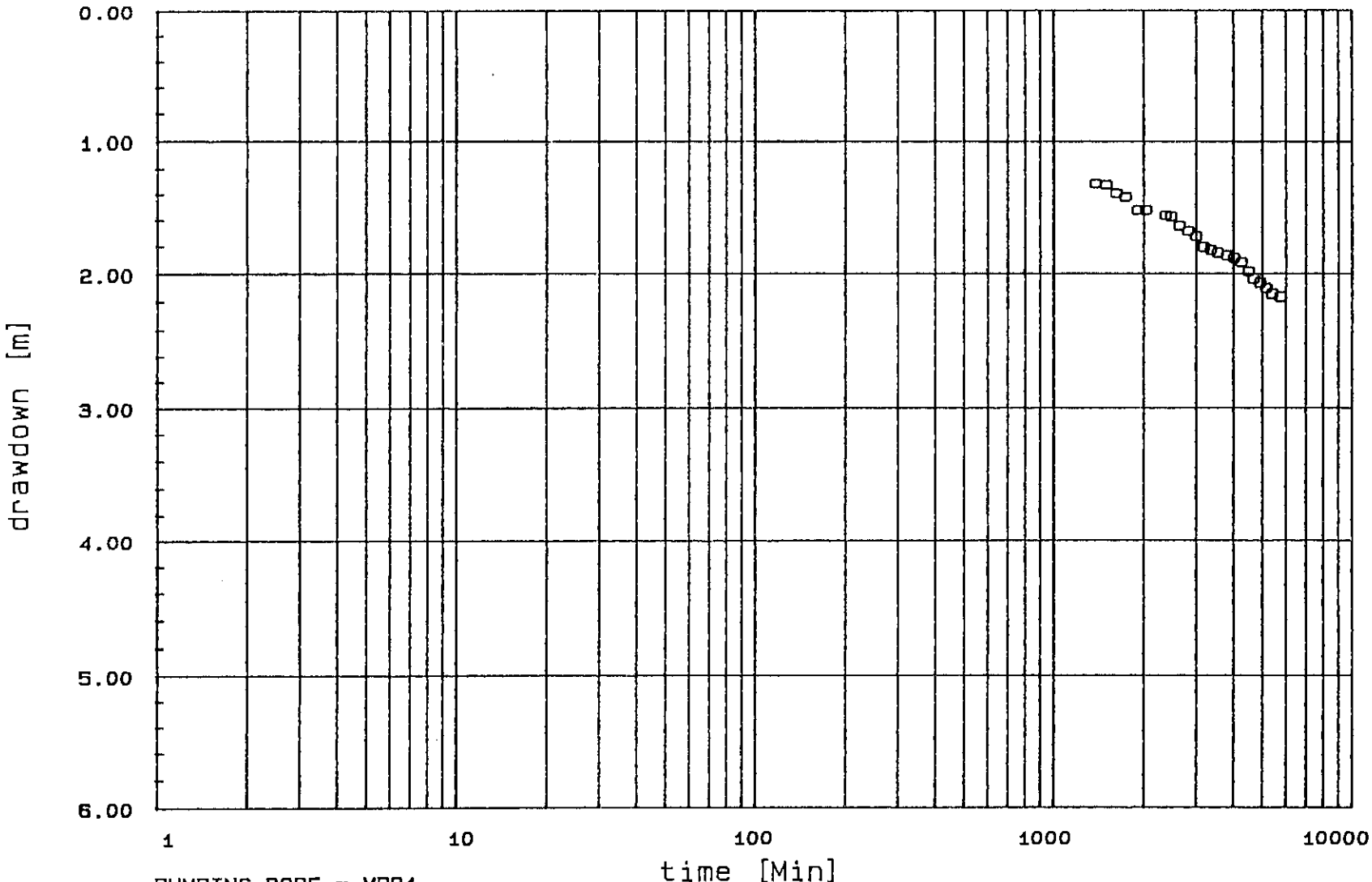
PUMPING BORE - MPB1
DIST. TO PUMPING BORE - 16.3 M.
PUMPING RATE - 432 Cub.M./day.
START OF TEST ON 25.7.94

PROJECT NO. 807
KH MORGAN and ASSOCIATES
FIGURE 5

CP871

DIAMOND HOLE DD1: DRAWDOWN v ELAPSED TIME

GONDWANA RESOURCES NL. MARDA PROJECT.



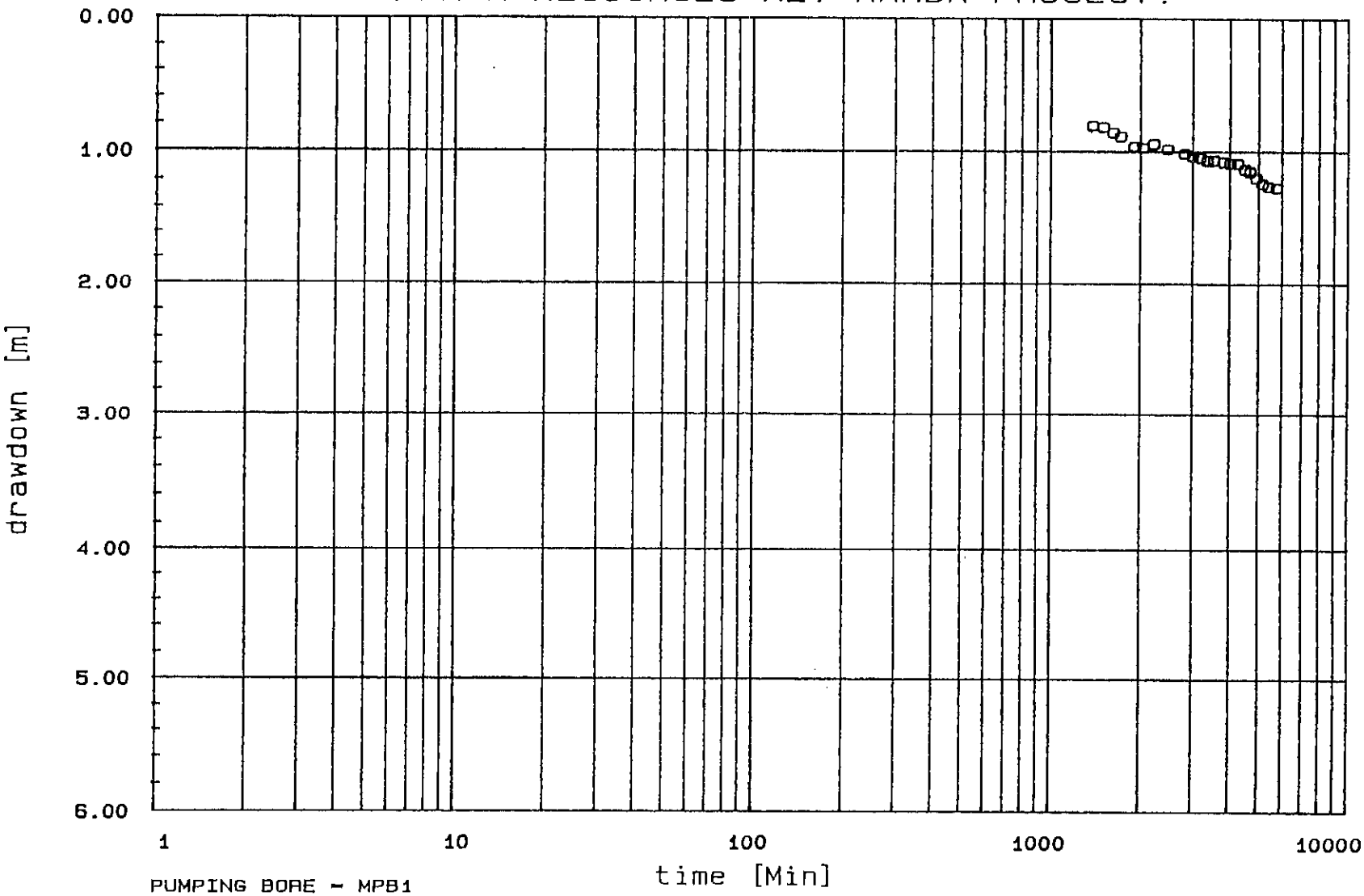
PUMPING BORE = MPB1
DIST. TO PUMPING BORE = 103.0 M.
PUMPING RATE = 432 Cub.M./day.
START OF TEST ON 25.7.94

PROJECT NO. 807
KH MORGAN and ASSOCIATES
FIGURE 6

CP872

DIAMOND HOLE DD2: DRAWDOWN v ELAPSED TIME

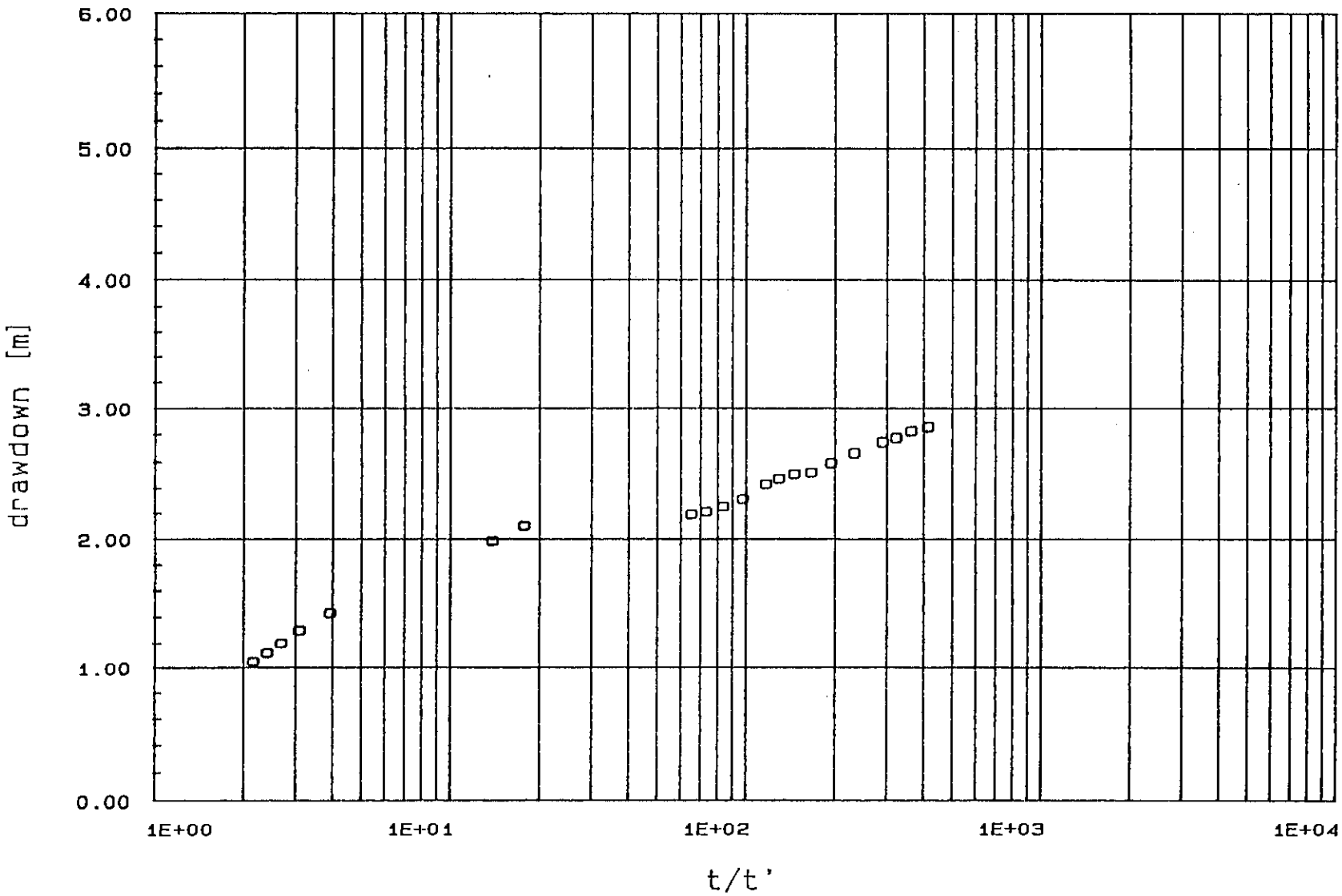
GONDWANA RESOURCES NL. MARDA PROJECT.



