BIG BELL GOLD OPERATIONS PTY LTD
(ACN 090 642 809)

MAID MARION MINING PROJECT

WORKS APPROVAL SUPPORTING DOCUMENTATION

NOVEMBER 2019

Westgold Resources

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1.0 PREMISE DETAILS

Westgold Resources Limited is the sole owner of the Meekatharra Gold Operation (MGO) through its subsidiary Big Bell Gold Operations Pty Ltd (BBGO). MGO includes four mining projects (Yaloginda, Paddy's Flat, Reedy and Nannine) located in the Mid-West region of Western Australia within the Murchison mineral field (Figure 1). BBGO currently hold Prescribed Premise Licence L4496/1988/11.

1.1. Owner of Premises

All compliance and regulatory requirements should be forwarded by post or e-mail to the following address provided in Table 1.

Table 1: Westgold Resources Contact Details

Peter Storey	Cheryl Low	Tim Cook
General Manager	Environment Manager	Manager Titles & Leases
Registered office: Level 6, 197 St Georges Tce Perth WA 6005 **Postal:** PO Box 1959 WEST PERTH WA 6872		
9980 2104	0447 130 638	9462 3400
Peter.Storey@westgold.com.au	Cheryl.low@westgold.com.au	compliance@westgold.com.au

1.2. Name and Location Details of Premises

Name: Maid Marion Mining Project – Paddy's Flat

Description: The Maid Marion deposit and associated infrastructure are located within mining tenement M51/504 approximately 32km north of the Bluebird processing facility. (Figure 2). Site access and ore haulage to the Bluebird processing facility will be undertaken via a short East/West aligned haul road located on tenement M51/668 which will connect the project site to the Great Northern Highway. The topography is considered to be relatively flat, with no drainage lines impacting the main project area.

BBGO owns and operates a conventional CIL gold processing plant at the Bluebird mine site, approximately 15 km south of Meekatharra, Western Australia. The purpose of this proposal is to access a satellite ore reserve to continue supply of oxide ore for the processing facility. As a consequence of the proposed mining operations, mine dewatering in excess of 50,000kL is required to safely mine the Maid Marion pit.

A general layout of the project area has been provided in Figure 3.

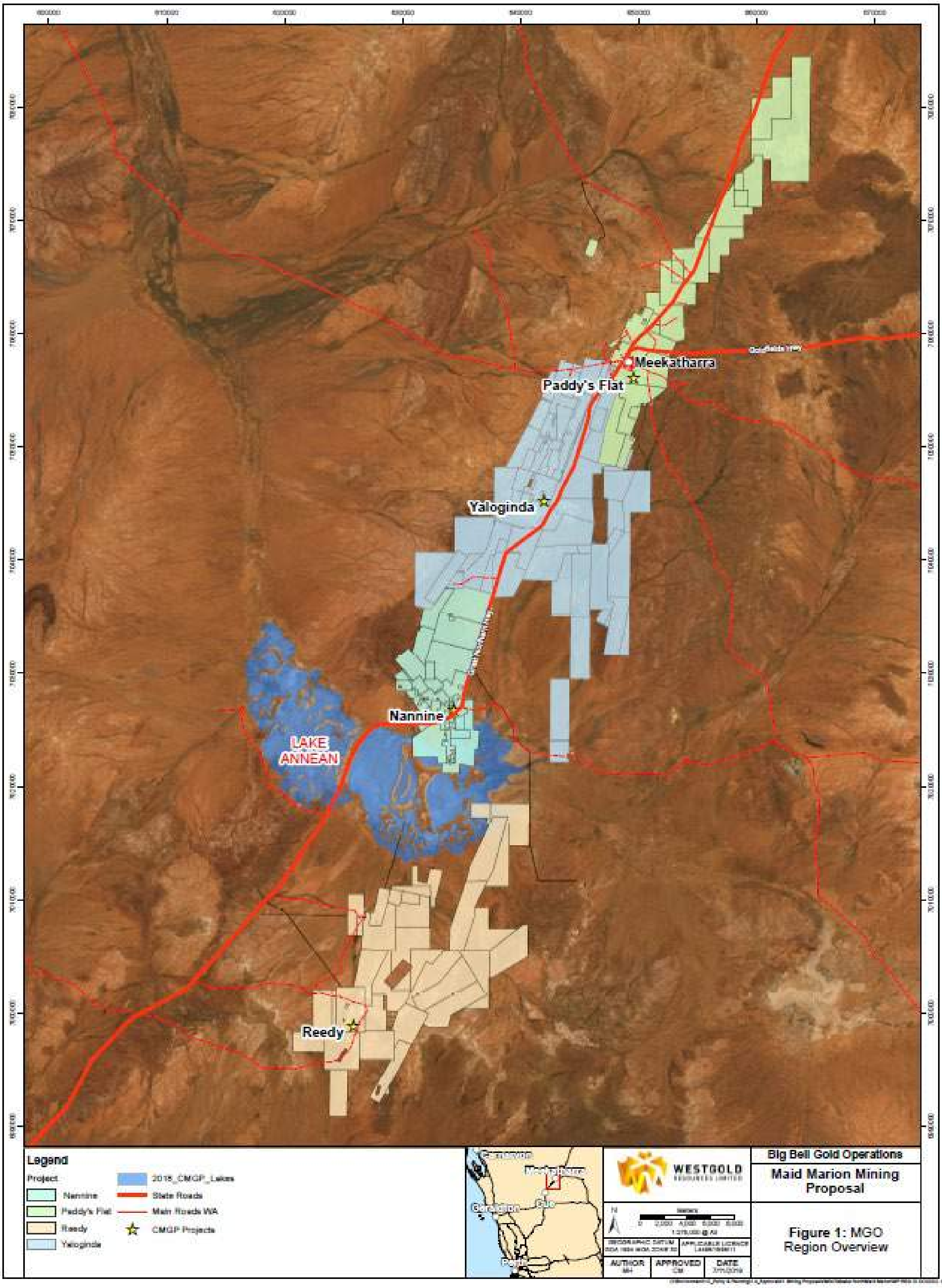


Figure 1: MGO Location Plan

Figure 2: Project General Overview

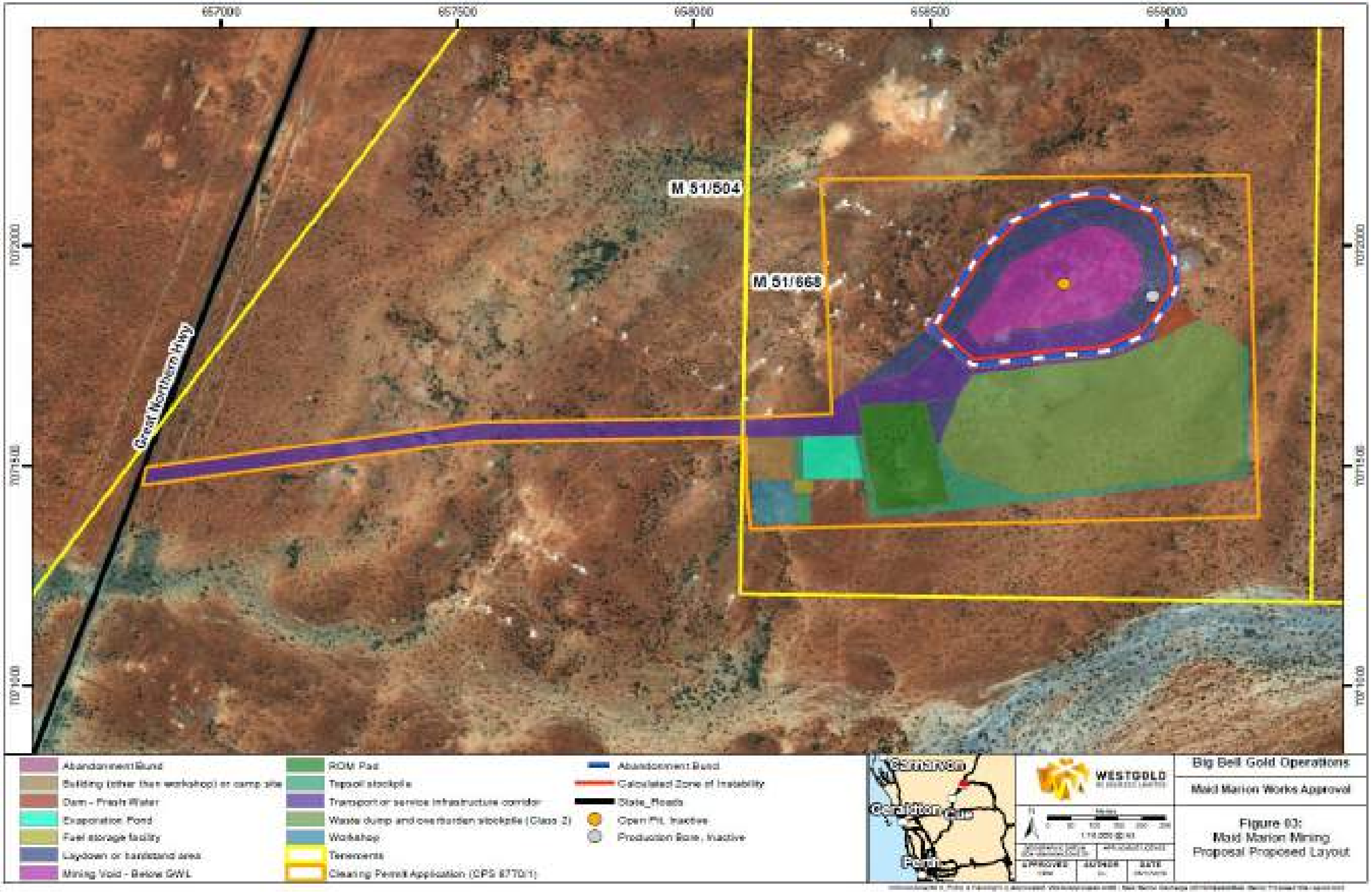


Figure 3: Maid Marion Project Layout

1.3. Legal Land Description

The Maid Marion project infrastructure is located within mining tenements M51/504 and M51/668 (Table 2 and Figure 2). Copies of Tenement Summaries for both tenements have been provided in both Appendix A and submitted with the Licence amendment application. The current prescribed premise boundary and contained tenements are presented in Table 3 and Figure 4. New tenements proposed for inclusion within the prescribed premise are noted in red.