PUMPING BORE - MPB1
DIST. TO PUMPING BORE - 78.0 M.
PUMPING RATE - 432 Cub.M./day.
START OF TEST ON 25.7.94

PROJECT NO. 807
KH MORGAN and ASSOCIATES
FIGURE 7

CP873

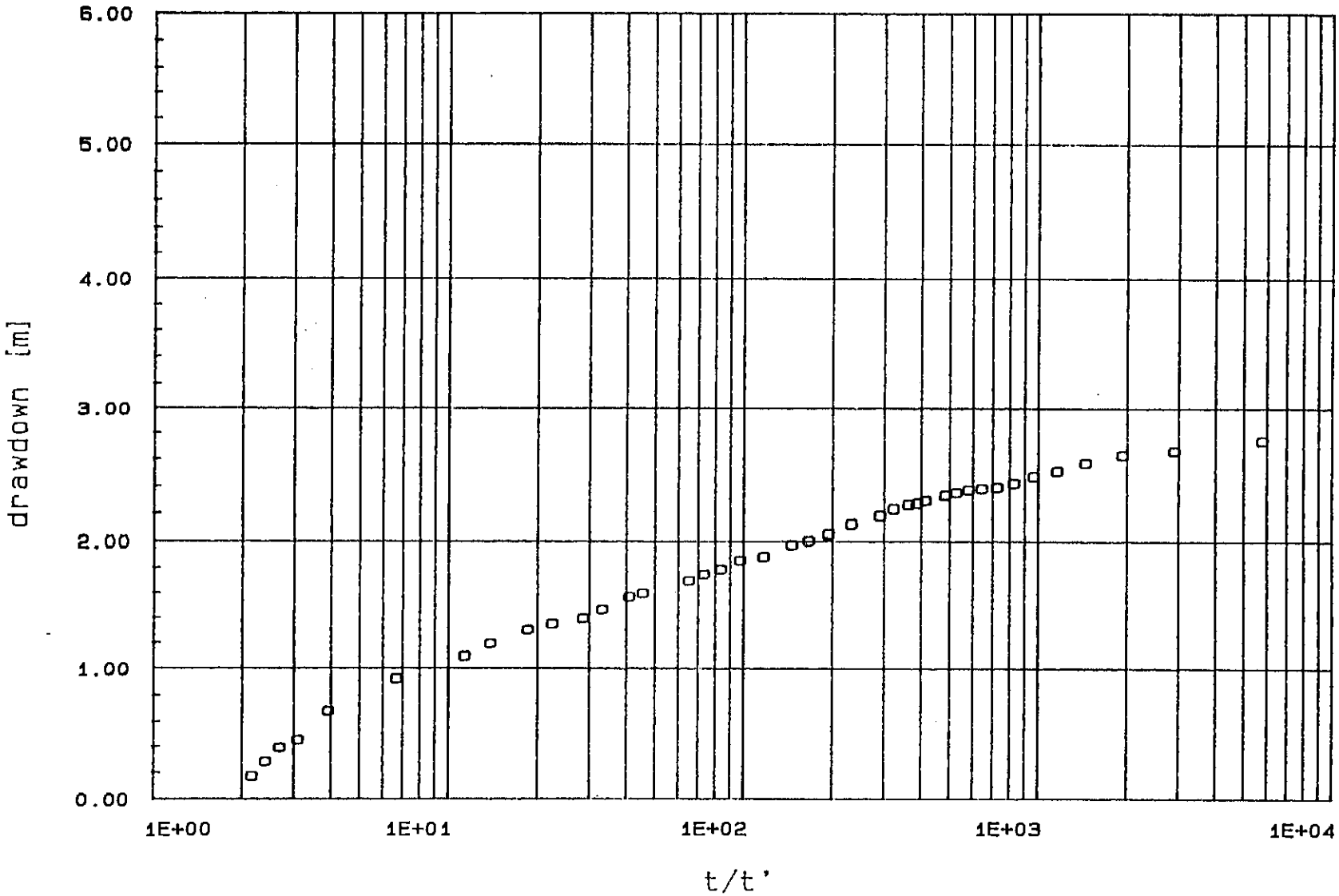


FILE: B:\GOND\ME11.REC

CP874

FIGURE 8

OBSERVATION BORE ME11: RECOVERY

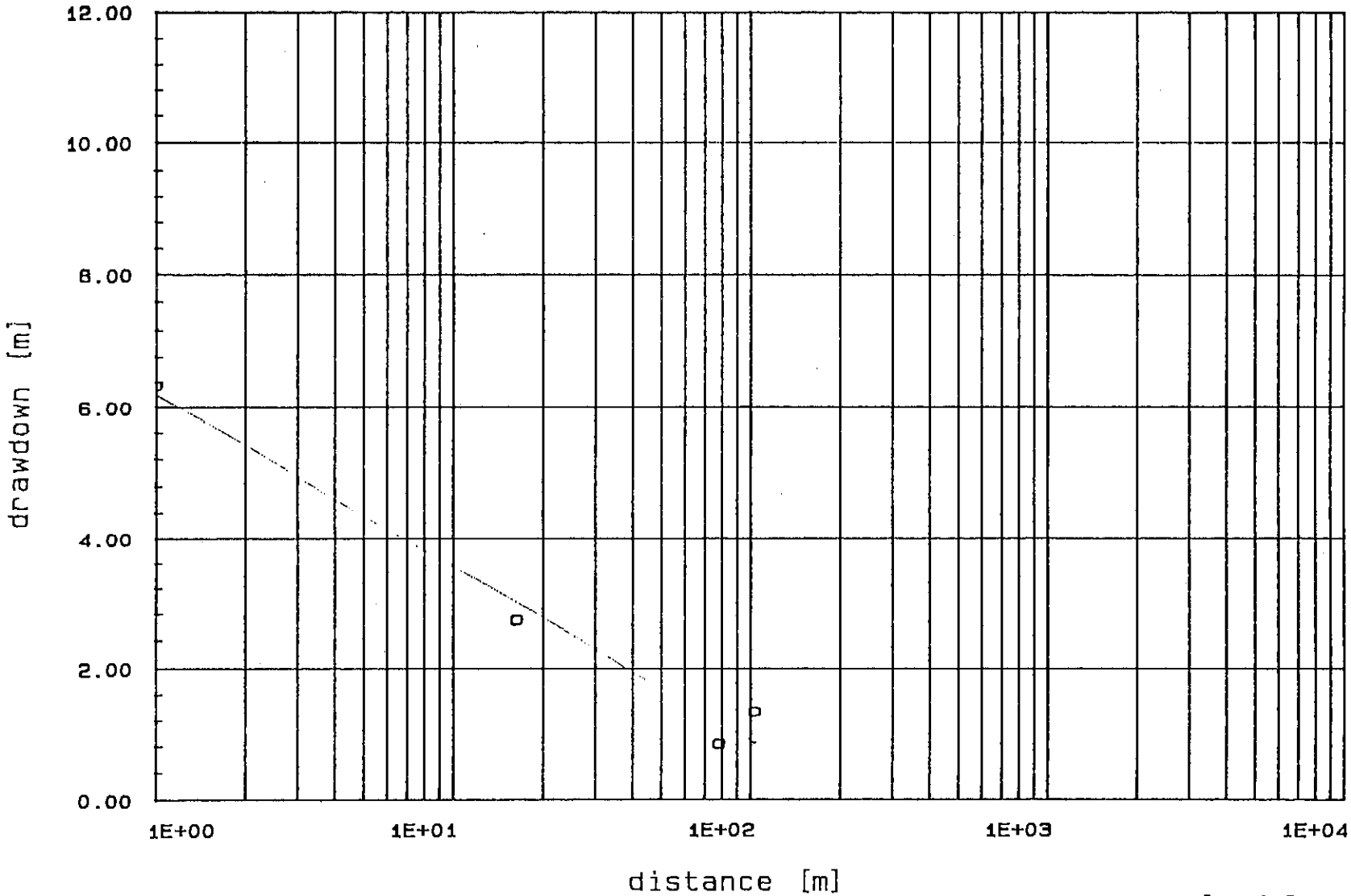


FILE: B:\GOND\ME11.REC

CP875

FIGURE 9

1380 MINUTE : DISTANCE DRAWDOWN ANALYSIS



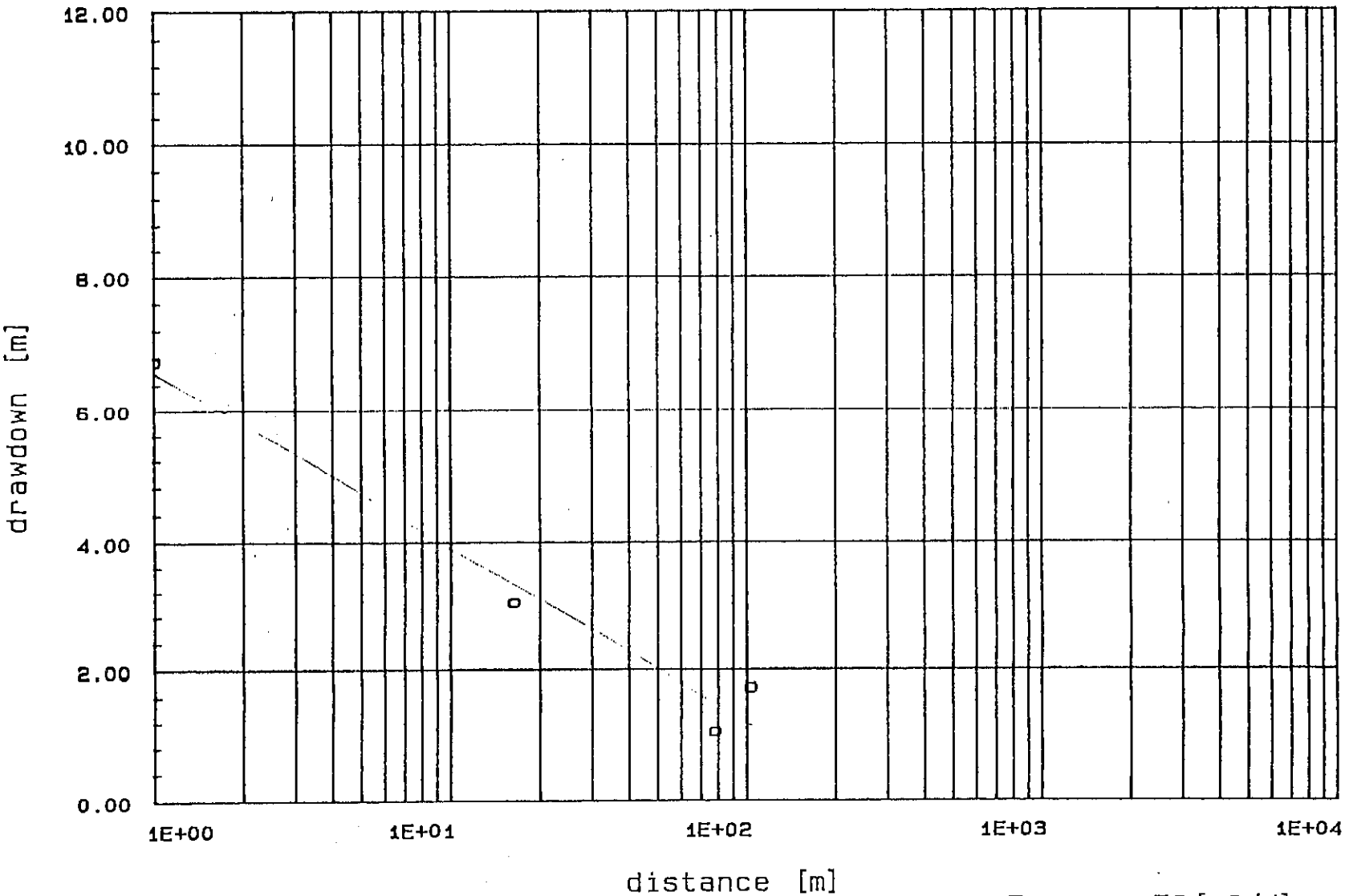
T = 59 [m2/d]
S = .283E-02

FILE: B:\GOND\1380.DIS

CP876

FIGURE 10

3000 MINUTE: DISTANCE DRAWDOWN ANALYSIS

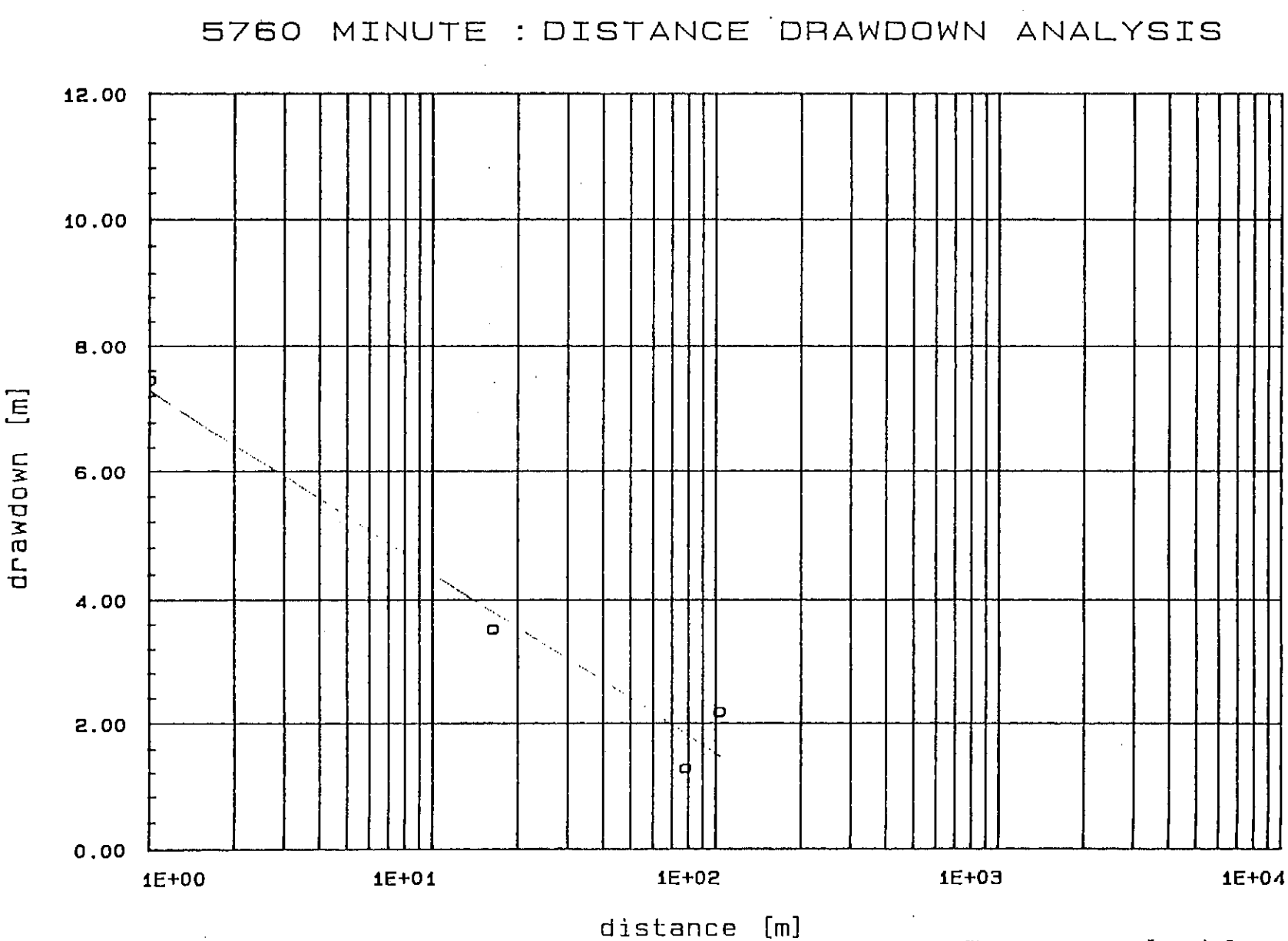


T = 58 [m2/d]
S = .367E-02

FILE: B:\GOND\3000.DIS

CP877

FIGURE 11



CP878

FIGURE 12

APPENDICES

APPENDIX 1

DRILL LOGS

WATER BORE DRILL LOG

PROJECT:	807.01 GONDWANA RESOURCES NL MARDA WATER SUPPLY
DRILLHOLE NUMBER:	MPB1 (ME10)
Date drilled	16.7.94 to 21.7.94
Location	Python 10850E/30025N
Total depth	154 metres (cased to 126m)
Standing water level	59 metres
Water encountered	88 metres
Main aquifer	95 to 126 metres
Yield and test method	$25 m^3 h^{-1}$, vee notch weir
Salinity	10,200 ppm tds
Drilling contractor	Dunlop Drilling
Drilling rig	Ingersoll Rand T4
Drilling method	reverse circulation
Hole sizes, bits, depths	300mm, rolla 0m - 44m; 256mm, hammer 0m - 126m 150mm, hammer 126m - 154m
Driller	T Westcott
Logged by	S Doyle
Down-hole logs	-
Completion details:	
collar and cementing	0m - 42m 155mm 273mm outer diameter steel casing
casing	0m - 126m 179mm od (157mm id) ABS threaded casing
screens and slots	slotted from 90m - 126m
development	3 hours airlifting
gravel pack	$4 m^3$ of 3.2 to 6.4mm diameter graded gravel

DRILLHOLE MPB1 (ME10)

0 - 2	Light brown and red-brown sandy clay.
2 - 9	Pale grey highly weathered felsic rock.
9 - 44	Light yellow-brown and light red-brown weathered siliceous rock.
44 - 57	Dark red-brown banded iron formation.
57 - 85	Light yellow-brown and light red-brown weathered siliceous basalt; minor narrow quartz veins occurring throughout. Increasing freshness with depth.
85 - 89	Dark red-brown jasperoidal banded iron formation.
89 - 95	Grey brown and black moderately weathered to fresh basalt. Wet samples at upper and lower contacts with banded iron formation.
95 -124	Banded iron formation. Predominately black, siliceous (cherty) iron-stone. High specific gravity from 95 to 104 metres. Banded iron enriched bands. Moderate fracturing throughout.
124 -126	Grey-green fine grained basalt with minor quartz veining; broken ground on upper and lower contact with banded iron formation (main aquifer).

Total depth of bore casing 126 metres.

126 -154 Banded iron formation with variable quartz veining (up to 10%). Minor pyritic mineralisation throughout. Predominately red-brown jasperoidal chert with iron enriched bands. Grey banded chert from 148 to 152 metres.

Flow testing during reaming:

Depth (m)	Yield (m^3h^{-1})
90	5
112	15
118	30
124	42
126	50

Flow testing during development:

Time	Yield (m^3h^{-1})
10 minutes	30
1 hour	28
2 hours	26
3 hours	25

WATER BORE DRILL LOG

PROJECT:	807.01 GONDWANA RESOURCES NL MARDA CENTRAL
DRILLHOLE NUMBER:	ME11 (OBS1)
Date drilled	24.7.94 to 25.7.94
Location	Python, 30025N/10838.7E
Total depth	133 metres
Standing water level	59.05 metres
Water encountered	80 metres
Main aquifer	80 to 133 metres
Yield and test method	$4m^3h^{-1}$ bucket fill
Salinity	12,000 ppm tds
Drilling contractor	Dunlop Drilling
Drilling rig	Ingersoll Rand T4
Drilling method	reverse circulation
Hole sizes, bits, depths	150mm diameter hammer
Driller	C Dunlop
Logged by	F Jerinic, S Doyle
Down-hole logs	-
Completion details:	
collar and cementing	0m - 2m 150mm diameter class 9 pvc, cemented
casing	0m - 133m 32mm diameter class 9 pvc
screens and slots	73m - 133m slotted internal
development	30 minutes airlifting
gravel pack	$2m^3$ of 3.2mm to 6.4mm diameter washed gravel

DRILLHOLE ME11

0 - 4	Light grey and pale red-brown highly weathered felsic rock and red-brown sandy clay.
4 - 11	Pale yellow-grey highly weathered siliceous rock.
11 - 12	Pale grey moderately weathered siliceous rock.
12 - 15	Dark and pale grey, red-brown moderately weathered to highly siliceous banded iron formation. 14 - 15 Containing quartz infilled hairline fractures.
15 - 16	Dark grey and red-brown moderately weathered cherty banded iron formation.
16 - 18	Light grey and dark grey moderately weathered cherty banded iron formation.
18 - 19	As above; highly weathered, clay rich.
19 - 27	Light grey and red-brown moderately weathered cherty banded iron formation.
27 - 29	Orange clay with oxidised cherty fragments.
29 - 30	As above with highly weathered siliceous fragments.
30 - 38	Orange oxidised mafic, clay rich.
38 - 39	Dark orange oxidised mafic.
39 - 40	Dark orange and grey moderately weathered banded iron formation. Quartz five percent.
40 - 43	Brown-red moderately weathered banded iron formation.
43 - 46	Orange highly weathered gritty banded iron formation.
46 - 52	Purple-red banded iron formation, highly specific gravity.
52 - 61	Orange and red-brown highly oxidised banded iron formation.
61 - 69	Purple-red and dark grey moderately weathered iron rich banded iron formation. Red brown cherty banded iron formation contain quartz two percent and green-grey basalt fragments. Damp 67 to 68 metres.
69 - 77	Dark grey and red-brown iron rich banded iron formation.
77 - 80	Dark red-brown iron rich banded iron formation.
80 - 81	Red-brown and dark grey banded iron rich banded iron formation. Quartz content two percent.

DRILLHOLE ME11

84 - 88	Dark grey iron rich banded iron formation, contain minor disseminated and crystalline pyrite and trace pyrrhotite.
88 - 91	Grey-green basalt.
91 - 93	Dark grey and red-brown finely banded iron formation and grey-green basalt. Quartz veins 15 percent. Trace of disseminated pyrite present.
93 - 94	Medium green-grey medium grained mafic.
94 -100	Pale grey highly weathered foliated mafic.
100-101	Medium grey orange stained moderately weathered mafic contains finely disseminated sulphides and minor quartz.
101-102	Light brown moderately weathered cherty banded iron formation.
102-103	Dark grey iron rich, moderately weathered banded iron formation.
103-105	Black-brown iron rich, banded iron formation.
105-117	Dark grey and red finely banded iron rich, banded iron formation.
117-120	Green-grey and medium brown stained moderately weathered foliated ultramafic. Quartz 5 to 10 percent veins. Minor pyrite.
120-121	Dark grey highly weathered mafic.
121-127	Dark green-grey slightly weathered fractured mafic. Contains quartz four percent fragments and contains trace finely disseminated sulphides.
127-133	Dark grey and red-brown finely banded iron rich, banded iron formation quartz veined, less than one percent.

Flow testing:	Depth	Yield (l/sec)
	112	0.30
	118	0.50
	124	0.72
	130	0.95
	133	1.2

APPENDIX 2

PUMP TEST DATA

PROJECT..... = GONDWANA RESOURCES NL. MARDA PROJECT
LOCATION..... = PYTHON PROSPECT
BORE..... = MPB1.VARIABLE RATE STEP TEST
STATUS..... = PUMPED BORE
STATIC WATER LEVEL = 59.000[m]
PUMPING RATE..... = 432 [m3/day]
START OF TEST..... = 25.7.94

TIME [min]	DRAWDOWN[m]
5.00	2.670
6.00	2.710
7.00	2.850
8.00	2.920
9.00	2.930
10.00	2.980
12.00	3.060
14.00	3.170
16.00	3.850
18.00	3.920
20.00	3.990
22.00	4.050
25.00	4.180
30.00	4.320
35.00	4.410
40.00	4.510
50.00	5.110
60.00	5.320
70.00	5.390
80.00	5.530
90.00	5.700

PROJECT..... = GONDWANA RESOURCES NL. MARDA PROJECT.
LOCATION..... = PYTHON PROSPECT (30025N 10850E)
BORE..... = MPB1
STATUS..... = PUMPED BORE
STATIC WATER LEVEL = 59.050[m]
PUMPING RATE..... = 432 [m3/day]
START OF TEST..... = 25.7.94

TIME [min]	DRAWDOWN[m]	TIME [min]	DRAWDOWN[m]
1.00	3.370	840.00	6.120
2.00	3.390	1035.00	6.220
3.00	3.580	1140.00	6.230
4.00	3.670	1260.00	6.240
5.00	3.800	1380.00	6.310
6.00	3.900	1500.00	6.330
7.00	4.010	1620.00	6.460
8.00	4.070	1740.00	6.470
9.00	4.140	1910.00	6.550
10.00	4.190	2040.00	6.600
12.00	4.290	2070.00	6.560
14.00	4.370	2220.00	6.600
16.00	4.430	2474.00	6.580
18.00	4.490	2640.00	6.600
20.00	4.540	2820.00	6.640
25.00	4.630	3000.00	6.740
30.00	4.750	3180.00	6.750
35.00	4.800	3360.00	6.810
40.00	4.840	3540.00	6.880
50.00	4.940	3810.00	6.960
60.00	4.980	4020.00	7.020
70.00	5.080	4260.00	7.050
80.00	5.180	4500.00	7.070
90.00	5.210	4680.00	7.170
100.00	5.280	4920.00	7.220
110.00	5.330	5160.00	7.300
120.00	5.350	5400.00	7.360
135.00	5.390	5760.00	7.440
152.00	5.440		
165.00	5.540		
195.00	5.570		
225.00	5.610		
255.00	5.670		
300.00	5.750		
330.00	5.780		
360.00	5.820		
420.00	5.870		
480.00	5.930		
600.00	5.980		
720.00	6.050		

****

TRANSMISSIVITY Kd = 40 [m2/d]

DATA SEGMENT ANALYZED :
- starting with data pair 50
- ending with data pair 68

PROJECT..... = GONDWANA RESOURCES NL. MARDA PROJECT.
LOCATION..... = PYTHON PROJECT (30025N 10838.7E).
BORE..... = ME11
STATUS..... = OBSERVATION BORE
DIST.TO PUMPED BORE = 16.30[m]
STATIC WATER LEVEL = 59.010[m]
PUMPING RATE..... = 432 [m3/day]
START OF TEST..... = 25.7.94

TIME [min]	DRAWDOWN[m]	TIME [min]	DRAWDOWN[m]
2.00	0.620	1035.00	2.510
3.00	0.630	1140.00	2.630
4.00	0.710	1260.00	2.660
5.00	0.780	1380.00	2.690
6.00	0.860	1500.00	2.710
7.00	0.910	1620.00	2.820
8.00	0.970	1740.00	2.850
9.00	1.020	1910.00	2.910
10.00	1.060	2040.00	2.900
12.00	1.150	2070.00	2.880
14.00	1.220	2220.00	2.890
16.00	1.260	2474.00	2.900
18.00	1.300	2640.00	2.940
20.00	1.350	2820.00	2.950
25.00	1.410	3000.00	3.020
30.00	1.520	3180.00	3.070
35.00	1.550	3360.00	3.120
40.00	1.650	3540.00	3.180
50.00	1.650	3810.00	3.210
60.00	1.680	4020.00	3.260
70.00	1.740	4260.00	3.280
80.00	1.790	4500.00	3.350
90.00	1.830	4680.00	3.410
100.00	1.860	4920.00	3.450
110.00	1.880	5160.00	3.450
120.00	1.900	5400.00	3.480
135.00	1.940	5760.00	3.510
152.00	1.990		
165.00	2.010		
195.00	2.030		
225.00	2.070		
255.00	2.120		
300.00	2.200		
330.00	2.220		
360.00	2.230		
420.00	2.280		
480.00	2.310		
600.00	2.350		
720.00	2.400		
840.00	2.510		

****

TRANSMISSIVITY Kd = 44 [m2/d]
STORATIVITY S = .0157458400

PROJECT..... = GONDWANA RESOURCES NL. MARDA PROJECT,
LOCATION..... = PYTHON PROJECT (29960N 10875E)
BORE..... = MDD1
STATUS..... = OBSERVATION BORE
DIST.TO PUMPED BORE = 103.00 [m]
STATIC WATER LEVEL = 61.000 [m]
PUMPING RATE..... = 432 [m3/day]
START OF TEST..... = 25.7.94

TIME [min]	DRAWDOWN [m]
1380.00	1.320
1500.00	1.330
1620.00	1.400
1740.00	1.430
1910.00	1.530
2040.00	1.530
2370.00	1.570
2474.00	1.580
2640.00	1.650
2820.00	1.690
3000.00	1.730
3180.00	1.810
3360.00	1.830
3540.00	1.850
3810.00	1.870
4020.00	1.890
4260.00	1.920
4500.00	1.990
4680.00	2.040
4920.00	2.070
5160.00	2.110
5400.00	2.150
5760.00	2.170

****

TRANSMISSIVITY Kd = 41 [m2/d]
STORATIVITY S = .0025267180

DATA SEGMENT ANALYZED :
- starting with data pair 16
- ending with data pair 23

DETERMINATION COEFFICENT = .9769094

****

PROJECT..... = GONDWANA RESOURCES NL. MARDA PROJECT.
LOCATION..... = PYTHON PROSPECT (10925N 30080E)
BORE..... = DD2
STATUS..... = OBSERVATION BORE
DIST.TO PUMPED BORE = 78.00[m]
STATIC WATER LEVEL = 59.000[m]
PUMPING RATE..... = 432 [m3/day]
START OF TEST..... = 25.7.94

TIME [min]	DRAWDOWN[m]
1380.00	0.820
1500.00	0.830
1620.00	0.870
1720.00	0.900
1910.00	0.970
2040.00	0.980
2220.00	0.950
2474.00	0.990
2820.00	1.020
3000.00	1.040
3180.00	1.050
3360.00	1.070
3540.00	1.070
3810.00	1.080
4020.00	1.090
4260.00	1.090
4500.00	1.130
4680.00	1.150
4920.00	1.190
5160.00	1.230
5400.00	1.250
5760.00	1.260

****

TRANSMISSIVITY Kd = 50 [m2/d]
STORATIVITY S = .0112339200

DATA SEGMENT ANALYZED :
- starting with data pair 17
- ending with data pair 21

DETERMINATION COEFFICENT = .9887388

****

```
**********************************************************
*                                                        *
*              program:  Recovery                        *
*              version:  IBM PC 1.0                      *
*                                                        *
*  A PROGRAM FOR PUMP TEST ANALYSIS USING JACOB'S        *
*  FORM OF THEIS EQUATION AND LEAST SQUARES' METHOD.     *
*                                                        *
**********************************************************

PROJECT..... = GONDWANA RESOURCES NL, MARDA PROJECT
LOCATION.... = PYTHON PROSPECT
WELL........ = MPB1
DATE........ = 29.7.94

STATIC WATER LEVEL   S.W.L.   =  59 [m]
DISCHARGE RATE.............. =  .005 [m3/s]
DURATION OF PUMPING PERIOD... =  5760 [min]
```

NO	TIME t'[min]	TIME t [min]	t/t'	DRAWDOWN s'[m]	DEVIATION
1	14.00	5774.00	412.43	2.850	+.112E-01
2	16.00	5776.00	361.00	2.820	+.233E-01
3	18.00	5778.00	321.00	2.770	+.105E-01
4	20.00	5780.00	289.00	2.740	+.137E-01
5	25.00	5785.00	231.40	2.660	+.397E-02
6	30.00	5790.00	193.00	2.590	-.865E-02
7	35.00	5795.00	165.57	2.520	-.302E-01
8	40.00	5800.00	145.00	2.510	+.176E-02
9	45.00	5805.00	129.00	2.470	-.127E-02
10	50.00	5810.00	116.20	2.430	-.822E-02
11	60.00	5820.00	97.00	2.310	-.711E-01
12	70.00	5830.00	83.29	2.250	-.829E-01
13	80.00	5840.00	73.00	2.210	-.812E-01
14	90.00	5850.00	65.00	2.190	-.645E-01
15	345.00	6105.00	17.70	2.100	+.257E+00
16	450.00	6210.00	13.80	1.980	+.215E+00
17	1980.00	7740.00	3.91	1.430	-.961E-02
18	2770.00	8530.00	3.08	1.300	+.501E-03
19	3450.00	9210.00	2.67	1.200	+.694E-03
20	4130.00	9890.00	2.39	1.120	-.307E-02
21	5000.00	%10760.00	2.15	1.050	+.188E-02

```
TRANSMISSIVITY T = .567E-03 [m2/s]
               T =     49 [m2/d]

DATA SEGMENT ANALYZED :
  - starting with data pair  18
  - ending   with data pair  21

DETERMINATION COEFFICENT = .9996108

**********************************************************
```

```
*********************************************************
*                                                       *
*              program:  Recovery                       *
*              version:  IBM PC 1.0                     *
*                                                       *
*  A PROGRAM FOR PUMP TEST ANALYSIS USING JACOB'S       *
*  FORM OF THEIS EQUATION AND LEAST SQUARES' METHOD.    *
*                                                       *
*********************************************************

PROJECT..... = GONDWANA RESOURCES NL. MARDA PROJECT
LOCATION..... = PYTHON PROSPECT
WELL........... = ME11
DATE........... = 29.7.94

STATIC WATER LEVEL   S.W.L.   =  59 [m]
DISCHARGE RATE.............. =  .005 [m3/s]
DURATION OF PUMPING PERIOD... =  5760 [min]
```

NO	TIME t'[min]	TIME t [min]	t/t'	DRAWDOWN s'[m]	DEVIATION
1	1.00	5761.00	5761.00	2.740	-.364E+00
2	2.00	5762.00	2881.00	2.660	-.214E+00
3	3.00	5763.00	1921.00	2.630	-.110E+00
4	4.00	5764.00	1441.00	2.570	-.749E-01
5	5.00	5765.00	1153.00	2.510	-.611E-01
6	6.00	5766.00	961.00	2.470	-.408E-01
7	7.00	5767.00	823.86	2.420	-.398E-01
8	8.00	5768.00	721.00	2.390	-.257E-01
9	9.00	5769.00	641.00	2.380	+.324E-02
10	10.00	5770.00	577.00	2.370	+.281E-01
11	11.00	5771.00	524.64	2.350	+.396E-01
12	12.00	5772.00	481.00	2.330	+.483E-01
13	14.00	5774.00	412.43	2.290	+.592E-01
14	15.00	5775.00	385.00	2.270	+.620E-01
15	16.00	5776.00	361.00	2.260	+.733E-01
16	18.00	5778.00	321.00	2.230	+.822E-01
17	20.00	5780.00	289.00	2.180	+.670E-01
18	25.00	5785.00	231.40	2.120	+.805E-01
19	30.00	5790.00	193.00	2.050	+.706E-01
20	35.00	5795.00	165.57	2.000	+.714E-01
21	40.00	5800.00	145.00	1.970	+.853E-01
22	50.00	5810.00	116.20	1.880	+.686E-01
23	60.00	5820.00	97.00	1.850	+.984E-01
24	70.00	5830.00	83.29	1.780	+.788E-01
25	80.00	5840.00	73.00	1.740	-.726E-01
26	90.00	5850.00	65.00	1.690	-.734E-01
27	130.00	5890.00	45.31	1.590	-.206E-01
28	145.00	5905.00	40.72	1.560	-.540E-02
29	180.00	5940.00	33.00	1.460	-.163E-01
30	210.00	5970.00	28.43	1.390	-.232E-01
31	270.00	6030.00	22.33	1.350	+.391E-01
32	330.00	6090.00	18.45	1.300	-.521E-01
33	450.00	6210.00	13.80	1.190	-.152E-01
34	560.00	6320.00	11.29	1.090	-.135E-01
35	1020.00	6780.00	6.65	0.920	-.405E-01
36	1980.00	7740.00	3.91	0.680	+.692E-01
37	2770.00	8530.00	3.08	0.450	-.213E-01
38	3450.00	9210.00	2.67	0.390	+.316E-01

39	4130.00	9890.00	2.39	0.280	+.758E-02
40	5000.00	%10760.00	2.15	0.170	-.179E-01

TRANSMISSIVITY T = .503E-03 [m2/s]
T = 43 [m2/d]

DATA SEGMENT ANALYZED :
- starting with data pair 37
- ending with data pair 40

DETERMINATION COEFFICENT = .9600162

****

```
*                program:  Distance                    *
*                version:  IBM PC 1.0                  *
*                                                      *
*  A PROGRAM FOR PUMP TEST ANALYSIS USING JACOB'S      *
*  FORM OF THEIS EQUATION AND LEAST SQUARES' METHOD.   *
*                                                      *
********************************************************

PROJECT..... = GONDWANA RESOURCES NL,MARDA PROJECT
LOCATION..... = PYTHON PROSPECT
WELL........... = MPB1
DATE........... = 25.7.94

STATIC WATER LEVEL   S.W.L.   =  59 [m]
DISCHARGE RATE.............. =  .005 [m3/s]
TIME OF THE OBSERVATION..... =  1380 [min]
```

NO	DISTANCE [m]	DRAWDOWN [m]	u	DEVIATION
1	1.00	6.330	.124E-04	+.128E+00
2	16.30	2.700	.331E-02	-.271E+00
3	78.00	0.820	.757E-01	-.339E+00
4	103.00	1.320	.132E+00	+.482E+00

```
TRANSMISSIVITY T = .688E-03 [m2/s]
                 T =     59 [m2/d]
STORATIVITY      S = .283E-02

DATA SEGMENT ANALYZED :
  - starting with data pair  1
  - ending   with data pair  4

DETERMINATION COEFFICENT = .9764302

********************************************************
```

```
*                                                      *
*              program:  Distance                      *
*              version:  IBM PC 1.0                    *
*                                                      *
*  A PROGRAM FOR PUMP TEST ANALYSIS USING JACOB'S      *
*  FORM OF THEIS EQUATION AND LEAST SQUARES' METHOD.   *
*                                                      *
********************************************************

PROJECT..... = GONDWANA RESOURCES NL, MARDA PROJECT
LOCATION..... = PYTHON PROSPECT
WELL........... = MPB1
DATE........... = 25.7.94

STATIC WATER LEVEL   S.W.L.   =  59 [m]
DISCHARGE RATE.............. =  .005 [m3/s]
TIME OF THE OBSERVATION..... =  3000 [min]
```

NO	DISTANCE [m]	DRAWDOWN [m]	u	DEVIATION
1	1.00	6.740	.754E-05	+.143E+00
2	16.30	3.020	.200E-02	-.294E+00
3	78.00	1.040	.459E-01	-.433E+00
4	103.00	1.730	.800E-01	+.584E+00

```
TRANSMISSIVITY T = .677E-03 [m2/s]
               T =     58 [m2/d]
STORATIVITY    S = .367E-02

DATA SEGMENT ANALYZED :
  - starting with data pair  1
  - ending   with data pair  4

DETERMINATION COEFFICENT = .9671921

********************************************************
```

```
*                                                      *
*              program:  Distance                      *
*              version:  IBM PC 1.0                    *
*                                                      *
*  A PROGRAM FOR PUMP TEST ANALYSIS USING JACOB'S      *
*  FORM OF THEIS EQUATION AND LEAST SQUARES' METHOD.   *
*                                                      *
********************************************************

PROJECT..... = GONDWANA RESOURCES NL. MARDA PROJECT
LOCATION..... = PYTHON PROSPECT
WELL........... = MPB1
DATE........... = 25.7.94

STATIC WATER LEVEL   S.W.L.   =  59 [m]
DISCHARGE RATE.............. =  .005 [m3/s]
TIME OF THE OBSERVATION..... =  5760 [min]
```

NO	DISTANCE [m]	DRAWDOWN [m]	u	DEVIATION
1	1.00	7.440	.507E-05	+.145E+00
2	16.30	3.510	.135E-02	-.279E+00
3	78.00	1.260	.308E-01	-.562E+00
4	103.00	2.170	.538E-01	+.697E+00

```
TRANSMISSIVITY T = .633E-03 [m2/s]
                 T =     55 [m2/d]
STORATIVITY      S = .444E-02

DATA SEGMENT ANALYZED :
  - starting with data pair  1
  - ending   with data pair  4

DETERMINATION COEFFICENT = .9595627

********************************************************
```

APPENDIX 3

DETAILED GROUNDWATER ANALYSIS CERTIFICATE

Analabs

Analabs Pty. Ltd.
ACN 004 591 564
50 Murray Rd. Welshpool
Western Australia 6106.
P.O. Box 210. Bentley, W.A. 6102
Telephone: (619) 458 7999
Telex: AA 92560
Facsimile: (619) 458 2922

JV/sp

26 August 1994

TO:
KH Morgan & Associates
Attn: S Doyle
Unit 10/4 Queen Street
BENTLEY WA 6102

OUR REF: 108080.09.21705
YOUR REF: -

CERTIFICATE OF ANALYSIS

SAMPLE DESCRIPTION

14 water samples were received on the 22/8/94 for analysis.