Table 2: Tenement Details

Tenement	Tenement Holder	Area	Date Granted	Expiry Date
M51/504	Big Bell Gold Operations Pty Ltd	181.90	31/05/1994	31/08/2036
M51/668	Big Bell Gold Operations Pty Ltd	695.00	05/06/2013	04/06/2034
M51/669	Big Bell Gold Operations Pty Ltd	869.00	05/06/2013	04/06/2034
M51/670	Big Bell Gold Operations Pty Ltd	869.00	05/06/2013	04/06/2034

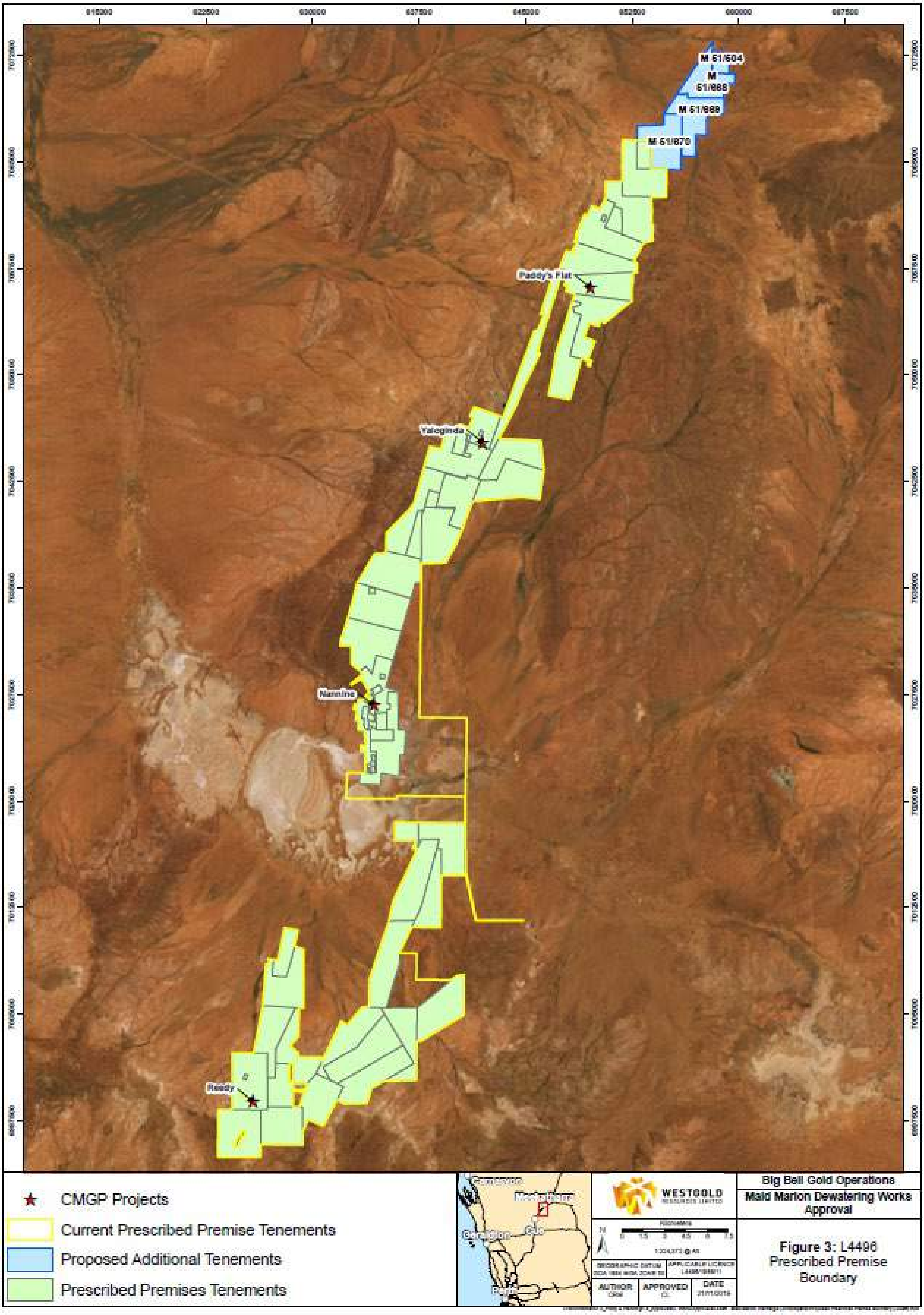


Figure 4: Prescribed Premise Boundary

Table 3: L4496 Prescribed Premise Tenements

Tenement	Holder	Area (ha)	Granted	Expiry
G51/9	Big Bell Gold Operations Pty Ltd	33.64	10/04/1986	22/09/2027
L20/75	Big Bell Gold Operations Pty Ltd	9.379	27/03/2017	26/03/2038
L51/18	Big Bell Gold Operations Pty Ltd	0.84	26/02/1985	25/07/2026
L51/78	Big Bell Gold Operations Pty Ltd	75.00	24/02/2000	23/02/2021
L51/79	Big Bell Gold Operations Pty Ltd	19.00	15/03/2001	14/03/2022
M20/12	Big Bell Gold Operations Pty Ltd	969.8	14/04/1984	17/04/2026
M20/45	Big Bell Gold Operations Pty Ltd	988.8	24/08/1986	25/08/2028
M20/68	Big Bell Gold Operations Pty Ltd	717.25	18/07/1988	17/07/2030
M20/70	Big Bell Gold Operations Pty Ltd	789.5	18/07/1988	17/07/2030
M20/71	Big Bell Gold Operations Pty Ltd	996.60	18/07/1988	17/07/2030
M20/73	Big Bell Gold Operations Pty Ltd	693.45	18/07/1988	17/07/2030
M20/77	Big Bell Gold Operations Pty Ltd	770.20	08/02/1988	07/02/2030
M20/107	Big Bell Gold Operations Pty Ltd	709.1	02/10/1988	09/10/2030
M20/214	Big Bell Gold Operations Pty Ltd	468.70	02/09/1991	01/09/2033
M20/219	Big Bell Gold Operations Pty Ltd	8.94250	02/09/1991	01/09/2033
M20/249	Big Bell Gold Operations Pty Ltd	916	02/02/1993	01/02/2035
M20/421	Big Bell Gold Operations Pty Ltd	692.20	22/11/2012	21/11/2033
M51/6	Big Bell Gold Operations Pty Ltd	40.4	29/12/1982	28/12/2024
M51/12	Big Bell Gold Operations Pty Ltd	8.45	29/03/1983	28/03/2025
M51/31	Big Bell Gold Operations Pty Ltd	262.8	26/07/1984	25/07/2026
M51/33	Big Bell Gold Operations Pty Ltd	25.03	5/09/1984	4/09/2026
M51/35	Big Bell Gold Operations Pty Ltd	8.9035	09/09/1984	06/09/2026
M51/39	Big Bell Gold Operations Pty Ltd	15.81	23/10/1984	22/10/2026
M51/62	Big Bell Gold Operations Pty Ltd	14.665	23/09/1985	22/09/2027
M51/75	Big Bell Gold Operations Pty Ltd	55.32	18/03/1986	17/03/2028
M51/92	Big Bell Gold Operations Pty Ltd	343.55	25/07/1986	24/07/2028
M51/96	Big Bell Gold Operations Pty Ltd	9.71	19/12/1986	18/12/2028
M51/132	Big Bell Gold Operations Pty Ltd	867.55	25/09/1987	24/09/2029
M51/190	Big Bell Gold Operations Pty Ltd	491.15	06/05/1988	05/05/2030
M51/199	Big Bell Gold Operations Pty Ltd	203.05	19/05/1988	18/05/2030
M51/200	Big Bell Gold Operations Pty Ltd	817.7	19/05/1988	18/05/2030
M51/203	Big Bell Gold Operations Pty Ltd	87.57	12/07/1988	11/07/2030
M51/209	Big Bell Gold Operations Pty Ltd	117.4	08/08/1988	07/08/2030
M51/211	Big Bell Gold Operations Pty Ltd	782.05	30/08/1988	29/08/2030
M51/233	Big Bell Gold Operations Pty Ltd	841.85	22/09/1988	21/09/2030
M51/236	Big Bell Gold Operations Pty Ltd	991.85	22/09/1988	21/09/2030
M51/237	Big Bell Gold Operations Pty Ltd	998	22/09/1988	21/09/2030
M51/254	Big Bell Gold Operations Pty Ltd	924.35	17/01/1989	16/01/2031