SAMPLE : M (large bottle), M (large bottle), M (small bottle), M (MPB1 45min), M (10min). M (84min), MPB4-1, MPB4-2, MPB4-3, MPB4-4, MPB4-5, SPB7-1, SPB7-2, SPB1 End

CHEMICAL DATA

PARAMETERS	SAMPLE IDENTIFICATION						
	M (large bottle)	M (large bottle)	M (small bottle)	M (MPB1 45min)	M (10min)	M (84min)	
Total Dissolved Solids(calc) (mg/l)	11150	11110	11130	11430	11410	11120	

ANALYST J VENNING
Supervisor-Waters

Normet Pty. Ltd
12 AITKEN WAY
KEWDALE
W.A. 6105

6069
0375
17 June 1994

CERTIFICATE OF ANALYSIS

Sample: 6069/3067 MC10 Python (MPB1)

Analyte	Result	Units	Method	Ref: 02048.005
Conductivity	19.	mS/cm	APHA 2510.B	
TDS	10200.	mg/L	APHA 2540.C	
pH	7.6		APHA 4500-H.B	
Ca	130.	mg/L	APHA 3110;3111.A,B,C	
Mg	338.	mg/L	APHA 3110;3111.A,B,C	
Fe	<0.1	mg/L	APHA 3110;3111.A,B,C	
Si	6.2	mg/L	APHA 3110;3111.A,B,C	
Na	2840.	mg/L	APHA 3110;3111.A,B,C	
K	18.	mg/L	APHA 3110;3111.A,B,C	
CO3	<1.	mg/L	APHA 2320.B	
HCO3	1050.	mg/L	APHA 2320.B	
Cl	4850.	mg/L	APHA 4500-Cl.B	
SO4	1010.	mg/L	SO4_Turbidity	
NO3	<0.2	mg/L	SKALAR	
C/A_Balance	0.9		Calculation	

Lien Tang Chemist

Perth Office
3 Hardy Road, Bayswater, Western Australia 6021
Telephone (09) 344 9122 Facsimile (09) 345 1737

The results pertain to the samples as received.

Australian Laboratory Services Pty Ltd
A.C.N. 009 443 887

9/9's

Appendix B: Section 26D Licences to Construct Wells.

Government of **Western Australia**
Department of **Water**

looking after all our water needs

Our ref: RF10491
Enquires: Bree Lyons
Phone: (08) 6250 8035

Southern Cross Goldfields
PO Box 708
WEST PERTH WA 6872

Attention: Mr. Glenn Jardine

Dear Mr. Jardine,

Re: Your application for a licence to construct or alter well
Property: Marda: M77/394, Kings Brown: M77/931 & M77/646 – Marda Gold Project

Please find enclosed your licenses, CAW176209 and CAW176670, authorising you to construct or alter a well(s), subject to certain terms, limitations and conditions. It does not absolve you from responsibility for compliance with the requirements of all Commonwealth and State legislation.

Please note the two licenses correspond to different resources within the Deborah groundwater subarea:

- CAW176209 – Goldfields – Deborah - Combined – Fractured Rock West
- CAW176670 – Goldfields – Deborah - Palaeochannel – Fractured Rock

Under section 26E of the *Rights in Water and Irrigation Act 1914, Form 2 - Information to be provided on completion of a non-artesian well* (enclosed) is to be completed and submitted by your driller to the department within one month after completing the well. The completed form is to be submitted to this office.

It is important that you read your licences carefully. If you do not understand your licences, please contact the department as soon as possible, as there are penalties for failing to comply with all of your licence terms, limitations and conditions. Please ensure your driller is also aware of all the terms, limitations and conditions of the licence before drilling commences.

Please see the attachment regarding your rights for a review of the department's decision.

For further information on water licensing, please refer to the frequently asked questions (FAQ's) series on the department's website, under the *Business with water* tab.

Swan Avon Region
7 Ellam Street Victoria Park Western Australia 6100
Telephone (08) 6250 8000 Facsimile (08) 6250 8050
www.water.wa.gov.au
wa.gov.au

This licence is for investigation of the groundwater resource only. It allows you to conduct test drilling to support the preparation of a Hydrogeological Report. Your Hydrogeolocial Report must be submitted with future applications for a *Licence to Take Water*. The department will accept data and reports in the electronic format. Electronic submissions should be made using the following spreadsheet and guidelines: *Requirements for the Provision of Resource Information Reports and Data in the Electronic Format: Part A & B.* These documents can be located on the Department of Water's web site www.water.wa.gov.au, under the headings of Doing Business with Us/Water licensing/Licensing publications Forms.

After completion of the investigation, should you wish to submit an application for a *Licence to Take Water*, a thorough assessment of the proposal and the Hydrogeological Report will be conducted by the department. It is important to realise that the outcome of the assessment cannot be guaranteed and may not always result in a *Licence to Take Water* being granted.

This licence does not give you authority to trespass onto land or grant you access to any mining tenements. It is your responsibility to ensure that legal access is acquired and maintained on all land where investigation works will be conducted.

If the water from the wells is being improperly used, is being wasted or is having a harmful effect, the department may direct the closing of the wells.

If you wish to discuss this further, or to arrange a meeting, please contact Bree Lyons by telephone on (08) 6250 8035.

Yours sincerely

Gillian Phillips
Natural Resource Management Officer
Swan Avon Region

27 / 11 / 2012

Encl. CAW176209 & CAW176670
Attachment – Your rights for a review
Form 2
CC Pendragon Environmental Solutions

ATTACHMENT – YOUR RIGHTS FOR A REVIEW

Under section 26GI of the *Rights in Water and Irrigation Act 1914*, you have a right to apply to the State Administrative Tribunal for a review of any term, limitation or condition included in a licence. You have 28 days from the date you received this letter to request that the decision be reviewed.

For further information please contact the State Administrative Tribunal:

State Administrative Tribunal
12 St Georges Terrace
PERTH WA 6000

GPO Box U1991
PERTH WA 6845

Telephone: (08) 9219 3111
Toll-free: 1300 306 017
Facsimile: (08) 9325 5099
www.sat.justice.wa.gov.au

Under section 21 of the *State Administrative Tribunal Act 2004*, you have a right to request a written statement of reasons for the decision to issue a licence to construct or alter a well. This request must be made, in writing, to the Department of Water within 28 days after receiving this letter.

Government of Western Australia
Department of Water

Instrument No. CAW176209(1)

LICENCE TO CONSTRUCT OR ALTER WELL

Granted by the Minister under section 26D of the Rights in Water and Irrigation Act 1914

Licensee(s)	Southern Cross Goldfields Limited	
Description of Water Resource	Goldfields Combined - Fractured Rock West - Fractured Rock	
Location of Well(s)	M77/394, M77/931 & M77/646 - Marda Gold Project	
Authorised Activities	**Activity**	**Location of Activity**
	Construct 5 exploratory well(s).	M77/394, M77/931 & M77/646 - Marda Gold Project
Duration of Licence	From 26 November 2012 to 31 May 2013	

This Licence is subject to the following terms, limitations and conditions:

1 That should the bore/s be abandoned it/they shall be sealed off to the satisfaction of the Department of Water.

2 The well must be constructed by a driller having a current class 1 (one) water well drillers certificate issued by the Western Australian branch of the Australian Drilling Industry Association or other certification approved by the Department of Water as equivalent.

3 That the depth of the well/s shall be limited to the Combined - Fractured Rock West aquifer.

4 That no well shall be sunk within 500 metres of an existing well without the written permission of the owner of that well.

5 That exploratory bores are capped to the satisfaction of the Department of Water.

End of terms, limitations and conditions

Government of Western Australia
Department of Water

Instrument No. CAW176670(1)

LICENCE TO CONSTRUCT OR ALTER WELL

Granted by the Minister under section 26D of the Rights in Water and Irrigation Act 1914

Licensee(s)	Southern Cross Goldfields Limited	
Description of Water Resource	Goldfields Palaeochannel - Fractured Rock	
Location of Well(s)	M77/931 - Marda Gold Project	
Authorised Activities	**Activity**	**Location of Activity**
	Construct 5 exploratory well(s).	M77/931 - Marda Gold Project
Duration of Licence	From 26 November 2012 to 31 May 2013	

This Licence is subject to the following terms, limitations and conditions:

1 That should the bore/s be abandoned it/they shall be sealed off to the satisfaction of the Department of Water.

2 The well must be constructed by a driller having a current class 1 (one) water well drillers certificate issued by the Western Australian branch of the Australian Drilling Industry Association or other certification approved by the Department of Water as equivalent.

3 That the depth of the well/s shall be limited to the Palaeochannel aquifer.

4 That no well shall be sunk within 500 metres of an existing well without the written permission of the owner of that well.

5 That exploratory bores are capped to the satisfaction of the Department of Water.

End of terms, limitations and conditions

Government of Western Australia
Department of Water

OFFICE USE ONLY

Form 2

Information to be provided on completion of a non-artesian well

Information to be provided to the Department of Water under the *Water Agencies (Powers) Act 1984* and Section 26E of the *Rights in Water and Irrigation Act 1914* and Regulation 39 of the *Rights in Water and Irrigation Regulations 2000*

Please note:

- All information is to be written clearly and in block letters.
- If insufficient room please use a separate piece of paper.
- It is the responsibility of the person carrying out the works to fill out this form.

Part 1: Details of any licence granted for the work under the *Rights in Water And Irrigation Act 1914* section 26D

Licence number CAW

☐ Individual ☐ Company

Licensee's full name

Part 2: Details of person carrying out the works

Company

Driller

Driller licence number (non-mandatory)

Driller classification (non-mandatory)

Postal address

Telephone

Facsimile

Email

Part 3: Location of well

A 26D licence will list the premises on which well construction is to occur.

If the physical address of the well is different from the property address listed on the licence, contact the Department of Water prior to the commencement of construction.

Property address of well or other tenure details

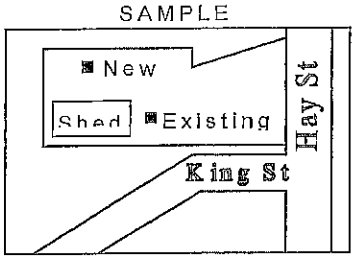
Well coordinates ☐ GPS reading ☐ Estimate

Zone **Easting/ latitude** **Northing/ longitude**

Datum (e.g. GDA94/WGS84) **GPS reliability**

Location plan – in the box below please sketch a plan showing position of well in relation to building, boundaries, road, nearest cross road and any additional information to assist in locating the well.

SAMPLE



In the box to the right, please sketch a plan showing:
- location of all wetlands / watercourses / wells / soaks (existing and proposed).

- shaded sections to indicate areas under development.

Part 4: Construction details (All measurements are to be taken from ground level)

Production casing detail					
Material	Nominal bore	Diameter O.D (mm)	Wall thickness (mm)	Depth	
				From (m)	To (m)

Please complete well construction diagram in box provided below. If insufficient room please attach on separate piece of paper.

Screens/slots				
Screens/slot (type)	Diameter O.D (mm)	Aperture (mm)	Top of screen (m)	Bottom of screen (m)

Gravel pack details		
Gravel size (mm)	From (m)	To (m)

Annular fill		
Material type	From (m)	To (m)

Cementing detail		
☐ Pressure cement grouted ☐ Tremmie		
Casing diameter (mm O.D)	Depth	
	From (m)	To (m)

Total depth drilled (from ground level) ____

Geophysical log required as condition of licence? ☐ Yes ☐ No

Geophysical log taken? (attach log and contractor details) ☐ Yes ☐ No

From (m)	To (m)	Strata description (If insufficient room attach on separate page)

Part 5: Particulars of well

Drilling start date refers to the date drilling begins. Do not include set up date.

Drilling completion date includes well development and testing.

Well name / number

Drilling start **Drilling completion**

Drilling method used
☐ Rotary air ☐ Cable tool ☐ Auger ☐ Rotary mud
☐ Sludge ☐ Other (specify) _____

Final status of well
☐ Ready to operate ☐ Decommissioned
☐ Other (specify) _____

Purpose (use) of well
☐ Production ☐ Investigation ☐ Monitoring
☐ Other (specify) _____

Part 6: Well development

Date (dd/mm/yy) **Duration of development** hours

Method ☐ Airlift ☐ Pump ☐ Jetting ☐ Surging

Development pump rate (e.g. L/s, m^3/day)

Part 7: Pump testing (if applicable)

Date start (dd/mm/yy) **Date end (dd/mm/yy)** **Duration of test** hours

☐ Step test ☐ Constant rate ☐ Other

Constant rate - pump rate (e.g. m^3/day) **Pump type (e.g submersible)**

Water rest level prior to test (m)

Measurements taken from ☐ top of casing (TOC) ☐ ground level (GL)
☐ other (specify) _____

Final drawdown is the distance between the static water level measured prior to the test and the water level measured at the end of the pumping test.

Elevation of measurement reference point if known (metres AHD) ☐ GPS ☐ Estimate
☐ other (specify) _____

Final drawdown m **Recommended supply (e.g. m^3/day)**

Comments.....

Part 8: Field samples

Specify unit measurements.

Collection method (e.g. pump test, airlift)

Conductivity (e.g. mS/m) ☐ Temperature compensated ☐ Temperature uncompensated **pH**

Water temperature at test

Comments.....

.....

Part 9: Lab samples

Lab samples taken (Please attach) ☐ Yes ☐ No

TDS (e.g. mg/l)

Please submit samples separately to form if not received before the 1 month submission deadline.

Part 10: Water levels

SWL (Static water level) ____ m **Water cut at** ____ m

Measurements taken from ☐ top of casing (TOC) ☐ ground level (GL)
☐ other (specify) _____

Date of reading (dd/mm/yy) ____

Comments.....

Part 11: Declaration and signature

Capacity of person making declaration:

☐ **An individual who carried out the work**

☐ **An officer who is a director or secretary of a corporation that carried out the work.**

☐ **Other (describe)**.....

I, _____(name of person making declaration) declare that the information provided on this form is true and correct.

Important information

- All information must be completed on the form unless otherwise indicated as optional for example; provision of the drillers licence number and classification fields are not mandatory and can be filled in at the drillers discretion. Provision of non-mandatory details would greatly assist the department in completion of its data set.
- Failure to complete all mandatory details and to submit the form to the department is an offence under the *Rights in Water and Irrigation Act 1914.*
- Under section 26E and regulation 39 within 1 month of completion of the construction of or deepening of the well, the person carrying out the work for a 26D licence must submit this form.
- Non-artesian wells in proclaimed areas require a licence unless exempted under the *Rights in Water and Irrigation Exemption (S26C) Order 2007.*

Where and how to submit this form

This form can be submitted by fax, post or in person to the appropriate Department of Water regional office. For assistance in completing this form contact your regional office.

Kimberley Region
Kununurra Regional Office
27 Victoria Hwy
Kununurra WA 6743
Tel: 08 9166 4100
Fax: 08 9168 3174
PO Box 625
Kununurra WA 6743

Kwinana Peel Region
Mandurah Regional Office
107 Breakwater Parade
Mandurah WA 6210
Tel: 08 9550 4222
Fax: 08 9581 4560
PO Box 332
Mandurah WA 6210

South Coast Region
Albany Regional Office
5 Bevan Street
Albany WA 6330
Tel: 08 9842 5760
Fax: 08 9842 1204
PO Box 525
Albany WA 6331

Manjimup
Manjimup District Office
52 Bath Street
Manjimup WA 6528
Tel: 08 9771 8108
Fax: 08 9771 4435

Midwest Gascoyne Region
Geraldton Regional Office
94 Sanford Street
Geraldton WA 6531
Tel: 08 9965 7400
Fax: 08 9964 5983
Po Box 73
Geraldton WA 6531

South West Region
Bunbury Regional Office
35-39 McCombe Road
Bunbury WA 6230
Tel: 08 9726 4111
Fax: 08 9726 4100
PO Box 261
Bunbury WA 6231

Pilbara Region
Karratha Regional Office
Lot 4608 Cherratta Road
Karratha Industrial Estate
Karratha WA 6714
Tel: 08 9144 2000
Fax: 08 9144 2610
PO Box 836
Karratha WA 6714

Carnarvon
Carnarvon District Office
211 Robinson Street
Carnarvon WA 6701
Tel: 08 9941 6100
Fax: 08 9941 4931
PO Box 81
Carnarvon WA 6701

Busselton
Busselton District Office
Suite 2, 72 Duchess Street
Busselton WA 6280
Tel: 08 9781 0188
Fax: 08 9754 4335
PO Box 269
Busselton WA 6280

Swan Avon Region
Victoria Park Regional Office
7 Ellam Street
Victoria Park WA 6100
Tel: 08 6250 8000
Fax: 08 6250 8050

Please retain a copy of this form for your records

Appendix C: Ground Water Quality and Laboratory Certificates.

Sample Type:	Ground Water
Work Group:	EP1209389005
Sample Date:	Wednesday, 7 November 2012

Physical and Major Chemistry

Analyte	Deposit/Area	pH Value	Electrical Conductivity @ 25℃	Total Dissolved Solids @180℃	Hydroxide Alkalinity as $CaCO_3$	Carbonate Alkalinity as $CaCO_3$	Bicarbonate Alkalinity as $CaCO_3$	Total Alkalinity as $CaCO_3$	Acidity as $CaCO_3$	Sulfate as SO_4	Chloride	Calcium	Magnesium	Sodium	Potassium
Units		pH Unit	µS/cm	mg/L											
LoR		0.01	1	10	1	1	1	1	1	1	1	1	1	1	1
Assessment Level															
SXG-ME011	Python	7.4	10,500	6,450	<1	<1	752	752	63	632	2,590	121	251	1,540	20
SXG-PYRC064D	Python	7.4	4,420	2,830	<1	<1	436	436	34	239	1,020	81	137	588	13
SXG-DUDD001	Dugite	7.7	4,560	3,070	<1	<1	645	645	28	165	1,020	43	76	729	13
SXG-MCR001	Marda Regional	7.6	3,590	2,050	<1	<1	386	386	16	205	819	70	59	550	13
SXG-MCR002	Marda Regional	7.0	860	512	<1	<1	116	116	18	30	165	18	22	99	13
SXG-MCR003	Marda Regional	7.9	2,080	1,270	<1	<1	546	546	10	27	369	22	33	338	18
SXG-MCR004	Marda Regional	7.3	2,080	1,180	<1	<1	233	233	33	85	489	27	41	281	15
SXG-KBRC052	King Brown	8.4	118,000	100,000	<1	<1	197	197	39	8,330	45,800	681	3,650	23,900	523
SXG-KBRC021	King Brown	7.0	73,600	56,200	<1	<1	552	552	146	2,460	26,200	356	1,960	13,400	240
SXG-KBR060	King Brown	7.2	88,700	71,800	<1	<1	230	230	66	4,710	32,700	537	2,560	15,600	250
SXG-GORC0161	Golden Orb	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SXG-GOR055	Golden Orb	7.3	29,900	17,700	<1	<1	527	527	57	2,400	10,300	213	712	5,400	65

Dissolved Metals

Analyte	Deposit/Area	Aluminium	Arsenic	Beryllium	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Lithium	Manganese	Molybdenum	Nickel	Selenium	Silver	Tin	Uranium	Vanadium	Zinc	Iron
Units		mg/L																			
LoR		0.010	0.001	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.010	0.001	0.001	0.001	0.01	0.005	0.050
Assessment Level																					
SXG-ME011	Python	<0.010	<0.001	<0.001	0.018	<0.0001	<0.001	0.002	0.001	<0.001	0.018	0.340	0.001	0.140	0.010	<0.001	<0.001	<0.001	<0.010	1.360	<0.050
SXG-PYRC064D	Python	<0.010	0.001	<0.001	0.005	<0.0001	<0.001	0.002	0.004	<0.001	0.012	0.032	0.001	0.010	<0.010	<0.001	<0.001	<0.001	<0.010	<0.005	<0.050
SXG-DUDD001	Dugite	<0.010	0.109	<0.001	0.048	<0.0001	<0.001	0.018	<0.001	<0.001	0.066	1.350	0.009	0.047	0.010	<0.001	<0.001	<0.001	<0.010	0.029	<0.050
SXG-MCR001	Marda Regional	<0.010	<0.001	<0.001	0.015	<0.0001	<0.001	<0.001	0.002	<0.001	0.015	0.043	<0.001	0.006	<0.010	<0.001	<0.001	<0.001	<0.010	<0.005	<0.050
SXG-MCR002	Marda Regional	0.010	<0.001	<0.001	0.030	<0.0001	<0.001	<0.001	0.001	<0.001	0.003	0.029	<0.001	0.004	<0.010	<0.001	<0.001	<0.001	<0.010	0.045	<0.050
SXG-MCR003	Marda Regional	0.010	0.006	<0.001	0.028	<0.0001	<0.001	<0.001	<0.001	<0.001	0.004	0.123	<0.001	0.002	<0.010	<0.001	<0.001	<0.001	<0.010	<0.005	0.160
SXG-MCR004	Marda Regional	<0.010	0.005	<0.001	0.051	<0.0001	<0.001	0.001	0.008	<0.001	0.007	0.297	<0.001	0.004	<0.010	<0.001	<0.001	<0.001	<0.010	0.012	0.130
SXG-KBRC052	King Brown	<0.010	<0.001	<0.001	0.136	<0.0001	<0.001	<0.001	<0.001	<0.001	0.078	1.350	<0.001	<0.001	<0.010	<0.001	<0.001	<0.001	<0.010	<0.005	<0.050
SXG-KBRC021	King Brown	<0.010	<0.001	<0.001	0.120	<0.0001	<0.001	0.015	<0.001	<0.001	0.098	7.140	<0.001	0.018	<0.010	<0.001	<0.001	<0.001	<0.010	<0.005	1.840
SXG-KBR060	King Brown	<0.010	<0.001	<0.001	0.040	0.0026	<0.001	<0.001	<0.001	<0.001	0.097	0.012	<0.001	<0.001	<0.010	<0.001	<0.001	<0.001	<0.010	<0.005	<0.050
SXG-GORC0161	Golden Orb	<0.010	<0.001	<0.001	0.025	0.0001	<0.001	0.001	0.002	<0.001	0.025	0.063	<0.001	0.003	0.010	<0.001	<0.001	<0.001	<0.010	0.008	<0.050
SXG-GOR055	Golden Orb	<0.010	<0.001	<0.001	0.025	0.0008	<0.001	0.005	0.002	<0.001	0.038	0.224	0.004	0.010	0.010	<0.001	<0.001	0.002	<0.010	0.024	<0.050

Total Metals and **Ionic Balance**

Analyte	Deposit/Area	Aluminium	Arsenic	Beryllium	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Lithium	Manganese	Molybdenum	Nickel	Selenium	Silver	Tin	Uranium	Vanadium	Zinc	Iron	Total Anions	Total Cations	Ionic Balance
Units		mg/L																				meq/L		%
LoR		0.010	0.001	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.010	0.001	0.001	0.001	0.010	0.005	0.05	0.01	0.01	0.01
Assessment Level		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
SXG-ME011	Python	0.160	<0.001	<0.001	0.020	<0.0001	0.004	0.002	0.002	<0.001	0.019	0.359	0.001	0.145	0.010	<0.001	0.001	<0.001	<0.010	1.430	0.580	101.0	94.2	3.6
SXG-PYRC064D	Python	3.900	0.006	<0.001	0.006	<0.0001	0.252	0.016	0.014	0.001	0.017	0.065	0.001	0.243	<0.010	<0.001	<0.001	<0.001	0.020	0.020	5.990	42.5	41.2	1.5
SXG-DUDD001	Dugite	10.400	0.354	<0.001	0.130	0.0002	0.295	0.099	0.120	0.170	0.074	3.460	0.009	0.370	<0.010	0.001	0.001	<0.001	0.060	0.482	33.200	45.1	40.4	5.5
SXG-MCR001	Marda Regional	4.460	0.007	<0.001	0.020	<0.0001	0.072	0.013	0.016	0.001	0.020	0.288	<0.001	0.034	0.010	<0.001	<0.001	<0.001	0.020	0.016	9.200	35.1	32.6	3.7
SXG-MCR002	Marda Regional	4.740	0.005	<0.001	0.065	<0.0001	0.038	0.009	0.033	0.008	0.005	0.194	<0.001	0.027	0.010	<0.001	<0.001	<0.001	0.020	0.384	6.580	7.6	7.4	1.7
SXG-MCR003	Marda Regional	1.730	0.008	<0.001	0.036	<0.0001	0.023	0.002	0.013	0.002	0.005	0.141	<0.001	0.012	<0.010	<0.001	<0.001	<0.001	0.010	0.082	4.020	21.9	19.0	7.1
SXG-MCR004	Marda Regional	4.360	0.018	<0.001	0.100	0.0002	0.056	0.014	0.057	0.013	0.009	0.413	0.001	0.057	<0.010	<0.001	0.002	<0.001	0.020	1.000	7.730	20.2	17.3	7.7
SXG-KBRC052	King Brown	0.140	<0.001	<0.001	0.141	<0.0001	<0.001	0.011	<0.001	<0.001	0.078	1.420	<0.001	<0.001	<0.010	<0.001	<0.001	<0.001	<0.010	0.052	0.520	1,470.0	1,390.0	2.9
SXG-KBRC021	King Brown	4.390	0.095	<0.001	0.136	<0.0001	0.035	0.022	0.028	<0.010	0.091	7.620	<0.001	0.030	<0.010	<0.001	<0.001	<0.001	<0.010	0.052	44.400	801.0	768.0	2.1
SXG-KBR060	King Brown	12.500	0.040	<0.001	0.051	0.0031	0.079	0.017	0.072	0.077	0.093	0.594	<0.001	0.045	<0.010	<0.001	<0.001	<0.001	0.150	0.054	53.600	1,020.0	922.0	5.3
SXG-GORC0161	Golden Orb	12.900	0.008	<0.001	0.047	0.0002	0.025	0.030	0.065	0.019	0.031	0.395	<0.001	0.026	0.010	<0.001	0.001	0.002	0.090	0.090	25.900	-	-	-
SXG-GOR055	Golden Orb	11.100	0.009	<0.001	0.034	0.0011	0.061	0.018	0.054	0.024	0.044	0.476	0.005	0.035	0.020	0.002	<0.001	0.003	0.110	0.034	29.800	351.0	306.0	6.9

Notes: 2.4 **Detection: concentration exceeds Limit of Reporting LOR. Numbers in bold indicate exceedance of Assessment Level.**

SOUTHERN CROSS GOLDFIELDS LTD

ABN 71 124 374 321
Unit 16, 162 Colin Street, West Perth
(access via Campbell Street) WA 6005
PO Box 708, West Perth WA 6872
Phone +61 8 9215 7600
Fax +61 8 6485 1283

MEMORANDUM

TO:	**Kim Taylor**	**DATE: 05/11/2012**
CC:	**Richard Simmons, Steve Jones, Rob Wright, Pendragon**	
FROM:	**Mairi Walsh**	
SUBJECT:	**Water sampling for environmental studies**	

Water Sampling Information

Kim,

This follows on from the previous memo regarding dipping all the holes. I've gone through the instructions from Pendragon and all the water depth information gathered by you and come up with the following:

Holes to obtain water samples from: (3 from each hole – see later).

1. ME011
2. PYRC064D
3. KBRC052
4. KBRC021
5. KBRC060
6. MCRC001
7. MCRC002
8. MCRC003
9. MCRC004
10. GORC016
11. GORC055
12. DUDD001

I think there are only bottles up on site for a maximum of 12 samples, so I've only allowed for that.

Holes should be sampled **in that order** as we need to minimise the chances of losing the sampling gear down the hole while getting as many samples and as much useful coverage as possible. Samples need to be taken on Wednesday and kept on ice for Richard to bring them back to Perth to submit to ALS within the 48 hour sample-to-lab timeframe. Sample ID's will be the Hole ID pre-fixed by SXG_, for example - "SXG_PYRC064D" etc.

Instructions for collecting the water samples are from Pendragon as follows:

- Lower clear bailer into the bore on the cord
- Leave for a few seconds with enough slack for the bailer to fill and sink
- Pull up bailer and discard water
- Repeat process until the water becomes a regular colour (normally 8 – 15 bailer volumes)
- Fill one set of water bottles for each bore totally to the top (2 red bottles and 1 green) and label the bottles with the sample ID

I've filled in a chain of custody sheet with sample ID's and your name; you'll need to add the date and time that you collect the sample in the highlighted section for laboratory purposes as well as write the sample names on the bottles as you take them.

In addition to the chain of custody sheet, the lab will need the second sheet with all the analytes required, as Coffey's have asked for some additional elements for the TSF study. Richard is aware of this.

I've attached a spreadsheet with all 12 holes, in order, to try and sample. We'll get the best results from the vertical holes which is why they are first, followed by the remaining holes according to dip/importance. If you can't get them all done on the day, don't stress, just do what you can. Richard or Steve can take you through the process and the forms, which will be easier than me going through it here. When you hand the bottles to Richard you'll need to sign off on the COC sheet where highlighted.

Cross out any samples that don't get taken on the sheets so the labs are aware that those samples don't exist.

Any questions, give me a call. I've got a copy of all the paperwork here.

Mairi Walsh

Mairi Walsh

Priority order	Prospect	Hole_ID	Dip	Max_Depth	Actual_Depth	Water Depth	Water Comments	Hole_Type	NAT_East	NAT_North	Local_East	Local_North
1	Python	ME011	-90	?	100.00	58.30	clean water - vertical hole - old water bore	DD	718766.52	6656693.99	10838.70	30025.00
2	Python	PYRC064D	-90	70.20	69.00	55.20	clean water - vertical hole	RD	718916.32	6656706.18	10975.08	30088.07
3	King Brown	KBRC052	-90	60.00	?	~7.5	clean water - vertical hole	RC	704222.85	6666137.16	4502.67	1900.70
4	King Brown	KBRC021	-80	40.00	20.00	13.50	clean water	RC	704211.35	6666448.60	4512.63	2212.27
5	King Brown West	KBRC060	-60	66.00	49.00	11.50	clean water	RC	704061.57	6666450.10	4363.27	2224.08
6	Marda Regional	MCRC001	-70	132.00	100.00	53.50	clean water	RC	717760.00	6657115.00	9749.04	30073.17
7	Marda Regional	MCRC002	-65	120.00	100.00	76.20	clean water	RC	716788.00	6657328.00	8763.47	29938.03
8	Marda Regional	MCRC003	-65	108.00	98.00	66.30	clean water	RC	716730.00	6657440.00	8670.43	30023.14
9	Marda Regional	MCRC004	-65	114.00	100.00	73.00	clean water	RC	717200.00	6657060.00	9242.47	29828.53
10	Golden Orb	GORC016	-60	100.00	65.00	63.80	clean water	RC	709697.61	6647696.45	9779.79	10028.81
11	Golden Orb	GORC055	-60	80.00	73.00	62.50	clean water	RC	709931.79	6647474.27	10098.61	9977.68
12	Dugite	DUDD001	-60	75.50	57.00	53.00	clean water	DD	718287.31	6657060.60	10262.63	30203.87

9582 8236 Pendragon – Ed – 0424316721

Carel

0439 993 933

CHAIN OF CUSTODY DOCUMENTATION
Pendragon environmental solutions

Project Manager (PM): Edgardo Alarcon Leon
Job Number: PES12006
Site: Southern Cross
Results required(Date):

FOR LABORATORY USE ONLY
COOLEAR SEAL
INTACT: YES NO N/A
SAMPLE TEMPERATURE
CHILLED YES NO

COMMENTS / SPECIAL HANDLING / STORAGE OR DISP: Not Field Filtered

Sampler: KIM TAYLOR
Mobile: 0429 116 252
Email analysis/report to:
Email invoice to (if different to report): carel@pendragonenvironmental.com

SAMPLE INFORMATION (S = Soil, W=Water) | CONTAINER INFORMATION | ANALYSIS REQUIRED

Lab ID	Sample ID	Matrix	Date	Time	Type / Code	Total bottles	pH	EC	TDS	Major Anions (Acidity, Alkalinities, SO4, CL)	Major Cations (Ca, Mg, Na, K)	Al	Fe	Cr	Cd	Cu	Ni	Zn	Ni	Co	As	Pb				Notes: e.g Highly contaminated samples,extra volume for QC or trace LORs etc
	SXG-ME011	W			P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
	SXG-PYRC060 D	W			P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
	SXG-KBRC052	W			P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
	SXG-KBRC021	W			P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
	SXG-KBRC060	W			P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
	SXG-MCRC001	W			P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
	SXG-MCRC002	W			P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
	SXG-MCRC003	W			P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
	SXG-MCRC004	W			P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
	SXG-GORC016	W			P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
	SXG-GORC055	W			P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
	SXG-DUP0001	W			P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				

RELINQUISHED BY:			RECEIVED BY:			METHOD OF SHIPMENT
Name:	Date:		Name:	Date:	Courrier	
Of:	Time:		Of:	Time:		
Name:	Date:		Name:	Date:	Other:	
Of:	Time:		Of:	Time:		

Water Container Codes: P = Unpreserved Plastic, N = Nitric Preserved Plastic, ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved,
V = VOA Vial HCl Preserved, VS = VOA Vial Sulphuric Preserved, SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic, HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass,
Z = Zinc Acetate Preserved Bottle, E = EDTA Preserved Bottle; ST = Sterile Bottle; ASS = Plastic Bad for Acid Sulphate Soils; B = Unpreserved Bag.