Tenement	Holder	Area (ha)	Granted	Expiry
M51/321	Big Bell Gold Operations Pty Ltd	3.05	25/08/1989	24/08/2031
M51/393	Big Bell Gold Operations Pty Ltd	703.95	04/11/1991	03/11/2033
M51/437	Big Bell Gold Operations Pty Ltd	936.675	10/08/1993	09/08/2035
M51/438	Big Bell Gold Operations Pty Ltd	794.35	10/08/1993	09/08/2035
M51/439	Big Bell Gold Operations Pty Ltd	750.25	10/08/1993	09/08/2035
M51/440	Big Bell Gold Operations Pty Ltd	823.30	10/08/1993	09/08/2035
M51/459	Big Bell Gold Operations Pty Ltd	932.20	05/02/1993	04/02/2035
M51/483	Big Bell Gold Operations Pty Ltd	878.10	19/02/2013	81/02/2034
M51/485	Big Bell Gold Operations Pty Ltd	9.7125	03/11/1993	02/11/2035
M51/486	Big Bell Gold Operations Pty Ltd	663.3	09/11/1993	08/11/2035
M51/491	Big Bell Gold Operations Pty Ltd	749.55	08/03/1994	07/03/2036
M51/492	Big Bell Gold Operations Pty Ltd	999.05	02/02/1994	01/02/2036
M51/493	Big Bell Gold Operations Pty Ltd	951.20	02/02/1994	01/02/2036
M51/494	Big Bell Gold Operations Pty Ltd	994.35	02/02/1994	01/02/2036
M51/495	Big Bell Gold Operations Pty Ltd	792.20	02/02/1994	01/02/2036
M51/504	Big Bell Gold Operations Pty Ltd	181.90	31/05/1994	31/08/2036
M51/523	Big Bell Gold Operations Pty Ltd	513.15	23/12/1994	22/12/2036
M51/539	Big Bell Gold Operations Pty Ltd	4.91	26/07/1995	25/07/2037
M51/569	Big Bell Gold Operations Pty Ltd	8.95	17/10/2012	16/10/2033
M51/572	Big Bell Gold Operations Pty Ltd	836.80	05/06/2013	04/06/2034
M51/581	Big Bell Gold Operations Pty Ltd	6.00	17/10/2012	16/10/2033
M51/654	Big Bell Gold Operations Pty Ltd	172.00	05/06/2013	04/06/2034
M51/668	Big Bell Gold Operations Pty Ltd	695.00	05/06/2013	04/06/2034
M51/669	Big Bell Gold Operations Pty Ltd	695.00	05/06/2013	04/06/2034
M51/670	Big Bell Gold Operations Pty Ltd	695.00	05/06/2013	04/06/2034
M51/671	Big Bell Gold Operations Pty Ltd	794.00	05/06/2013	04/06/2034
M51/672	Big Bell Gold Operations Pty Ltd	825.00	05/06/2013	04/06/2034
M51/757	Big Bell Gold Operations Pty Ltd	568.40	22/11/2012	21/11/2033
M51/762	Big Bell Gold Operations Pty Ltd	845.10	28/09/2010	27/09/2031
M51/784	Big Bell Gold Operations Pty Ltd	233.25	19/10/2012	18/10/2033
M51/788	Big Bell Gold Operations Pty Ltd	836.00	05/06/2013	04/06/2034
M51/793	Big Bell Gold Operations Pty Ltd	4.86	11/12/2000	10/12/2021
M51/794	Big Bell Gold Operations Pty Ltd	18.65	11/12/2000	1/12/2021
M51/795	Big Bell Gold Operations Pty Ltd	9.7064	11/12/2000	1/12/2021
M51/820	Big Bell Gold Operations Pty Ltd	9.7059	17/06/2002	16/06/2023
M51/824	Big Bell Gold Operations Pty Ltd	228.4087	05/06/2013	04/06/2034
M51/834	Big Bell Gold Operations Pty Ltd	93.105	19/10/2012	18/10/2033

1.4. Prescribed Premise Category

Bluebird mine site currently operates under Department of Water and Environment Regulation (DWER) Part V (of the EP Act) Prescribed Premises Licence 4496/1988/11. This amendment seeks to increase the approved premises production rate for the "Prescribed Premises" category number 6 under Schedule 1 of the Environmental Protection Regulations 1987. The current facility approvals as prescribed within Schedule 1 of the *Environmental Protection Regulations 1987* is outlined in Table 4.

Table 4: Prescribes Premise Categories

Category Number	Category Description	Category Production	Approved Premises Production
5	Processing or beneficiation of metallic or non-metallic ore	50,000 tonnes or more per year	2,500,000 tonnes per annual period
6	Mine dewatering	50,000 tonnes or more per year	5,823,000 tonnes per annual period
63	Class 1 inert landfill site	500 tonnes **or more** per year	3000 tonnes per year
85	Sewage facility	More than 20 but less than 100 cubic metres per day	99 cubic metres per day

2.0 DESCRIPTION OF ACTIVITY

BBGO is seeking required approvals to mine the Maid Marion gold project located on tenements M51/504 and M51/668. Infrastructure associated with the development will include a Waste Rock Landform (WRL), temporary workshop, temporary fuel facility, office/crib room, laydown area, topsoil stockpile, abandonment bund and haul road. An evaporation pond has also been proposed. However, will only be constructed should the volume of water encountered be greater than operational mine requirements. Ore will be transported via road train to the existing Bluebird processing facility located 32 km south of the Maid Marion Run-of-Mine (RoM) pad via the Great Northern Highway. A 2 km haul road will be constructed on M51/504 and M51/668 which will connect the project site with the Great Northern Highway.

Conventional open cut mining methods involving drilling, blasting, excavator loading and truck haulage will be used to mine the deposit. Dewatering activities will be required to allow mining of ore, with groundwater encountered to be used for dust suppression accessed from a newly constructed production bore or in pit pumping. The pit will be excavated to a maximum depth of 75 m from natural ground level. Geochemical characterisation of waste rock shows the material is benign and non-acid forming (NAF) with low concentrations of metals and metalloids.

An estimated life of mine (LoM) for the Maid Marion project of seven months is expected. Approximately 100,000 BCM of ore and 1,000,000 BCM of waste rock will be mined during this period. Ore will be processed at the Bluebird Processing Plant using the standard carbon-in-leach (CIL) methods with tailings discharged into the approved Bluebird East in-pit tailings storage facility (TSF). The Maid Marion project footprint is approximately 55ha and has been classified as previously undisturbed land. Clearing permit application 8710/1 covering the project area was lodged with Department of Mining, Industry Regulation and Safety (DMIRS) in October 2019.

Mine dewatering will involve abstraction of groundwater via a combination of a single production bore and an inpit sump, once mining encounters the standing water level. Groundwater will be pumped via a dedicated pipeline into a series of water storage tanks located adjacent to the pit. Abstracted water will be used for dust suppression and other project requirements. Groundwater modelling has identified a range of abstraction rates with a lower (95,000m^3), average (190,000m^3) and upper (580,000m^3) range produced. However, the figure is unlikely to be greater than 300,000 m^3.

Should water abstraction volumes exceed mining requirements, BBGO propose construction of an evaporation pond. Construction of the evaporation pond will only occur if required and will be sized accordingly to the excess water encountered.

3.0 LEGISLATIVE APPROVALS

3.1. Part IV *Environmental Protection Act 1986* Environmental Impact Assessment

No assessment from the Office of Environmental Protection Authority (OEPA) under Part IV of the *Environmental Protection Act 1986* is required for this dewatering proposal.

3.2. Part V Environmental Protection Act 1986, Works Approval and Licensing

This document addresses Works Approval requirements of the Environmental Protection Regulations 1987 Licence Amendment application has been submitted to DWER under the requirements of Part V of the *Environmental Protection Act 1986*.

3.3. Other Decision Making Authorities

Application has been made to the Department of Water and Environmental Regulation (DWER) water division to amend the existing GWL 156252 (12) and associated Groundwater Operating Strategy to permit the abstraction and discharge of water from the nominated locations.

In accordance with the provisions of section 26D of the *Rights in Water and Irrigation Act 1914,* BBGO have received approval (CAW 203610) to construct a dewatering bore ~25m south west of the proposed Maid Marion Pit. BBGO intend to undertake dewatering activities by a combination of in pit pumping and via the proposed production bore. The location of the proposed production bore and in pit dewatering are shown within Figure 3.

A clearing permit under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* is required for the proposed activities as disturbance will be located within previously undisturbed land. Clearing Permit Application CPS 8710/1 was submitted to Department of Mines and Industry Regulation (DMIRS) and was released for public comment on 4th November 2019.

A mining proposal under the *Mining Act 1978* was submitted to DMIRS seeking approval to construct the Maid Marion mining project on 21 November 2019.

No further environmental approvals are required for this project.

3.4. Other Guidance Material and Legislation

The following guidance and legislation material is specific to this Licence Amendment:

- *Aboriginal Heritage Act 1972*;
- Aboriginal Heritage Regulations 1974;
- *Biodiversity Conservation Act 2016;*

- *Contaminated Sites Act 2003*;
- Contaminated Sites Regulations 2006;
- *Environmental Protection Act 1986*;
- Environmental Protection Regulations 1987;
- Environmental Protection (Unauthorised Discharges) Regulations 2004;
- *Mining Act 1978;*
- *Rights in Water and Irrigation Act 1914;*
- *Soil and Land Conservation Act 1945*;
- Soil and Land Conservation Regulations 1992;
- Wildlife Conservation Regulations 1970;
- Department of Water (2000a) Water Quality Protection Guideline 11 Water Quality Management in Mining and Mineral Processing: Mine Dewatering;
- Department of Water (2000b) Water Quality Protection Guideline 5 Water Quality Management in Mining and Mineral Processing: Minesite Water Quality Monitoring;
- ANZG 2018 Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management of Australia and New Zealand, Canberra.