Note: Job number must be reflected on all invoices and statements. Attach copy of CoC to invoice.

Southern Cross Goldfields/Pendragon - Analytes required

All samples:	pH	EC	TDS	Major Anions *1	Major Cations *2	Ag	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe	Li	Mn	Mo	Ni	Pb	Se	Sn	U	V	Zn
SXG_ME011	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_PYRC064D	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_KBRC052	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_KBRC021	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_KBRC060	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_MCRC001	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_MCRC002	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_MCRC003	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_MCRC004	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_GORC016	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_GORC055	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_DUDD001	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Major Anions *1	Acidity, Alkalinities, SO4, Cl
Major Cations *2	Ca, Mg, Na, K

	Additional Analytes to the Pendragon COC document

9582 8236 Pendragon – Ed – 0424516721

Carel

0439 993 933

CHAIN OF CUSTODY DOCUMENTATION
Pendragon environmental solutions

Project Manager (PM): Edgardo Alarcon Leon
Job Number: PES12006
Site: Southern Cross
Results required(Date):

FOR LABORATORY USE ONLY
COOLEAR SEAL
INTACT: YES NO N/A
SAMPLE TEMPERATURE
CHILLED YES NO

COMMENTS / SPECIAL HANDLING / STORAGE OR DISP: Not Field Filtered

Sampler: KIM TAYLOR
Mobile: 0429 116 252
Email analysis/report to: edgardo@pendragonenvironmental.com carel@pendragonenvironmental.com
Email invoice to: (if different to report) carel@pendragonenvironmental.com

SAMPLE INFORMATION (S = Soil, W=Water) | CONTAINER INFORMATION | ANALYSIS REQUIRED

Lab ID	Sample ID	Matrix	Date	Time	Type / Code	Total bottles	pH	EC	TDS	Major Anions (Acidity, Alkalinities, SO4, Cl)	Major Cations (Ca, Mg, Na, K)	Al	Fe	Cr	Cd	Cu	Ni	Zn	Pb	Mn	As	Pb	Notes: e.g Highly contaminated samples,extra volume for QC or trace LORs etc
	SXG-ME011	W	7-11-2012	11:05 AM	P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	SXG-PYRC004D	W	7-11-2012	12:10 AM	P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	SXG-KBRC052	W	7-11-2012	2:15 pm	P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	SXG-KBRC021	W	7-11-2012	2:25 pm	P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	SXG-KBRC060	W	7-11-2012	2:35 pm	P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	SXG-MKRC001	W	7-11-2012	3:15 pm	P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	SXG-MKRC002	W	7-11-2012	4:00 pm	P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	SXG-MCRC003	W	7-11-2012	3:50 pm	P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	SXG-MCRC004	W	7-11-2012	3:30 pm	P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	SXG-GORC016	W	7-11-2012	5:30 pm	P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	SXG-GORC055	W	7-11-2012	5:00 pm	P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	SXG-DUP0001	W	7-11-2012	6:45 pm	P/SP	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	

Environmental Division
Perth
Work Order
EP1209389

Telephone : +61-8-9209 7655

RELINQUISHED BY:
Name: Kim Taylor
Of: PICHARD SIMMONS
Date: 7-11-2012
Time: 6:30 pm
Name:
Of:
Date:
Time:

RECEIVED BY:
Name: RICHARD SIMMONS
Of:
Name: M Westlund
Of: ALS
Date: 8/11/12
Time: 1145

METHOD OF SHIPMENT
Courier:
Other:

Water Container Codes: P = Unpreserved Plastic, N = Nitric Preserved Plastic, ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved.
V = VOA Vial HCl Preserved, VS = VOA Vial Sulphuric Preserved, SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic, HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass.
Z = Zinc Acetate Preserved Bottle, E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.
Note: Job number must be reflected on all invoices and statements. Attach copy of CoC to invoice.

Copy of COC - Marda Project

Southern Cross Goldfields/Pendragon - Analytes required

All samples:	pH	EC	TDS	Major Anions *1	Major Cations *2	Ag	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe	Li	Mn	Mo	Ni	Pb	Se	Sn	U	V	Zn
SXG_ME011	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_PYRC064D	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_KBRC052	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_KBRC021	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_KBRC060	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_MCRC001	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_MCRC002	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_MCRC003	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_MCRC004	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_GORC016	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_GORC055	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SXG_DUDD001	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Major Anions *1	Acidity, Alkalinities, SO4, Cl
Major Cations *2	Ca, Mg, Na, K

	Additional Analytes to the Pendragon COC document

SAMPLE RECEIPT NOTIFICATION (SRN)

Comprehensive Report

Work Order	: **EP1209389**		
Client	: **PENDRAGON ENVIRONMENTAL SOLUTIONS**	Laboratory	: Environmental Division Perth
Contact	: EDGARDO LEON	Contact	: Scott James
Address	: 131-135 ROKEBY ROAD SUBIACO WESTERN AUSTRALIA 6008	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: edgardo@pendragonenvironmental.com	E-mail	: perth.enviro.services@alsglobal.com
Telephone	: +61 08 9382 8286	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 9382 8693	Facsimile	: +61-8-9209 7600
Project	: PES12006	Page	: 1 of 3
Order number	: ----		
C-O-C number	: ----	Quote number	: ----
Site	: Southern Cross		
Sampler	: K.T	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement

Dates

Date Samples Received	: 08-NOV-2012	Issue Date	: 09-NOV-2012 10:49
Client Requested Due Date	: 15-NOV-2012	Scheduled Reporting Date	: **15-NOV-2012**

Delivery Details

Mode of Delivery	: Client Drop off	Temperature	: 3.7 - Ice present
No. of coolers/boxes	: 2 medium esky	No. of samples received	: 12
Security Seal	: Intact.	No. of samples analysed	: 12

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- Samples received in appropriately pretreated and preserved containers.
- Please see scanned COC for sample discrepencies: extra samples , samples not received etc.
- **Samples received in appropriately pretreated and preserved containers.**
- **pH analysis should be conducted within 6 hours of sampling.**
- Analytical work for this work order will be conducted at ALS Environmental Perth.
- Please direct any turnaround / technical queries to the laboratory contact designated above.
- Please direct any queries related to sample condition / numbering / breakages to Sample Receipt (SamplesPerth@alsenviro.com)
- Sample Disposal - Aqueous (14 days), Solid (90 days) from date of completion of Work Order.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exist.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process neccessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default to 15:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory for processing purposes and will be shown bracketed without a time component.

Matrix: **WATER**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	WATER - Balance Suite Balance Suite with DA Chloride	WATER - EA005P pH (PC)	WATER - EA010P Conductivity (PC)	WATER - EA015H Total Dissolved Solids - High Level	WATER - ED038 CaCO3 Acidity as CaCO3 only	WATER - EG020F Dissolved Metals by ICPMS	WATER - EG020T Total Recoverable Metals by ICPMS (including digestion)
EP1209389-001	07-NOV-2012 11:05	SXG-ME011	✓	✓	✓	✓	✓	✓	✓
EP1209389-002	07-NOV-2012 12:10	SXG-PYRC064D	✓	✓	✓	✓	✓	✓	✓
EP1209389-003	07-NOV-2012 02:15	SXG-KBRC052	✓	✓	✓	✓	✓	✓	✓
EP1209389-004	07-NOV-2012 02:25	SXG-KBRC021	✓	✓	✓	✓	✓	✓	✓
EP1209389-005	07-NOV-2012 02:35	SXG-KBR060	✓	✓	✓	✓	✓	✓	✓
EP1209389-006	07-NOV-2012 03:15	SXG-MCR001	✓	✓	✓	✓	✓	✓	✓
EP1209389-007	07-NOV-2012 04:00	SXG-MCR002	✓	✓	✓	✓	✓	✓	✓
EP1209389-008	07-NOV-2012 03:50	SXG-MCR003	✓	✓	✓	✓	✓	✓	✓
EP1209389-009	07-NOV-2012 03:30	SXG-MCR004	✓	✓	✓	✓	✓	✓	✓
EP1209389-010	07-NOV-2012 05:30	SXG-GORC0161						✓	✓
EP1209389-011	07-NOV-2012 05:00	SXG-GOR055	✓	✓	✓	✓	✓	✓	✓
EP1209389-012	07-NOV-2012 06:45	SXG-DUDD001	✓	✓	✓	✓	✓	✓	✓

Proactive Holding Time Report

The following table summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory.

Matrix: **WATER** Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method		Due for extraction	Due for analysis	Samples Received		Instructions Received	
Client Sample ID(s)	Container			Date	Evaluation	Date	Evaluation
EA005-P: pH by PC Titrator							
SXG-DUDD001	Clear Plastic Bottle - Natural	07-NOV-2012	----	08-NOV-2012	×	----	----
SXG-GOR055	Clear Plastic Bottle - Natural	07-NOV-2012	----	08-NOV-2012	×	----	----
SXG-KBR060	Clear Plastic Bottle - Natural	07-NOV-2012	----	08-NOV-2012	×	----	----
SXG-KBRC021	Clear Plastic Bottle - Natural	07-NOV-2012	----	08-NOV-2012	×	----	----
SXG-KBRC052	Clear Plastic Bottle - Natural	07-NOV-2012	----	08-NOV-2012	×	----	----
SXG-MCR001	Clear Plastic Bottle - Natural	07-NOV-2012	----	08-NOV-2012	×	----	----
SXG-MCR002	Clear Plastic Bottle - Natural	07-NOV-2012	----	08-NOV-2012	×	----	----
SXG-MCR003	Clear Plastic Bottle - Natural	07-NOV-2012	----	08-NOV-2012	×	----	----
SXG-MCR004	Clear Plastic Bottle - Natural	07-NOV-2012	----	08-NOV-2012	×	----	----
SXG-ME011	Clear Plastic Bottle - Natural	07-NOV-2012	----	08-NOV-2012	×	----	----
SXG-PYRC064D	Clear Plastic Bottle - Natural	07-NOV-2012	----	08-NOV-2012	×	----	----

Requested Deliverables

EDGARDO LEON

- *AU Certificate of Analysis - NATA (COA)	Email	edgardo@pendragonenvironmental.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	edgardo@pendragonenvironmental.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	edgardo@pendragonenvironmental.com
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	edgardo@pendragonenvironmental.com
- Chain of Custody (CoC) (COC)	Email	edgardo@pendragonenvironmental.com
- EDI Format - ENMRG (ENMRG)	Email	edgardo@pendragonenvironmental.com
- EDI Format - ESDAT (ESDAT)	Email	edgardo@pendragonenvironmental.com
- EDI Format - XTab (XTAB)	Email	edgardo@pendragonenvironmental.com

MR CAREL VAN DER WESTHUIZEN

- *AU Certificate of Analysis - NATA (COA)	Email	carel@pendragonenvironmental.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	carel@pendragonenvironmental.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	carel@pendragonenvironmental.com
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	carel@pendragonenvironmental.com
- A4 - AU Tax Invoice (INV)	Email	carel@pendragonenvironmental.com
- Chain of Custody (CoC) (COC)	Email	carel@pendragonenvironmental.com
- EDI Format - ENMRG (ENMRG)	Email	carel@pendragonenvironmental.com
- EDI Format - ESDAT (ESDAT)	Email	carel@pendragonenvironmental.com
- EDI Format - XTab (XTAB)	Email	carel@pendragonenvironmental.com

CERTIFICATE OF ANALYSIS

Work Order	: **EP1209389**	Page	: 1 of 8
Client	: **PENDRAGON ENVIRONMENTAL SOLUTIONS**	Laboratory	: Environmental Division Perth
Contact	: EDGARDO LEON	Contact	: Scott James
Address	: 131-135 ROKEBY ROAD SUBIACO WESTERN AUSTRALIA 6008	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: edgardo@pendragonenvironmental.com	E-mail	: perth.enviro.services@alsglobal.com
Telephone	: +61 08 9382 8286	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 9382 8693	Facsimile	: +61-8-9209 7600
Project	: PES12006	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 08-NOV-2012
Sampler	: K.T	Issue Date	: 16-NOV-2012
Site	: Southern Cross		
		No. of samples received	: 12
Quote number	: ----	No. of samples analysed	: 12

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Chas Tucker	Inorganic Chemist	Perth Inorganics
Scott James	Laboratory Manager	Perth Inorganics
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: SXG-ME011	SXG-PYRC064D	SXG-KBRC052	SXG-KBRC021	SXG-KBR060
				Client sampling date / time: 07-NOV-2012 11:05	07-NOV-2012 12:10	07-NOV-2012 02:15	07-NOV-2012 02:25	07-NOV-2012 02:35
				EP1209389-001	EP1209389-002	EP1209389-003	EP1209389-004	EP1209389-005
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.40**	**7.37**	**8.41**	**7.02**	**7.20**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**10500**	**4420**	**118000**	**73600**	**88700**
EA015: Total Dissolved Solids								
Total Dissolved Solids @180°C	GIS-210-010	10	mg/L	**6450**	**2830**	**100000**	**56200**	**71800**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**752**	**436**	**197**	**552**	**230**
Total Alkalinity as CaCO3	----	1	mg/L	**752**	**436**	**197**	**552**	**230**
ED038A: Acidity								
Acidity as CaCO3	----	1	mg/L	**63**	**34**	**39**	**146**	**66**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**632**	**239**	**8330**	**2460**	**4710**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	**2590**	**1020**	**45800**	**26200**	**32700**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**121**	**81**	**681**	**356**	**537**
Magnesium	7439-95-4	1	mg/L	**251**	**137**	**3650**	**1960**	**2560**
Sodium	7440-23-5	1	mg/L	**1540**	**588**	**23900**	**13400**	**15600**
Potassium	7440-09-7	1	mg/L	**20**	**13**	**523**	**240**	**250**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.10	<0.10	<0.10
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.001**	<0.010	<0.010	<0.010
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.010	<0.010	<0.010
Barium	7440-39-3	0.001	mg/L	**0.018**	**0.005**	**0.136**	**0.120**	**0.040**
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0010	<0.0010	**0.0026**
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.010	<0.010	<0.010
Cobalt	7440-48-4	0.001	mg/L	**0.002**	**0.002**	<0.010	**0.015**	<0.010
Copper	7440-50-8	0.001	mg/L	**0.001**	**0.004**	<0.010	<0.010	<0.010
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.010	<0.010	<0.010
Lithium	7439-93-2	0.001	mg/L	**0.018**	**0.012**	**0.078**	**0.098**	**0.097**
Manganese	7439-96-5	0.001	mg/L	**0.340**	**0.032**	**1.35**	**7.14**	**0.012**
Molybdenum	7439-98-7	0.001	mg/L	**0.001**	**0.001**	<0.010	<0.010	<0.010
Nickel	7440-02-0	0.001	mg/L	**0.140**	**0.010**	<0.010	**0.018**	<0.010
Selenium	7782-49-2	0.01	mg/L	**0.01**	<0.01	<0.10	<0.10	<0.10
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.010	<0.010	<0.010

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: SXG-ME011	SXG-PYRC064D	SXG-KBRC052	SXG-KBRC021	SXG-KBR060
				Client sampling date / time: 07-NOV-2012 11:05	07-NOV-2012 12:10	07-NOV-2012 02:15	07-NOV-2012 02:25	07-NOV-2012 02:35
				EP1209389-001	EP1209389-002	EP1209389-003	EP1209389-004	EP1209389-005
EG020F: Dissolved Metals by ICP-MS - Continued								
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.010	<0.010	<0.010
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.010	<0.010	<0.010
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.10	<0.10	<0.10
Zinc	7440-66-6	0.005	mg/L	**1.36**	<0.005	<0.050	<0.050	<0.050
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.50	**1.84**	<0.50
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.16**	**3.90**	**0.14**	**4.39**	**12.5**
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.006**	<0.010	**0.095**	**0.040**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.010	<0.010	<0.010
Barium	7440-39-3	0.001	mg/L	**0.020**	**0.006**	**0.141**	**0.136**	**0.051**
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0010	<0.0010	**0.0031**
Chromium	7440-47-3	0.001	mg/L	**0.004**	**0.252**	<0.010	**0.035**	**0.079**
Cobalt	7440-48-4	0.001	mg/L	**0.002**	**0.016**	**0.011**	**0.022**	**0.017**
Copper	7440-50-8	0.001	mg/L	**0.002**	**0.014**	<0.010	**0.028**	**0.072**
Lead	7439-92-1	0.001	mg/L	<0.001	**0.001**	<0.010	<0.010	**0.077**
Lithium	7439-93-2	0.001	mg/L	**0.019**	**0.017**	**0.078**	**0.091**	**0.093**
Manganese	7439-96-5	0.001	mg/L	**0.359**	**0.065**	**1.42**	**7.62**	**0.594**
Molybdenum	7439-98-7	0.001	mg/L	**0.001**	**0.001**	<0.010	<0.010	<0.010
Nickel	7440-02-0	0.001	mg/L	**0.145**	**0.243**	<0.010	**0.030**	**0.045**
Selenium	7782-49-2	0.01	mg/L	**0.01**	<0.01	<0.10	<0.10	<0.10
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.010	<0.010	<0.010
Tin	7440-31-5	0.001	mg/L	**0.001**	<0.001	<0.010	<0.010	<0.010
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.010	<0.010	<0.010
Vanadium	7440-62-2	0.01	mg/L	<0.01	**0.02**	<0.10	<0.10	**0.15**
Zinc	7440-66-6	0.005	mg/L	**1.43**	**0.020**	<0.052	<0.052	**0.054**
Iron	7439-89-6	0.05	mg/L	**0.58**	**5.99**	<0.52	**44.4**	**53.6**
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**101**	**42.5**	**1470**	**801**	**1020**
Total Cations	----	0.01	meq/L	**94.2**	**41.2**	**1390**	**768**	**922**
Ionic Balance	----	0.01	%	**3.63**	**1.49**	**2.89**	**2.13**	**5.28**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: SXG-MCR001	SXG-MCR002	SXG-MCR003	SXG-MCR004	SXG-GORC0161
				Client sampling date / time: 07-NOV-2012 03:15	07-NOV-2012 04:00	07-NOV-2012 03:50	07-NOV-2012 03:30	07-NOV-2012 05:30
				EP1209389-006	EP1209389-007	EP1209389-008	EP1209389-009	EP1209389-010
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.57**	**7.02**	**7.93**	**7.30**	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**3590**	**860**	**2080**	**2080**	----
EA015: Total Dissolved Solids								
Total Dissolved Solids @180°C	GIS-210-010	10	mg/L	**2050**	**512**	**1270**	**1180**	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**386**	**116**	**546**	**233**	----
Total Alkalinity as CaCO3	----	1	mg/L	**386**	**116**	**546**	**233**	----
ED038A: Acidity								
Acidity as CaCO3	----	1	mg/L	**16**	**18**	**10**	**33**	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**205**	**30**	**27**	**85**	----
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	**819**	**165**	**369**	**489**	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**70**	**18**	**22**	**27**	----
Magnesium	7439-95-4	1	mg/L	**59**	**22**	**33**	**41**	----
Sodium	7440-23-5	1	mg/L	**550**	**99**	**338**	**281**	----
Potassium	7440-09-7	1	mg/L	**13**	**13**	**18**	**15**	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	**0.01**	**0.01**	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	**0.006**	**0.005**	<0.001
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.015**	**0.030**	**0.028**	**0.051**	**0.025**
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	**0.0001**
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	**0.001**	**0.001**
Copper	7440-50-8	0.001	mg/L	**0.002**	**0.001**	<0.001	**0.008**	**0.002**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L	**0.015**	**0.003**	**0.004**	**0.007**	**0.025**
Manganese	7439-96-5	0.001	mg/L	**0.043**	**0.029**	**0.123**	**0.297**	**0.063**
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.006**	**0.004**	**0.002**	**0.004**	**0.003**
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	**0.01**
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: SXG-MCR001 Client sampling date / time: 07-NOV-2012 03:15 EP1209389-006	SXG-MCR002 07-NOV-2012 04:00 EP1209389-007	SXG-MCR003 07-NOV-2012 03:50 EP1209389-008	SXG-MCR004 07-NOV-2012 03:30 EP1209389-009	SXG-GORC0161 07-NOV-2012 05:30 EP1209389-010
EG020F: Dissolved Metals by ICP-MS - Continued								
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.045**	<0.005	**0.012**	**0.008**
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	**0.16**	**0.13**	<0.05
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**4.46**	**4.74**	**1.73**	**4.36**	**12.9**
Arsenic	7440-38-2	0.001	mg/L	**0.007**	**0.005**	**0.008**	**0.018**	**0.008**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	**0.020**	**0.065**	**0.036**	**0.100**	**0.047**
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	**0.0002**	**0.0002**
Chromium	7440-47-3	0.001	mg/L	**0.072**	**0.038**	**0.023**	**0.056**	**0.025**
Cobalt	7440-48-4	0.001	mg/L	**0.013**	**0.009**	**0.002**	**0.014**	**0.030**
Copper	7440-50-8	0.001	mg/L	**0.016**	**0.033**	**0.013**	**0.057**	**0.065**
Lead	7439-92-1	0.001	mg/L	**0.001**	**0.008**	**0.002**	**0.013**	**0.019**
Lithium	7439-93-2	0.001	mg/L	**0.020**	**0.005**	**0.005**	**0.009**	**0.031**
Manganese	7439-96-5	0.001	mg/L	**0.288**	**0.194**	**0.141**	**0.413**	**0.395**
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	**0.001**	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.034**	**0.027**	**0.012**	**0.057**	**0.026**
Selenium	7782-49-2	0.01	mg/L	**0.01**	**0.01**	<0.01	<0.01	**0.01**
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	**0.002**	**0.001**
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	**0.002**
Vanadium	7440-62-2	0.01	mg/L	**0.02**	**0.02**	**0.01**	**0.02**	**0.09**
Zinc	7440-66-6	0.005	mg/L	**0.016**	**0.384**	**0.082**	**1.00**	**0.090**
Iron	7439-89-6	0.05	mg/L	**9.20**	**6.58**	**4.02**	**7.73**	**25.9**
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**35.1**	**7.60**	**21.9**	**20.2**	----
Total Cations	----	0.01	meq/L	**32.6**	**7.35**	**19.0**	**17.3**	----
Ionic Balance	----	0.01	%	**3.68**	**1.68**	**7.14**	**7.72**	----

Analytical Results

Sub-Matrix: WATER				Client sample ID	SXG-GOR055	SXG-DUDD001	----	----	----
				Client sampling date / time	07-NOV-2012 05:00	07-NOV-2012 06:45	----	----	----
Compound	CAS Number	LOR	Unit		EP1209389-011	EP1209389-012	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		7.31	7.69	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		29900	4560	----	----	----
EA015: Total Dissolved Solids									
Total Dissolved Solids @180°C	GIS-210-010	10	mg/L		17700	3070	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		527	645	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		527	645	----	----	----
ED038A: Acidity									
Acidity as CaCO3	----	1	mg/L		57	28	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		2400	165	----	----	----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		10300	1020	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		213	43	----	----	----
Magnesium	7439-95-4	1	mg/L		712	76	----	----	----
Sodium	7440-23-5	1	mg/L		5400	729	----	----	----
Potassium	7440-09-7	1	mg/L		65	13	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	----	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	0.109	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	----	----	----
Barium	7440-39-3	0.001	mg/L		0.025	0.048	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		0.0008	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	----	----	----
Cobalt	7440-48-4	0.001	mg/L		0.005	0.018	----	----	----
Copper	7440-50-8	0.001	mg/L		0.002	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	----	----	----
Lithium	7439-93-2	0.001	mg/L		0.038	0.066	----	----	----
Manganese	7439-96-5	0.001	mg/L		0.224	1.35	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		0.004	0.009	----	----	----
Nickel	7440-02-0	0.001	mg/L		0.010	0.047	----	----	----
Selenium	7782-49-2	0.01	mg/L		0.01	0.01	----	----	----
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	----	----	----

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: SXG-GOR055	SXG-DUDD001	----	----	----
				Client sampling date / time: 07-NOV-2012 05:00	07-NOV-2012 06:45	----	----	----
				EP1209389-011	EP1209389-012	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	----	----	----
Uranium	7440-61-1	0.001	mg/L	**0.002**	<0.001	----	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.024**	**0.029**	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	----	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**11.1**	**10.4**	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.009**	**0.354**	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.034**	**0.130**	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	**0.0011**	**0.0002**	----	----	----
Chromium	7440-47-3	0.001	mg/L	**0.061**	**0.295**	----	----	----
Cobalt	7440-48-4	0.001	mg/L	**0.018**	**0.099**	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.054**	**0.120**	----	----	----
Lead	7439-92-1	0.001	mg/L	**0.024**	**0.170**	----	----	----
Lithium	7439-93-2	0.001	mg/L	**0.044**	**0.074**	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.476**	**3.46**	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.005**	**0.009**	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.035**	**0.370**	----	----	----
Selenium	7782-49-2	0.01	mg/L	**0.02**	<0.01	----	----	----
Silver	7440-22-4	0.001	mg/L	**0.002**	**0.001**	----	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	**0.001**	----	----	----
Uranium	7440-61-1	0.001	mg/L	**0.003**	<0.001	----	----	----
Vanadium	7440-62-2	0.01	mg/L	**0.11**	**0.06**	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.034**	**0.482**	----	----	----
Iron	7439-89-6	0.05	mg/L	**29.8**	**33.2**	----	----	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**351**	**45.1**	----	----	----
Total Cations	----	0.01	meq/L	**306**	**40.4**	----	----	----
Ionic Balance	----	0.01	%	**6.91**	**5.47**	----	----	----

QUALITY CONTROL REPORT

Work Order	: **EP1209389**	Page	: 1 of 9
Client	: **PENDRAGON ENVIRONMENTAL SOLUTIONS**	Laboratory	: Environmental Division Perth
Contact	: EDGARDO LEON	Contact	: Scott James
Address	: 131-135 ROKEBY ROAD SUBIACO WESTERN AUSTRALIA 6008	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: edgardo@pendragonenvironmental.com	E-mail	: perth.enviro.services@alsglobal.com
Telephone	: +61 08 9382 8286	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 9382 8693	Facsimile	: +61-8-9209 7600
Project	: PES12006	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: Southern Cross		
C-O-C number	: ----	Date Samples Received	: 08-NOV-2012
Sampler	: K.T	Issue Date	: 16-NOV-2012
Order number	: ----		
		No. of samples received	: 12
Quote number	: ----	No. of samples analysed	: 12

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Chas Tucker	Inorganic Chemist	Perth Inorganics
Scott James	Laboratory Manager	Perth Inorganics
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA005P: pH by PC Titrator (QC Lot: 2593912)									
EP1209389-001	SXG-ME011	EA005-P: pH Value	----	0.01	pH Unit	7.40	7.41	0.1	0% - 20%
EP1209389-011	SXG-GOR055	EA005-P: pH Value	----	0.01	pH Unit	7.31	7.33	0.3	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 2593911)									
EP1209389-001	SXG-ME011	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	10500	10600	0.9	0% - 20%
EP1209389-011	SXG-GOR055	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	29900	29900	0.0	0% - 20%
EA015: Total Dissolved Solids (QC Lot: 2596283)									
EP1209389-001	SXG-ME011	EA015H: Total Dissolved Solids @180°C	GIS-210-010	10	mg/L	6450	6280	2.7	0% - 20%
EP1209389-009	SXG-MCR004	EA015H: Total Dissolved Solids @180°C	GIS-210-010	10	mg/L	1180	1200	1.7	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 2593910)									
EP1209389-001	SXG-ME011	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	752	767	1.9	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	752	767	1.9	0% - 20%
EP1209389-011	SXG-GOR055	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	527	526	0.0	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	527	526	0.0	0% - 20%
ED038A: Acidity (QC Lot: 2595758)									
EP1209389-001	SXG-ME011	ED038: Acidity as CaCO3	----	1	mg/L	63	61	3.2	0% - 20%
EP1209389-011	SXG-GOR055	ED038: Acidity as CaCO3	----	1	mg/L	57	58	0.0	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 2590325)									
EP1209383-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	56	51	10.5	0% - 20%
EP1209389-011	SXG-GOR055	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	2400	2390	0.5	0% - 20%
ED045G: Chloride Discrete analyser (QC Lot: 2590327)									
EP1209389-001	SXG-ME011	ED045G: Chloride	16887-00-6	1	mg/L	2590	2610	0.8	0% - 20%
EP1209389-011	SXG-GOR055	ED045G: Chloride	16887-00-6	1	mg/L	10300	10500	1.9	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 2590326)									
EP1209389-001	SXG-ME011	ED093F: Calcium	7440-70-2	1	mg/L	121	123	1.7	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	251	252	0.0	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	1540	1580	2.8	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	20	20	0.0	0% - 20%
EP1209389-012	SXG-DUDD001	ED093F: Calcium	7440-70-2	1	mg/L	43	44	0.0	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	76	76	0.0	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	729	705	3.3	0% - 20%

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
ED093F: Dissolved Major Cations (QC Lot: 2590326) - continued									
EP1209389-012	SXG-DUDD001	ED093F: Potassium	7440-09-7	1	mg/L	13	13	0.0	0% - 50%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 2593111)									
EP1209389-001	SXG-ME011	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.018	0.019	5.6	0% - 50%
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	0.002	0.002	0.0	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.001	0.001	0.0	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Lithium	7439-93-2	0.001	mg/L	0.018	0.017	0.0	0% - 50%
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.340	0.343	1.1	0% - 20%
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	0.001	0.001	0.0	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.140	0.136	2.9	0% - 20%
		EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	1.36	1.34	1.2	0% - 20%
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.02	0.0	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	0.01	<0.01	0.0	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.0	No Limit
EP1209389-004	SXG-KBRC021	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0010	<0.0010	0.0	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.120	0.122	2.1	0% - 20%
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	0.015	0.016	0.0	0% - 50%
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-F: Lithium	7439-93-2	0.001	mg/L	0.098	0.093	5.6	0% - 20%
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	7.14	7.29	2.1	0% - 20%
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.018	0.016	12.1	0% - 50%
		EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.050	<0.050	0.0	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.10	<0.10	0.0	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.10	<0.10	0.0	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.10	<0.10	0.0	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	1.84	2.29	21.8	0% - 20%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 2593112)									

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020F: Dissolved Metals by ICP-MS (QC Lot: 2593112) - continued									
EP1209389-001	SXG-ME011	EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020B-F: Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
EP1209389-004	SXG-KBRC021	EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020B-F: Uranium	7440-61-1	0.001	mg/L	<0.010	<0.010	0.0	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 2593114)									
EP1209341-001	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.032	0.032	0.0	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.001	0.001	0.0	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.011	0.011	0.0	0% - 50%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Lithium	7439-93-2	0.001	mg/L	0.007	0.007	0.0	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.075	0.075	0.0	0% - 20%
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	0.070	0.073	3.8	0% - 20%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.004	0.004	0.0	No Limit
		EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.0	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.16	0.15	7.0	0% - 50%
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	0.10	0.11	0.0	No Limit
EP1209389-004	SXG-KBRC021	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0010	<0.0010	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.095	0.096	1.3	0% - 20%
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.136	0.135	0.0	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.035	0.033	4.4	0% - 20%
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	0.022	0.022	0.0	0% - 20%
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.028	0.028	0.0	0% - 20%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-T: Lithium	7439-93-2	0.001	mg/L	0.091	0.094	3.2	0% - 20%
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	7.62	7.61	0.2	0% - 20%
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.030	0.039	26.5	0% - 20%
		EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.052	<0.052	0.0	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	4.39	4.61	4.7	0% - 20%
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.10	<0.10	0.0	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020T: Total Metals by ICP-MS (QC Lot: 2593114) - continued									
EP1209389-004	SXG-KBRC021	EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.10	<0.10	0.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	44.4	45.4	2.2	0% - 20%
EG020T: Total Metals by ICP-MS (QC Lot: 2593115)									
EP1209341-001	Anonymous	EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020B-T: Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
EP1209389-004	SXG-KBRC021	EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.010	<0.010	0.0	No Limit
		EG020B-T: Uranium	7440-61-1	0.001	mg/L	<0.010	<0.010	0.0	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA005P: pH by PC Titrator (QCLot: 2593912)								
EA005-P: pH Value	----	0.01	pH Unit	----	7.00 pH Unit	100	70	130
EA010P: Conductivity by PC Titrator (QCLot: 2593911)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	24800 µS/cm	98.8	95	110
EA015: Total Dissolved Solids (QCLot: 2596283)								
EA015H: Total Dissolved Solids @180°C	GIS-210-010	10	mg/L	<10	293 mg/L	104	70	130
ED037P: Alkalinity by PC Titrator (QCLot: 2593910)								
ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	<1	----	----	----	----
ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	<1	200 mg/L	98.4	87	125
ED038A: Acidity (QCLot: 2595758)								
ED038: Acidity as CaCO3	----	1	mg/L	----	20 mg/L	108	85	119
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2590325)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	96.1	85	130
ED045G: Chloride Discrete analyser (QCLot: 2590327)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	1000 mg/L	99.8	78	130
ED093F: Dissolved Major Cations (QCLot: 2590326)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	102	88	112
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	101	88	112
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	102	85	111
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	104	84	114
EG020F: Dissolved Metals by ICP-MS (QCLot: 2593111)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	102	79	119
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	102	80	118
EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	100	76	120
EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	98.0	81	113
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	100	82	114
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	99.6	80	114
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	98.1	78	116
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	97.7	79	115
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	92.3	81	113
EG020A-F: Lithium	7439-93-2	0.001	mg/L	<0.001	0.1 mg/L	102	73	123

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 2593111) - continued								
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	99.8	80	114
EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	99.3	77	119
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	101	80	116
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	102	74	126
EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	0.1 mg/L	99.1	81	113
EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	99.9	70	120
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	97.1	75	121
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	98.1	78	116
EG020F: Dissolved Metals by ICP-MS (QCLot: 2593112)								
EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----
EG020B-F: Uranium	7440-61-1	0.001	mg/L	<0.001	----	----	----	----
EG020T: Total Metals by ICP-MS (QCLot: 2593114)								
EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	104	81	125
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	103	74	120
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	103	69	123
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	103	83	117
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	102	76	116
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	102	80	118
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	102	79	123
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	102	80	120
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	95.7	84	118
EG020A-T: Lithium	7439-93-2	0.001	mg/L	<0.001	0.1 mg/L	102	74	128
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	99.6	81	117
EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	104	81	125
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	102	81	121
EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	97.0	70	130
EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	0.1 mg/L	103	83	123
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	102	69	125
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	96.8	65	121
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	102	79	123
EG020T: Total Metals by ICP-MS (QCLot: 2593115)								
EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----
EG020B-T: Uranium	7440-61-1	0.001	mg/L	<0.001	----	----	----	----