4.0 STAKEHOLDER CONSULTATION

The dewatering project has been discussed with the Shire of Meekatharra, Department of Water, Department of Planning, Lands and Heritage and the owners of Polelle and Annean Station (where the project activities occur). Comments arising from consultation with the DMIRS, DWER, Water Corporation, DPLH and database searches (e.g. Department of Indigenous Affairs and Florabase), have been taken into account in the design and implementation of this project (Table 5). Heritage surveys were undertaken by consultant archaeologists including consultation with Aboriginal people within the area in October 2019 (Appendix B). No outstanding issues are identified from all stakeholder consultations conducted for the project.

Table 5: Stakeholder Consultation

Stakeholder	Contact	Date	Discussion
Department of Mines and Industry Resources	Damien Montague Richard Smetana	October 2019	Submission of Maid Marion Clearing Permit application. Maid Marion clearing permit submitted to DMIRS in late October and publicly advertised on 4 November 2019.
Department of Water and Environment Regulation – Mid West	Paul Anderson	October 2019	Summary of the Maid Marion mining project. DWER Industry Regulation Mid-West Branch advised that submission of a works approvals is required which once approved would then involve an amendment to the existing licence.
Department of Water and Environment Regulation – Mid West Branch	Mick Major	November 2019	Summary of the Maid Marion Mining Project. Proposed amendment to existing GWL (156252) and requirement to construct a new production bore to facilitate mine dewatering ahead of mining activities/ DWER Mid-West Branch advised that the dewatering required for the project could take place under the existing GWL, pending approval of an addendum.
Department of Mines and Industry Resources	Danielle Risbey and Tiffaney George	November 2019	Summary of the Maid Marion mining project. General overview of planning mining activities and potential environmental impacts and mining considerations including impacts on heritage, fauna and flora values for the project. Mining proposal to be submitted.
Shire of Meekatharra	Tralee Cable	November 2019	No immediate objections to the project. Further discussions to be held following election of new Shire president in late November. No Local Government approval requirements.
Department of Planning, Lands and Heritage	Valeria Ke	November 2019	Summary of the Maid Marion mining project and its location within Sherwood station.
Shire of Meekatharra	Roy Mclymont, Tralee Cable	November 2019	High level project overview detailing project location, proposed infrastructure, haulage routes,

Stakeholder	Contact	Date	Discussion
			indicative physicals and project timing and duration.
Main Roads WA	Mark Salt	November 2019	Discussion regarding project scope and interaction with Great Northern Highway and requirements for development of a suitable intersection to facilitate site access and road train haulage back to the Bluebird processing facility.
Sherwood Pastoral Station	Bill and Harvey Nichols	November 2019	General Overview of the Maid Marion project and proposed dewatering activities. No adverse comments received.
Water Corporation	Joe Miotti, Rob Woods	November 2019	Overview of the Maid Marion project including the proximity to the P1 Meekatharra town water supply and the proposed water management impacts and controls associated with the project, including key features from the completed RPS Hydrogeological report. Water Corporation personnel did see any notable risks associated with the proposal impacting the water reserve. Water Corporation also did not object to any proposal to discharge of groundwater within the ephemeral creek lines, due to the similarity in water quality between the production bores and Maid Marion project.

5.0 EXISTING AND RECEIVING ENVIRONMENT

5.1. Biogeographic Region

The Interim Biogeographic Regionalisation for Australia (IBRA) divides Australia in to 89 bioregions based on major biological and geographical or geological attributes (Thackway and Cresswell 1995). The bioregions are further divided into 419 subregions which are more localised and homogenous geomorphological units in each bioregion. The Project Area is located in the Western Murchison (MUR02) subregion (close to the boundary of the Eastern Murchison subregion) of the Murchison bioregion as delineated by the IBRA (Figure 5). The subregional area is 7,847,996 ha in size.

The Western Murchison subregion is dominated by Mulga (*Acacia aneura* group complex) low woodlands, often rich in ephemerals (usually with bunch grasses), on outcrop and fine textured Quaternary alluvial and eluvial surfaces (extensive hardpan washplains that dominate and characterise the subregion) mantling granitic and greenstone strata of the northern part of the Yilgarn Craton. Surfaces associated with the occluded drainage occur throughout with hummock grasslands on Quaternary sandplains, saltbush (*Atriplex* spp.) shrublands on calcareous soils and samphire (*Tecticornia* spp.) low shrublands on saline alluvia. The subregion contains the headwaters of the Murchison and Wooramel Rivers, which drain the subregion westwards to the coast (Desmond *et al*., 2001).

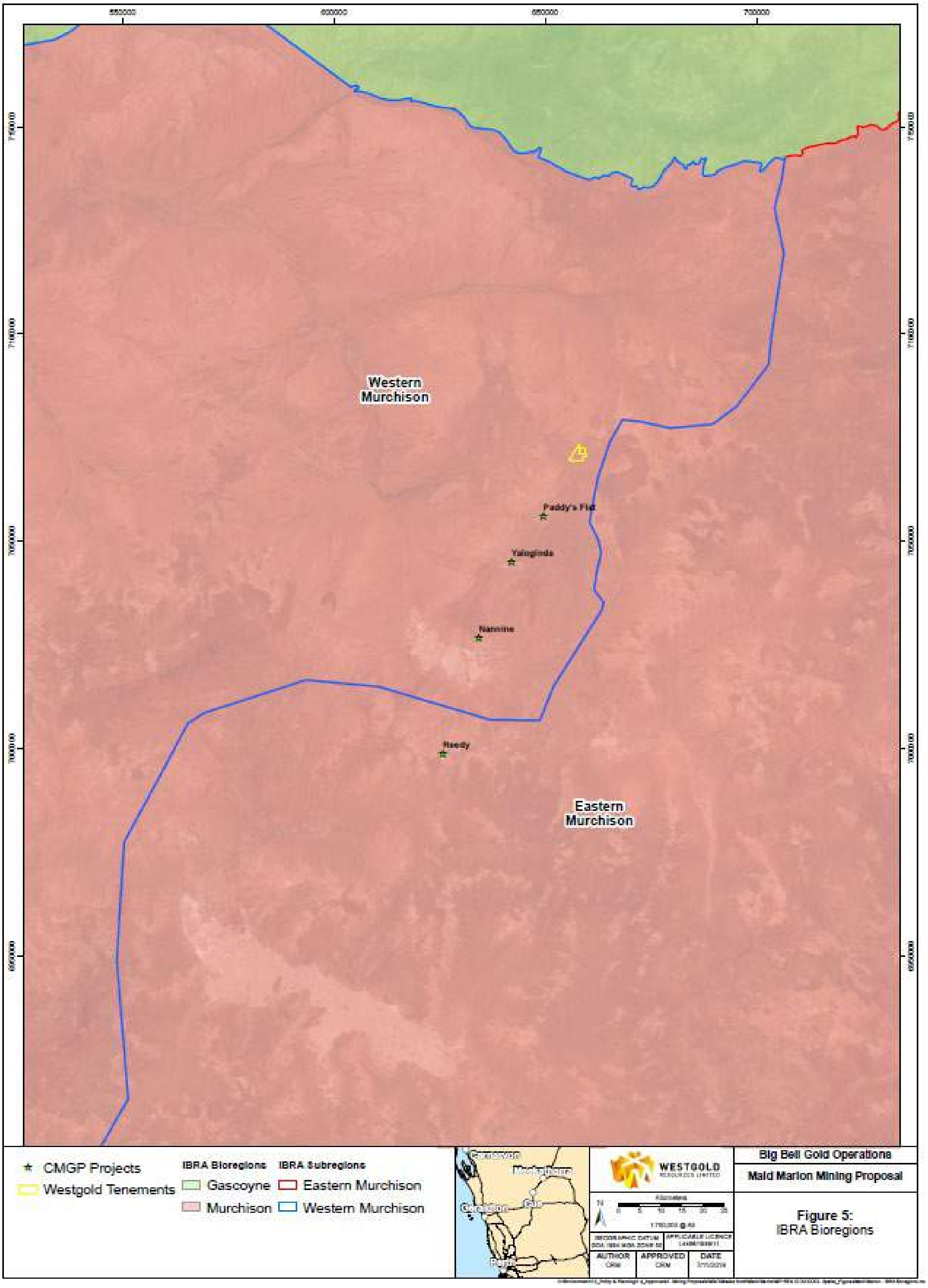


Figure 5: Project Area location with respect to the IBRA Bioregions and Subregions

5.2. Climate

The Murchison region is described as an arid climate characterised by summer and winter rainfall with annual totals rarely exceeding 200 mm (Beard, 1990). The nearest weather station that collects relevant climate data is Meekatharra Airport (station number 007045), located 4.5 km east of Meekatharra (BoM, 2019). The weather station has been operational since 1944.

The average annual rainfall for Meekatharra is 237.9 mm per annum, while the median is 218.4 mm per annum. The majority of the rain falls between January and August, although it is sporadic with annual monthly totals rarely exceeding 30 mm. The rainfall during the winter months is considered to be more reliable and is associated with cold fronts moving from the south of the State. The rainfall during the summer months is more sporadic, although heavier resulting in large flooding events across the landscape. The summer rainfall is associated with thunderstorm bands and ex-tropical cyclones that influence the Pilbara coastline and move in a south-easterly direction across the State (BoM, 2019).

The hottest months are from November to March, with average maximum temperatures exceeding 29°C, while minimum temperatures exceed 15.9°C (BOM, 2019). The coldest months are June to August, where the average minimum temperatures fall below 10°C, while the maximum daily temperatures rarely exceed 25°C (BoM, 2019). The long term climatic conditions at the Meekatharra Airport weather station are provided in Figure 6.

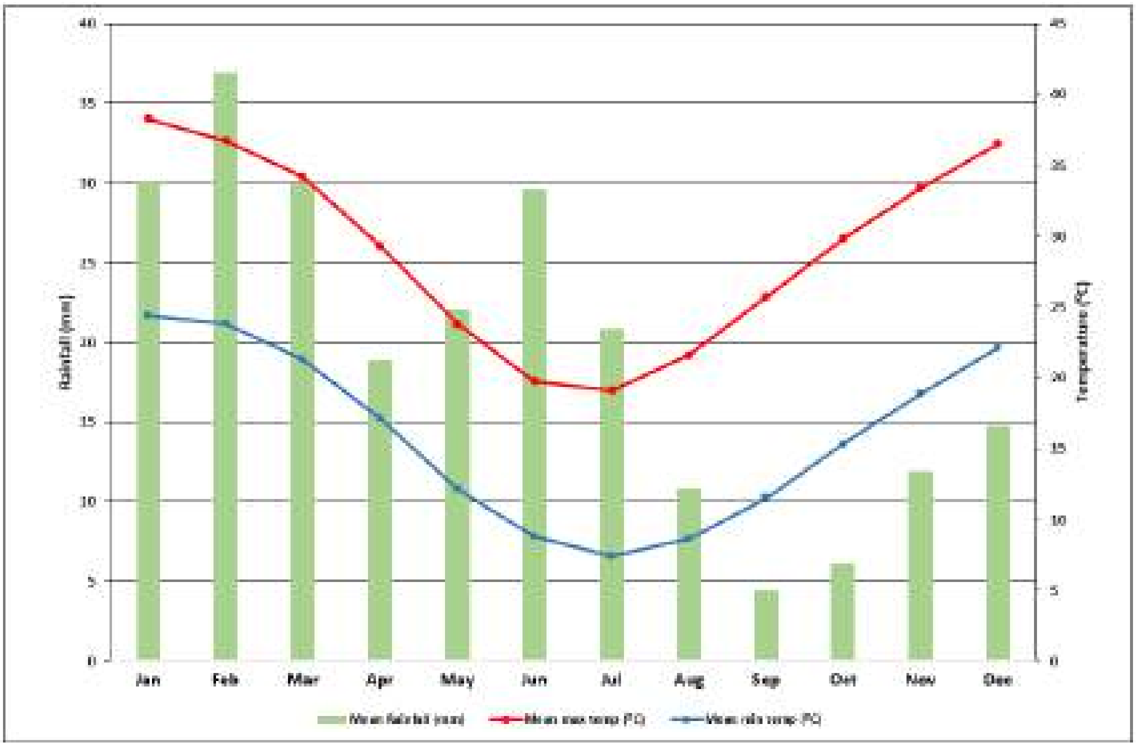


Figure 6: Meekatharra Airport weather station (007045) long term climatic conditions

5.3. Geology

The Project area lies on the western limb of a regional north-plunging synform; the Pollele Syncline (Timms, 2011) and rocks typically dip steeply to the east. The large NNE–SSW Meekatharra Shear Zone runs along the western side of the Project area and bounds the greenstone belt from granitoid rocks to the west.

The local geology has been deformed in the nose of a smaller antiform within the larger Pollele Syncline. The antiform swings from a N-E orientation to a distinctly E–W orientation where the inferred antiform is heavily faulted. The Project area features high-Mg basalts, Banded Iron Formation (BIF), talc schist, various metasedimentary rocks and is bounded to the west by granitic rocks. Quartz veining is common throughout the area.

Weathering in the area is commonly deep, except around cherty BIF and quartz veins that outcrop in the western part of the Project. Exploration drilling shows that the base of oxidation extends to more than 100m depth in some areas. The deep weathering appears most intense south of a jog in the Meekatharra Shear Zone through the centre of the project area. The immediate pit area features weathered BIF and Mafic schist.

5.4. Land Systems

Broad plains of red-brown soils and breakaway complexes as well as red sand plains are widespread (DotE&E, 2018). A thin surface cover of alluvial and colluvial materials (red sand, clayey sand and quartz gravel) occurs over bedrock.

The WA Department of Agriculture completed a regional survey of land systems occurring within the Murchison to develop a comprehensive description of biophysical resources and to provide an assessment of the condition of the soils and the vegetation of the north-eastern Goldfields (Pringle *et al*., 1994).

A component of the survey was the mapping of land types, land units and land systems of the Murchison including Maid Marion. An assessment of land systems provides an indication of the occurrence and distribution of vegetation types present within and surrounding Maid Marion. There are four land systems underlying the Maid Marion project area. Table 6 describes each of the land systems over the Region. The project area predominantly lies within the Yandil land system (Figure 7). .

Table 6: Land system descriptions

Land System	Description
Belele	Hardpan wash plains interspersed by low sandy (wanderrie) banks supporting tall shrublands of mulga with understorey shrubs on the hardpan plains and non-saline shrubs with perennial grasses on the banks.
Sherwood	Breakaways, kaolinised footslopes and extensive gently sloping plains on granite supporting mulga shrublands and minor halophytic shrublands.
Violet	Gently undulating gravelly plains on greenstone, laterite and hardpan, with low stony rises and minor saline plains; supporting groved mulga and bowgada shrublands and occasionally chenopod shrublands
Yandil	Flat hardpan wash plains with mantles of small pebbles and gravels; supporting groved mulga shrublands and occasional wanderrie grasses.

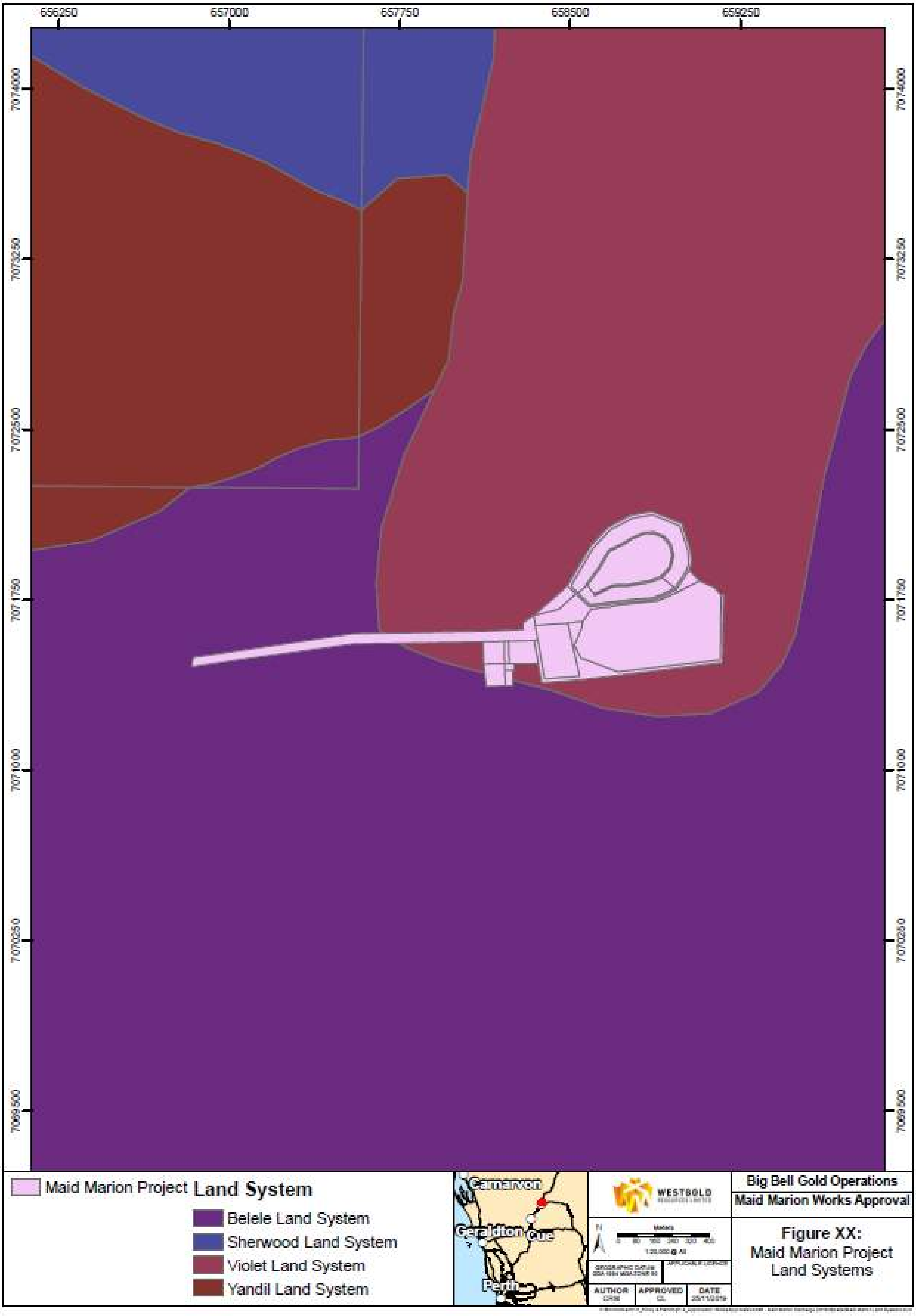


Figure 7: Land System – Maid Marion Region

5.5. Topography

The terrain is generally a flat undulating area and drainage within the infrastructure areas can be characterised as sheet flow towards the west. A creek 400m south of the infrastructure areas flows west across Great Northern Highway. There is one notable land feature within the project area, comprising a BIF peak, which rises 5 – 10m above the natural ground surface. The Meekatharra region is one of the driest regions in Western Australia. The area is relatively flat, between 450 and 600m above sea level with areas of low and high relief related to structural features with the Archaean bedrock and clay up to 30m thick. The topography, as in most of arid Australia, varies according to underlying or adjacent rock types.