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	Spike Recovery (%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2590325)							
EP1209383-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	100 mg/L	120	70	130
ED045G: Chloride Discrete analyser (QCLot: 2590327)							
EP1209389-001	SXG-ME011	ED045G: Chloride	16887-00-6	250 mg/L	# Not Determined	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 2593111)							
EP1209368-002	Anonymous	EG020A-F: Arsenic	7440-38-2	0.2 mg/L	98.8	70	130
		EG020A-F: Beryllium	7440-41-7	0.2 mg/L	97.2	70	130
		EG020A-F: Barium	7440-39-3	0.2 mg/L	96.8	70	130
		EG020A-F: Cadmium	7440-43-9	0.05 mg/L	95.9	70	130
		EG020A-F: Chromium	7440-47-3	0.2 mg/L	92.4	70	130
		EG020A-F: Cobalt	7440-48-4	0.2 mg/L	94.4	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	95.8	70	130
		EG020A-F: Lead	7439-92-1	0.2 mg/L	90.5	70	130
		EG020A-F: Manganese	7439-96-5	0.2 mg/L	90.0	70	130
		EG020A-F: Nickel	7440-02-0	0.2 mg/L	94.4	70	130
		EG020A-F: Vanadium	7440-62-2	0.2 mg/L	96.1	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	93.2	70	130
EG020T: Total Metals by ICP-MS (QCLot: 2593114)							
EP1209368-001	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	105	70	130
		EG020A-T: Beryllium	7440-41-7	1 mg/L	104	70	130
		EG020A-T: Barium	7440-39-3	1 mg/L	106	70	130
		EG020A-T: Cadmium	7440-43-9	0.25 mg/L	104	70	130
		EG020A-T: Chromium	7440-47-3	1 mg/L	101	70	130
		EG020A-T: Cobalt	7440-48-4	1 mg/L	114	70	130
		EG020A-T: Copper	7440-50-8	1 mg/L	102	70	130
		EG020A-T: Lead	7439-92-1	1 mg/L	112	70	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	99.3	70	130
		EG020A-T: Nickel	7440-02-0	1 mg/L	101	70	130
		EG020A-T: Vanadium	7440-62-2	1 mg/L	105	70	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	100	70	130

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: **EP1209389**	Page	: 1 of 9
Client	: PENDRAGON ENVIRONMENTAL SOLUTIONS	Laboratory	: Environmental Division Perth
Contact	: EDGARDO LEON	Contact	: Scott James
Address	: 131-135 ROKEBY ROAD SUBIACO WESTERN AUSTRALIA 6008	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: edgardo@pendragonenvironmental.com	E-mail	: perth.enviro.services@alsglobal.com
Telephone	: +61 08 9382 8286	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 9382 8693	Facsimile	: +61-8-9209 7600
Project	: PES12006	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: Southern Cross		
C-O-C number	: ----	Date Samples Received	: 08-NOV-2012
Sampler	: K.T	Issue Date	: 16-NOV-2012
Order number	: ----		
		No. of samples received	: 12
Quote number	: ----	No. of samples analysed	: 12

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Holding times for leachate methods (excluding elutriates) vary according to the analytes being determined on the resulting solution. For non-volatile analytes, the holding time compliance assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These soil holding times are: Organics (14 days); Mercury (28 days) & other metals (180 days). A recorded breach therefore does not guarantee a breach for all non-volatile parameters.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural							
SXG-ME011, SXG-KBRC052, SXG-KBR060, SXG-MCR002, SXG-MCR004, SXG-DUDD001, SXG-PYRC064D, SXG-KBRC021, SXG-MCR001, SXG-MCR003, SXG-GOR055,	**07-NOV-2012**	---	07-NOV-2012	----	**13-NOV-2012**	07-NOV-2012	×
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural							
SXG-ME011, SXG-KBRC052, SXG-KBR060, SXG-MCR002, SXG-MCR004, SXG-DUDD001, SXG-PYRC064D, SXG-KBRC021, SXG-MCR001, SXG-MCR003, SXG-GOR055,	**07-NOV-2012**	---	05-DEC-2012	----	**13-NOV-2012**	05-DEC-2012	✓
EA015: Total Dissolved Solids							
Clear Plastic Bottle - Natural							
SXG-ME011, SXG-KBRC052, SXG-KBR060, SXG-MCR002, SXG-MCR004, SXG-DUDD001, SXG-PYRC064D, SXG-KBRC021, SXG-MCR001, SXG-MCR003, SXG-GOR055,	**07-NOV-2012**	---	14-NOV-2012	----	**14-NOV-2012**	14-NOV-2012	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural							
SXG-ME011, SXG-KBRC052, SXG-KBR060, SXG-MCR002, SXG-MCR004, SXG-DUDD001, SXG-PYRC064D, SXG-KBRC021, SXG-MCR001, SXG-MCR003, SXG-GOR055,	**07-NOV-2012**	---	21-NOV-2012	----	**13-NOV-2012**	21-NOV-2012	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED038A: Acidity								
Clear Plastic Bottle - Natural								
SXG-ME011,	SXG-PYRC064D,	**07-NOV-2012**	**----**	----	----	**14-NOV-2012**	21-NOV-2012	✓
SXG-KBRC052,	SXG-KBRC021,							
SXG-KBR060,	SXG-MCR001,							
SXG-MCR002,	SXG-MCR003,							
SXG-MCR004,	SXG-GOR055,							
SXG-DUDD001								
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Clear Plastic Bottle - Natural								
SXG-ME011,	SXG-PYRC064D,	**07-NOV-2012**	**---**	05-DEC-2012	----	**13-NOV-2012**	05-DEC-2012	✓
SXG-KBRC052,	SXG-KBRC021,							
SXG-KBR060,	SXG-MCR001,							
SXG-MCR002,	SXG-MCR003,							
SXG-MCR004,	SXG-GOR055,							
SXG-DUDD001								
ED045G: Chloride Discrete analyser								
Clear Plastic Bottle - Natural								
SXG-ME011,	SXG-PYRC064D,	**07-NOV-2012**	**---**	05-DEC-2012	----	**13-NOV-2012**	05-DEC-2012	✓
SXG-KBRC052,	SXG-KBRC021,							
SXG-KBR060,	SXG-MCR001,							
SXG-MCR002,	SXG-MCR003,							
SXG-MCR004,	SXG-GOR055,							
SXG-DUDD001								
ED093F: Dissolved Major Cations								
Clear Plastic Bottle - Natural								
SXG-ME011,	SXG-PYRC064D,	**07-NOV-2012**	**---**	14-NOV-2012	----	**12-NOV-2012**	14-NOV-2012	✓
SXG-KBRC052,	SXG-KBRC021,							
SXG-KBR060,	SXG-MCR001,							
SXG-MCR002,	SXG-MCR003,							
SXG-MCR004,	SXG-GOR055,							
SXG-DUDD001								
EG020F: Dissolved Metals by ICP-MS								
Clear Plastic Bottle - Filtered; Lab-acidified								
SXG-ME011,	SXG-PYRC064D,	**07-NOV-2012**	**---**	06-MAY-2013	----	**14-NOV-2012**	06-MAY-2013	✓
SXG-KBRC052,	SXG-KBRC021,							
SXG-KBR060,	SXG-MCR001,							
SXG-MCR002,	SXG-MCR003,							
SXG-MCR004,	SXG-GORC0161,							
SXG-GOR055,	SXG-DUDD001							

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG020T: Total Metals by ICP-MS								
Clear Plastic Bottle - Unfiltered; Lab-acidified								
SXG-ME011,	SXG-PYRC064D,	**07-NOV-2012**	**14-NOV-2012**	06-MAY-2013	✓	**14-NOV-2012**	06-MAY-2013	✓
SXG-KBRC052,	SXG-KBRC021,							
SXG-KBR060,	SXG-MCR001,							
SXG-MCR002,	SXG-MCR003,							
SXG-MCR004,	SXG-GORC0161,							
SXG-GOR055,	SXG-DUDD001							

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(where) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Acidity as Calcium Carbonate	ED038	2	11	**18.2**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Alkalinity by PC Titrator	ED037-P	2	20	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	2	18	**11.1**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Conductivity by PC Titrator	EA010-P	2	20	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite B	EG020B-F	2	13	**15.4**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Major Cations - Dissolved	ED093F	2	18	**11.1**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
pH by PC Titrator	EA005-P	2	20	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	12	**16.7**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Dissolved Solids (High Level)	EA015H	2	20	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-MS - Suite A	EG020A-T	2	19	**10.5**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-MS - Suite B	EG020B-T	2	13	**15.4**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Acidity as Calcium Carbonate	ED038	1	11	**9.1**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Alkalinity by PC Titrator	ED037-P	2	20	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	2	18	**11.1**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Conductivity by PC Titrator	EA010-P	3	20	**15.0**	**15.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	13	**7.7**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Major Cations - Dissolved	ED093F	1	18	**5.6**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
pH by PC Titrator	EA005-P	2	20	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	12	**16.7**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Dissolved Solids (High Level)	EA015H	2	20	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-MS - Suite A	EG020A-T	1	19	**5.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-MS - Suite B	EG020B-T	1	13	**7.7**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Alkalinity by PC Titrator	ED037-P	1	20	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	1	18	**5.6**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Conductivity by PC Titrator	EA010-P	1	20	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	13	**7.7**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Major Cations - Dissolved	ED093F	1	18	**5.6**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	12	**8.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Dissolved Solids (High Level)	EA015H	1	20	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-MS - Suite A	EG020A-T	1	19	**5.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-MS - Suite B	EG020B-T	1	13	**7.7**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
Chloride by Discrete Analyser	ED045G	1	18	**5.6**	**5.0**	✓	ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.0**	**5.0**	✓	ALS QCS3 requirement

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Matrix Spikes (MS) - Continued							
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	12	**8.3**	**5.0**	✓	ALS QCS3 requirement
Total Metals by ICP-MS - Suite A	EG020A-T	1	19	**5.3**	**5.0**	✓	ALS QCS3 requirement

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	APHA 21st ed. 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Conductivity by PC Titrator	EA010-P	WATER	APHA 21st ed., 2510 B This procedure determines conductivity by automated ISE. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Dissolved Solids (High Level)	EA015H	WATER	In-House, APHA 21st ed., 2540C A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Alkalinity by PC Titrator	ED037-P	WATER	APHA 21st ed., 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Acidity as Calcium Carbonate	ED038	WATER	APHA 21st ed., 2310 B Acidity is determined by titration with a standardised alkali to an end-point pH of 8.3. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	APHA 21st ed., 4500-SO4 Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Chloride by Discrete Analyser	ED045G	WATER	APHA 21st ed., 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	Major Cations is determined based on APHA 21st ed., 3120; USEPA SW 846 - 6010 The ICPAES technique ionises the 0.45um filtered sample atoms emitting a characteristic spectrum. This spectrum is then compared against matrix matched standards for quantification. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2) Sodium Absorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2) Hardness parameters are calculated based on APHA 21st ed., 2340 B. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	(APHA 21st ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020): Samples are 0.45 um filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	(APHA 21st ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020): The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Metals by ICP-MS - Suite B	EG020B-F	WATER	(APHA 21st ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020): Samples are 0.45 um filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite B	EG020B-T	WATER	(APHA 21st ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020): The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	APHA 21st Ed. 1030F. The Ionic Balance is calculated based on the major Anions and Cations. The major anions include Alkalinity, Chloride and Sulfate which determined by PCT and DA. The Cations are determined by Turbi SO4 by DA. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

Preparation Methods	Method	Matrix	Method Descriptions
Digestion for Total Recoverable Metals	EN25	WATER	USEPA SW846-3005 Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED045G: Chloride Discrete analyser	EP1209389-001	SXG-ME011	**Chloride**	16887-00-6	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

- **For all matrices, no Method Blank value outliers occur.**
- **For all matrices, no Duplicate outliers occur.**
- **For all matrices, no Laboratory Control outliers occur.**

Regular Sample Surrogates

- **For all regular sample matrices, no surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

Matrix: **WATER**

Method / Container / Client Sample ID(s)		Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural							
SXG-ME011,	SXG-PYRC064D,	----	----	----	13-NOV-2012	07-NOV-2012	**6**
SXG-KBRC052,	SXG-KBRC021,						
SXG-KBR060,	SXG-MCR001,						
SXG-MCR002,	SXG-MCR003,						
SXG-MCR004,	SXG-GOR055,						
SXG-DUDD001							

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

- **No Quality Control Sample Frequency Outliers exist.**

Appendix D: Risk Assessment Methodology.

Risk Assessment Process

- Uses the Groundwater Inventory as primary data source.
- Departmental risk assessment framework
- Assess the environmental, economic and social/cultural risks
- Identify aquifers and water users *at risk*

	Assessment Criteria
Environmental	Declining water levels
	Deteriorating water quality
	Decreased stream flows
	Loss of GDEs
Economic	Reduced supplies for existing users
	Deteriorating water quality
	Increased pumping costs
	Reduced access & flexibility
Social/Cultural	Security of town water supplies
	Loss of water holes & springs
	Cultural heritage values
Technical	Pit inflow and flooding
	Dewatering water management

Risk Likelihood

Likelihood	Rating	Criteria
Improbable	1	Most unlikely to occur
Unlikely	2	Low frequency of occurrence is likely
Possible	3	Occurrence is possible
Likely	4	Occurrence is likely
Almost Certain	5	Occurrence is almost certain

Consequence Rating

Consequence	Rating	Description					
		Mortality	Health	Environment	Cost	Production	Community Concern
Catastrophic	5	Many	Lethal	Very extensive	Very high	Several months	Very high
Major	4	A few	Toxic	Extensive	High	Several weeks	High
Moderate	3	One	Temporary illness	Localised	Moderate	A week	Moderately high
Minor	2	Severe injury	Irritation	Low	Low	A few days	Low
Insignificant	1	Injury	Mild irritation	Insignificant	Insignificant	One day	Insignificant

Control Measures

Adequacy of Existing Controls		
High	4	Our existing controls are adequate and will prevent, or provide adequate warming of, and impending event.
Moderate	3	Our existing controls are reasonable and should provide some warming of an impending event.
Low	2	Our existing controls are not sufficient to provide adequate warning.
Nil	1	We have no controls in place in respect of this risk event.

Consequence

Public Outrage Factor		
High	4	Public pressure sufficient to halt the project, attract local and non-local opponents, cause lengthy delays and increase environmental investigations.
Moderate	3	Public pressure sufficient to attract only local persons, cause delays and increase environmental investigations.
Low	2	Public pressure from local people which can be resolved without delays.
Nil	1	None, if very little public reaction expected.

Hazard Rating

Risk Likelihood		Risk Consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
		1	2	3	4	5
Improbable	1	Low (1)	Low (2)	Low (3)	Low (4)	Significant (5)
Unlikely	2	Low (2)	Low (4)	Moderate (6)	Significant (8)	High (10)
Possible	3	Low (3)	Moderate (6)	Significant (9)	High (12)	High (15)
Likely	4	Moderate (4)	Low (8)	Significant (12)	High (16)	High (20)
Almost Certain	5	Low (5)	Significant (10)	High (15)	High (20)	High (25)

Risk Level	
Low	Low risk, monitor to ensure it does not change to significant or high
Moderate	Moderate risk, mitigation plan may be considered.
Significant	Significant risk, mitigation plan may be required.
High	High risk, mitigation planning is required.

Uncertainty Description

Uncertainty Description		
High	4	My prediction is a guess.
Moderate	3	My prediction feels right, but I'm unsure.
Low	2	My prediction is based on experience, and is reasonable.
Nil	1	I have little or no doubt about the prediction

			Uncertainty with Consequence			
			High, H	Moderate, M	Low, L	Nil, N
			4	3	2	1
Uncertainty with likelihood	High, H	4	16	12	8	4
	Moderate, M	3	12	9	6	3
	Low, L	2	8	6	4	2
	Nil, N	1	4	3	2	1

	High Uncertainty
	Moderate Uncertainty
	Low Uncertainty
	No Uncertainty

Risk Rating

Public outrage Factor		Hazard Rating			
		High, H	Significant, S	Moderate, M	Low, L
		13-25	7-12	5-6	1-4
High, H	4	52-100	28-48	20-14	4-16
Significant, S	3	39-75	21-36	15-18	3-12
Moderate, M	2	26-50	14-24	10-12	2-8
Low, L	1	13-25	7-12	5-6	1-4

	High Risk
	Significant Risk
	Moderate Risk
	Low Risk

Risk Treatment Priority

Treatment Priority	Rating	Definition
Low	1	Monitoring and reviewing
Medium	2	All Significant level risks. Treatment completion date has been specified, but execution as resources are available.
High	3	High level risks whose consequences are rated as Major or Moderate. Treatment shall be scheduled for completion before the risk event is likely to occur.
Critical	4	High level risks whose consequences are rated as Catastrophic. Risk Treatment activity shall be scheduled on the project Critical Path, with completion before the event is likely to occur (if possible).
Closed	5	Risk Closed.