5.6. Regional Geomorphology

The Meekatharra district lies within the upper Murchison River catchment, which drains north and then west to the Indian Ocean. Jutson (1950) called this region Murchisonia. The Archaean terrain of Murchisonia is characterised by broad shallow alluvial valleys (Curry *et al.*, 1994) between low rocky hills. The topography, as in most of arid Australia, varies according to underlying or adjacent rock types. Meekatharra township airport is 517mASL and the Bluebird mine is at the 470mASL.

The weathering of basalts generally results in rounded hills, while prominent strike ridges are formed from outcropping BIF's and ultramafics. Metafelsic volcanic units tend to produce gently undulating plains. To the south around the Bluebird minesite, Cainozoic deposits of Tertiary and Quaternary age overlie most of the low slopes of the Yaloginda Mine area. Colluvial and alluvial materials form slope wash deposits grading down slope to gently sloping sheet wash plains with minor incised basal drainage. The surface deposits in the area consist of poorly sorted clays, sand, silt and siliceous rock fragments often ferruginised and partly consolidated to form red brown hardpan. The generalised stratigraphy of the Meekatharra area is shown in Table 7.

Table 7: Generalised Meekatharra Stratigraphy

Age	Name	Lithology	Distribution
Quaternary	Alluvium Colluvium	Fine to coarse grained quartz sand with patches of clay and silt Rock fragments, sand quartz, ironstone, and silt	Creek beds and drainage lines Scree slopes to outwash plains and river flats
Tertiary	Calcrete Silcrete	Sheet calcrete Siliceous duricrust	Lakes and major drainages Local capping over greenstone
Archaean	Undifferentiated mafic and ultramafic rocks	Amphibolite, Dolerite, BIF, Schist	Hills, foot and scree slopes

5.7. Hydrology

Available databases and aerial imagery show that no permanent water bodies are present within project area or immediate surrounds. Runoff following rain events is ephemeral. The mine site is in a generally flat area and is not subject to impact from significant external runoff. The project area lies at the top of the catchments (Figure 8) and as such surface flows will be localised and small and only minor surface sheet flow patterns will be interrupted (and readily diverted). There is one creek to the south of the mine site which has a large catchment, but in very flat terrain has relatively minor flood flows (Q5 = $7m^3/s$), is 400m minimum from the bunded mine infrastructure and as such is very unlikely to impact the mine site.

Aquifers developed in the region include fractured-rock aquifers in the deeply weathered granite-greenstone rock, the alluvial aquifers developed in low-gradient drainage lines and the productive palaeochannel aquifers in Cenozoic sediments in the old river valleys.

The Maid Marion project is located within the Yalgar River sub-catchments of the Murchison River Catchment. The Yalgar River is a tributary of the Murchison River. The Yalgar River Sub Catchment has an area of 1,718,155 ha (Figure 9). The principal drainage is the Hope River palaeodrainage system (a tributary of the Murchison system) that flows to the north-west from Lake Annean, south of Bluebird mine. The catchment contains a series of salt lakes, which may link together and flow in periods of exceptional rainfall.

Figure 8: Maid Marion surface Water Catchments

Figure 9: Surface Water Catchments and Hydrology associated with the Maid Marion Project

5.7.1. Maid Marion Water Quality

Summary water quality data from groundwater bores located near the project area is presented in Table 8. Salinity in the Meekatharra Town Water Supply (in an alluvial aquifer) varies between 800 and 1,000 mg/L and the State Groundwater Atlas places regional water salinity at 1,000 mg/L to 3,000 mg/L. As the Maid Marion area is within a fractured-rock aquifer, the TDS is probably slightly higher than the alluvium so is estimated to range from 1,500mg/L to 3,000 mg/L.

One water sample was collected from the nearby Five Mile Well (about 1km south of the Project, on Sherwood Station) in October 2019. The sample was marginal water, with a TDS of 820mg/L and dominated by sodium-chloride ions (Figure 10). The water also contained 63mg/L nitrate. Nitrite, aluminium, cadmium, iron, lead, manganese and mercury are below the level of reporting (Figure 11).

A complete Hydrology and Hydrogeological assessment of the Maid Marion project was undertaken by RPS in November 2019 and has been provided as Appendix D.

Table 8: Water Quality Boomerang, Kurara and Kurara Central and Lake Annean

Parameter	Units	Five Mile Well (Sherwood Station)
Tenement		M51/504
Date Range		2019
Water type		Na-Cl
pH	pH units	8.5
EC	mg/L	1,300
TDS	mg/L	820
TSS	mg/L	<5
Alkalinity	mg $CaCO_3$/L	160
Aluminum (mg/L)	mg/L	<0.005
Arsenic (As)	mg/L	0.007
Bicarbonate (HCO_3)	mg/L	200
Cadmium (Cd)	mg/L	<0.0001
Calcium (Ca)	mg/L	39
Carbonate (CO_3)	mg/L	1
Chloride (Cl)	mg/L	230
Chromium (Cr)	mg/L	0.01
Cobalt (Co)	mg/L	0.003
Copper (Cu)	mg/L	0.006
Fluoride (F)	mg/L	0.4
Hardness	mg $CaCO_3$/L	250
Iron (Fe)	mg/L	<0.005

Parameter	Units	Five Mile Well (Sherwood Station)
Lead (Pb)	mg/L	<0.001
Magnesium (Mg)	mg/L	37
Manganese (Mn)	mg/L	<0.001
Mercury (Hg)	mg/L	<0.00005
Nickel (Ni)	mg/L	0.02
Nitrate (NO^3)	mg/L	68
Nitrite (NO2)	mg/L	<0.2
Potassium (K)	mg/L	14
Selenium (Se)	mg/L	0.003
Silicon (Si)	mg/L	35
Sodium (Na)	mg/L	160
Sulphate (SO^4)	mg/L	120
Zinc (Zn)	mg/L	<0.005

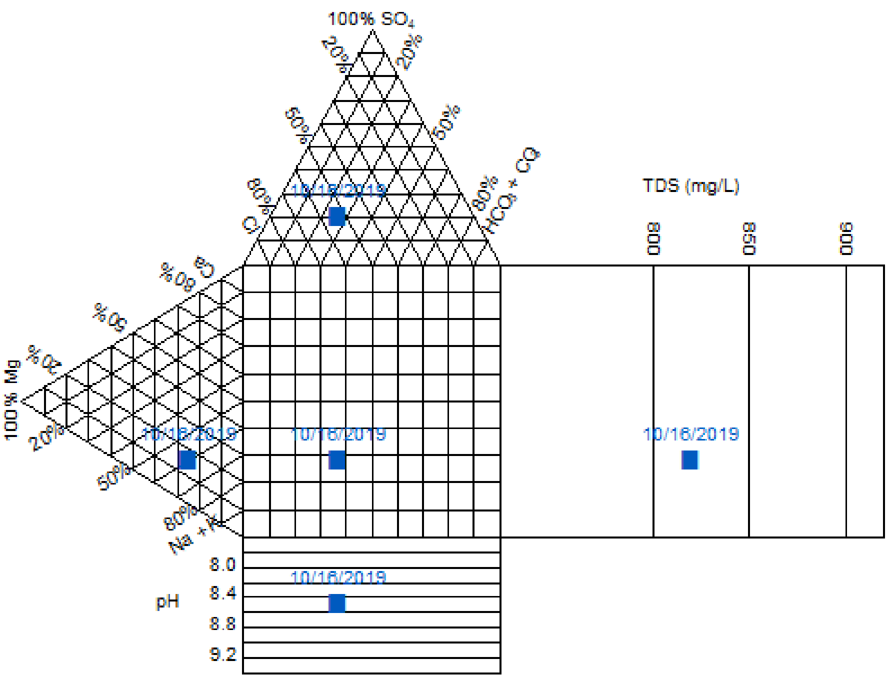


Figure 10: Durov Diagram Maid Marion Groundwater

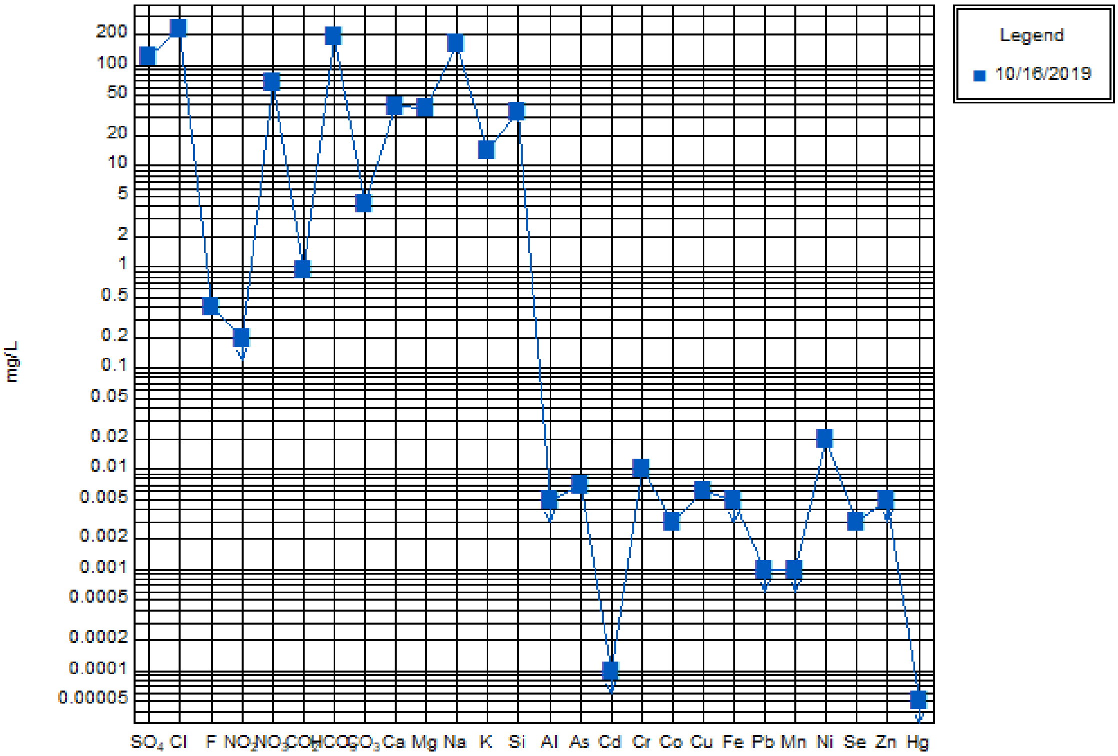


Figure 11: Schoeller Diagram Maid Marion. (Arrow denotes detection limit)

5.8. Soil/Sediment Quality

5.8.1. Soils

The Murchison region is spread over the northern third of the Yilgarn Craton. The underlying rocks are predominantly Archaean even-grained porphyritic granitic rocks intruded by quartz veins and dolerite dykes (Tille 2006). Throughout the Craton areas of Archaean migmatite and gneiss, common along the western margin, as well as in the north-west where Narryer Terrane and Yarlarweelor Gneiss Complex are located (Tille 2006). The latter consists of migmatite, gneiss, schist and quartzite (Tille 2006).

Soils within the region vary, with red loamy earths, red-brown hardpan shallow loams and some red shallow loams present on wash plains, while red sandy earths and red deep sands are found on sandy banks (Tille 2006). Red sandy earths and red deep sands, with some red loamy earths and calcareous loamy earth in low lying areas, are found on sandplains (Tille 2006). Yellow deep sands are found on sandplains in the south-west (Tille 2006). On mesas there are red shallow loams, red shallow sandy duplexes and red shallow sands, with some stony soils and red/brown non-cracking clays also present (Tille 2006).

Hilly terrain contains red shallow loams, stony soils and red shallow sands, with some bare rock and red shallow sandy duplexes (Tille 2006). Sandy soils tend to be more common on granitic hills (Tille 2006). Red shallow loams with red shallow sandy duplexes are found on stony plains, and red shallow sands occur on gritty plains over granite (Tille 2006). Red-brown hardpan shallow loams, calcareous loamy earths and red loamy earths are also present (Tille 2006).

A soil assessment was undertaken for soils within the Maid Marion project area in October 2019 (Appendix C). The primary objective of the study was to determine the volumes and suitability of topsoils for rehabilitation purposes as well as assessing baseline contaminant levels. All surface soils are suitable for rehabilitation of disturbed areas at mine closure. There is no need to segregate different soil types in terms of their “usability” characteristics, as differences in chemical and physical properties of surface soils are not significant.

Assessment of the physical and chemical properties through field assessments of soil profiles and laboratory analysis indicated:

- Surface soils are generally unconsolidated red-brown sandy loams with low concentrations of soil organic matter and nutrients;
- Surface soils rely mainly on stony surface lag materials, rather than vegetative cover, for stability against wind and water erosion;
- Surface soils and subsoils range from very strongly acidic to circum-neutral as indicated by pH values ranging from 4.0 to 6.4 and very high Base Saturation % values ranging from 96 to 100%. The inherent natural soil acidity is predicted to play an important role in determining suitability of native plant species to grow on Maid Marion soils;
- Topsoil and subsoil profiles were shallow before hardpan reached – depth to hardpan ranged from 135mm to 210mm corresponding to 1350 m^3/ha to 2100 m^3/ha of recoverable topsoil/subsoil;
- 10 of the 12 of the samples were classed as Emerson Class 2, 1 sample was classed as Emerson Class 1, whilst the final sample contained insufficient fines (predominantly rock);
- Very low to low CEC values, indicating dominance of “unreactive” clay minerals over “reactive” clay minerals, low nutrient retention capacity and a history of extensive weathering and leaching;
- Low salinity and low to moderate sodicity;
- All soil material sampled exhibited low organic carbon content (0.06 – 0.57%) with 11 of the 12 samples returning values at or below 0.33%;
- Exchangeable sodium percentage (ESP) values ranging from 1.7 to 15.4%;
- A propensity for dispersion of the clay fraction (for the majority of samples). Despite this, clays present were not associated with high elevated sodicity. Factors contributing to the dispersive behaviour of clays (and silts) are likely to include low salinity, low soil organic matter contents and “unreactive” clay minerals; and
- Generally low concentrations of heavy metals and metalloids. There is evidence for slight enrichment by arsenic and chromium.

5.9. Flora/Vegetation

5.9.1. *Maid Marion Flora/Vegetation*

BBGO commissioned Native Vegetation Solutions (NVS) to complete a reconnaissance Flora and Vegetation survey of Maid Marion Project area in August 2019 (NVS, 2019). The full report is presented in Appendix D. The survey was conducted in accordance with relevant EPA's Statements and Guidelines. The survey area encompassed both M51/504 and M51/668 covering an area of approximately 80.77ha.

A total of 11 Families, 17 Genera and 43 Species were recorded within the survey area. A summary of Vegetation groups contained within the survey area is presented in Table 9. Two major vegetation groups were recorded in the survey area and are in "Good" to "Degraded" condition (using the scale of Keighery 1994). No areas of vegetation were assessed to be in "Pristine" condition. Disturbance occurring in the survey area included historic extensive exploration clearing. However, no weed species were recorded in the survey area.

No Threatened Flora, TECs or PECs, Priority Flora Species or weed species were recorded in the survey area. One Priority Flora Species *Calytrix verruculosa* (P3) was recorded at one location within the survey area. Two plants were recorded at this location (Table 10 and Figure 12).

Any proposed disturbance/clearing of vegetation will result in a loss of species from the survey area. However, given the size of the area and the extent of the Beard (1990) vegetation associations elsewhere, the impact on the vegetation and its component flora will not affect the conservation values of either, or create fragmentation or patches of remnant vegetation.

Table 9: Vegetation Group Summary

Vegetation Group	Family	Genus	Species	Area (ha)	Percentage of Survey Area
Open *Acacia aneura* shrubland -. Dominant species were *Acacia aneura, Acacia mulganeura, Acacia victoriaei* and *Eremophila galeata.*	8	9	29	79.63	98.58%
***Acacia aneura* shrubland over ironstone outcrop** Dominant species were *Acacia aneura, Eremophila glutinosa, Acacia pruinocarpa* and *Thryptomene decussata.*	11	12	19	1.14	1.42%
Total	**14***	**23***	**52***	**80.77#**	**100%#**

* Within total survey area (not sum of column), # Sum of column

Table 10: Priority Flora Recorded

Taxon	Conservation Status	Abundance	GDA94 Zone 51 J	
			Easting (m)	Northing (m)
Calytrix verruculosa	P3	2	658790	7071617

Figure 12: *Calytrix verruculosa* (P3)

5.9.2. Fauna

The *Environmental Protection and Biodiversity Act 1999* Protected Matters Search Tool was used to conduct a desktop fauna survey of the Maid Marion project area in October 2019. The desktop survey covered a ten km buffer from the project location. The full desktop survey report can be found in Appendix F. Three threatened species of bird were recorded as likely (1) or possibly (2) occurring in the desktop survey area as well as seven species of migratory birds (Table 11).

Introduced fauna species or species habitat recorded as occurring in the desktop survey area included one bird species (domestic pigeon) and seven mammal species (camel, domestic dog, goat, donkey, domestic cat, European rabbit and red fox). An opportunistic fauna sightings survey was conducted during the Maid Marion flora and vegetation field survey. No native or introduced species were sighted during this survey. However, evidence of the presence of cattle and rabbits was noted (scats). As the vegetation groups (and corresponding habitats) recorded in the flora and vegetation survey are well represented in the region, the majority of threatened and migratory species recorded in the desktop survey are highly mobile and the area to be cleared/disturbed is relatively small, proposed clearing/disturbance of vegetation is deemed not likely to impact on fauna conservation values.

Table 11: EPBC Protected Matters Threatened Species and Migratory Bird List

Name	Status	Type of Presence
Threatened Species		
Calidris ferruginea (Curlew Sandpiper)	Critically Endangered	Species or species habitat **may**
Leipoa ocellata (Malleefowl)	Vulnerable	Species or species habitat **likely**
Pezoporus occidentalis (Night Parrot)	Endangered	Species or species habitat **may**
Migratory Species		
Motacilla cinerea (Grey Wagtail)	Threatened	Species or species habitat **may**
Motacilla flava (Yellow Wagtail)	Threatened	Species or species habitat **may**
Actitis hypoleucos (Common Sandpiper)	Threatened	Species or species habitat **may**
Calidris acuminate (Sharp-tailed Sandpiper)	Threatened	Species or species habitat **may**
Calidris ferruginea (Curlew Sandpiper)	Critically Endangered	Species or species habitat **may**
Calidris melanotos (Pectoral Sandpiper)	Threatened	Species or species habitat **may**
*Charidus veredus (*Oriental Plover, Oriental Dotterel	Threatened	Species or species habitat **may**

5.10. Aboriginal Heritage Sites

Daniel De Gand and Associates were engaged by BBGO to undertake archaeological site avoidance surveys of the Maid Marion mining tenements M51/504 and M51/688 (De Gand, 2019). The archaeological site avoidance survey ran concurrently with an ethnographic site avoidance consultation. Aboriginal Heritage Consultants of the *Yugunga Nya* Native Title Claim Group were involved in all the aspects of the Field Component and the Consultation of the Aboriginal Heritage Assessment. No sites was recorded within the Maid Marion survey area (Figure 13). A summary of the main findings/recommendations from the report are provided below.

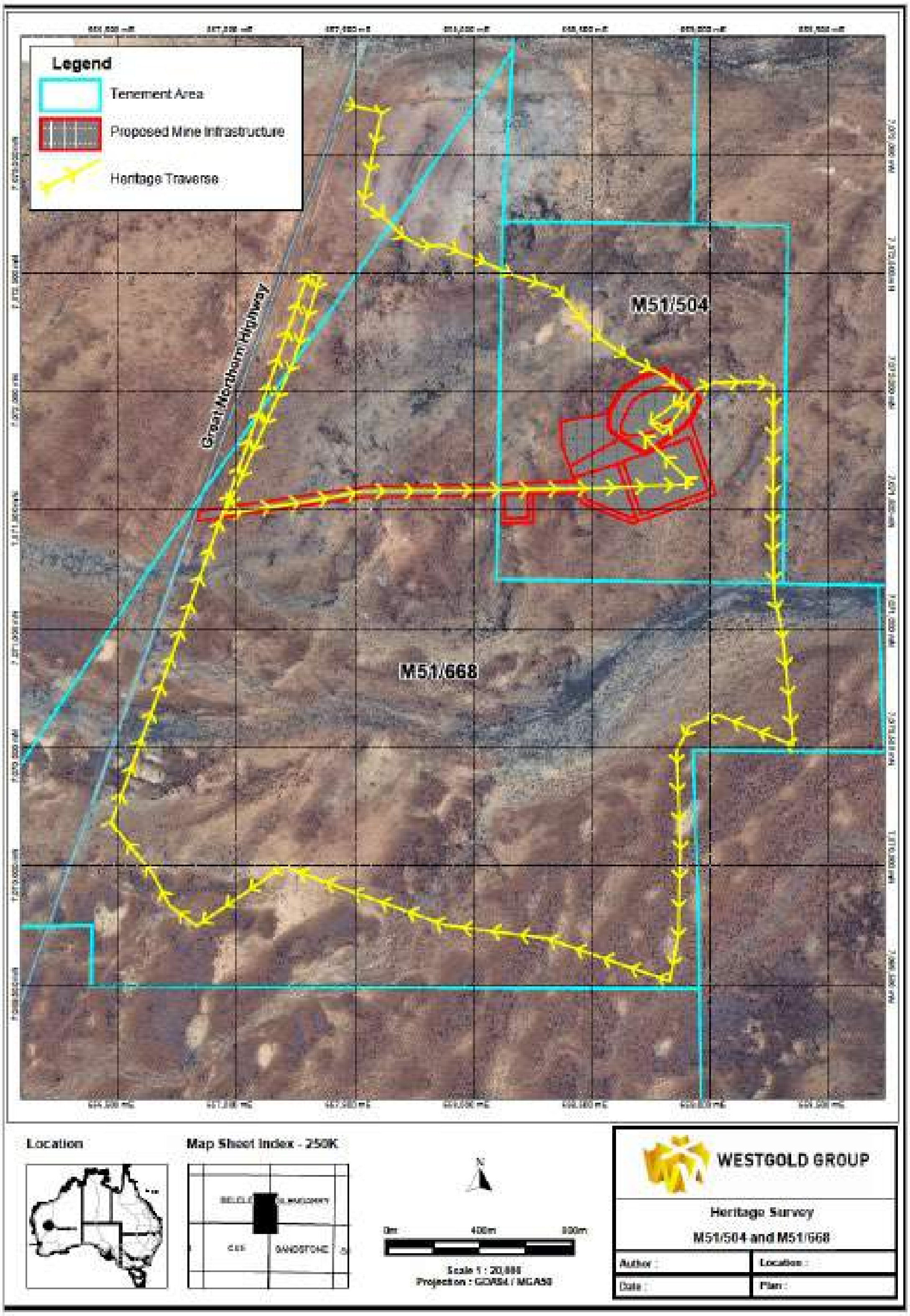
- Westgold ensure that its operations and contractors are advised that as the result of the Field Survey and the Aboriginal Consultations no Sites under Section 5 (a, b, and c) of the AHA 1972 or locations containing Aboriginal Heritage Significance are located on, or near, the Maid Marion Project Area.
- Westgold ensure that its operations and contractors are advised that after a Site Search at the DPLH on the tenements M51/504 and M51/668 which constitute the Maid Marion Project Area no previously registered Aboriginal Sites or places of Heritage Significance are located on or near the Maid Marion Project Area.
- Westgold and its operations and contractors be informed about the potential heritage significance of the ephemeral creeks that traverse the Maid Marion Project Area and

that the banks of these creeks, up to a distance of 50m, are locations were evidence of Aboriginal occupation may be found and that such locations may constitute Aboriginal Sites under Section 5 of the AHA 1972.

- Westgold and its operations and contractors are informed that the Aboriginal Heritage Consultants stipulated that because of the possibility of the presence of Aboriginal Sites buffer zones of a minimum of 25 m be maintained from the banks of the creeks traversing the Maid Marion Project Area as a management strategy to ensure that potential Aboriginal Sites are not be impacted.
- Westgold and its operations and contractors be informed that the Aboriginal Heritage Consultants stipulated that proposed Exploration works and Mining development may proceed as planned.
- Westgold and its operations and contractors be informed that Westgold Group can proceed with their proposed works on the designated Maid Marion Project Areas.
- Should Westgold and its operations and contractors come upon an Aboriginal Site or significant cultural material during any stage of the implementation of the proposed Works, all work in the vicinity of this Site must come to a halt and the location of the Site noted and the Aboriginal Heritage Consultants and other relevant parties, such as the *Yugunga Nya* Native Title Claim Group and the DPLH, notified. The Site must remain undisturbed until such time that heritage clearance of the relevant parties is obtained. If human remains or skeletal material are discovered or unearthed during the implementation of the Work Program, the WA Police and the DPLH need to be contacted.
- If Westgold intend to extend or alter their Proposed Works program (as stipulated in this Report) or their Project Area, or propose any new work programs or project areas in the region, then these should be discussed, prior to any ground disturbing activity, with the *Yugunga Nya* Aboriginal Heritage Consultants who participated in this Survey and Consultation and further heritage surveys conducted where deemed necessary.
- Westgold Group be advised that if there should be an extension, any further development, or new work programs which exceed the Proposed Works or Project Areas delineated in this Report, these may be subject to a new Heritage Survey, and should be discussed prior to any activity with representatives of the *Yugunga Nya* Native Title Claim Group and the *Yugunga Nya* Heritage Consultants.

A full copy of the heritage report is available within Appendix B.

Westgold will undertake a precautionary approach again aligned with the Aboriginal Heritage Due Diligence Guidelines. Should any disturbance or activity encounter an item or object that may have cultural significance, works will be suspended immediately until such time as confirmation can be obtained from an appropriate individual or group.



Map 3: The Maid Marion Project Area and the itinerary of the Field Survey Team

Figure 13: Maid Marion Heritage Survey Boundaries and Travel Path

5.11. Sensitive Receptors

Environmentally Sensitive Areas (ESAs) are declared by the Minister for Environment under section 51B of the *Environmental Protection Act 1986* to prevent incremental degradation of important environmental values. ESAs generally include areas within 50 metres of protected wetlands, within 50 metres of declared rare flora, Bush Forever sites, and those areas containing a threatened ecological community. The closest Environmentally Sensitive Area (ESA), Lake Annean, is located approximately 60 km south south-west from the proposed project.

The closest specified ecosystem (the Meekatharra Water Reserve), is situated 5 km southwest of the pit and the surrounding Meekatharra Groundwater Protection Zone (p1) lies about 2.5km to the southwest (Figure 9). This Meekatharra Water Reserve is a Priority 1 Public Drinking Water Source Area (PDWSA) and is also a proclaimed Water Reserve under the Country Areas Water Supply Act 1947. The Water Reserve draws water from the nearby Sherwood borefield. Locally, given the known geology and water levels of the area, along with some assumed fractured rock aquifer parameters, dewatering of the Maid Marion pit will see drawdown expanding to a few hundred metres (RPS, 2019). Within the pit, the east-northeast–west-southwest oriented BIF may provide a preferred pathway for drawdown to propagate – with drawdown possibly reaching up to 1200 m away from the pit.

The area has low potential for groundwater dependent ecosystems (GDEs) according to the Bureau of Meteorology GDE Atlas (RPS, 2019).

6.0 POTENTIAL IMPACTS AND MANAGEMENT MEASURES

6.1. Air Quality/Gaseous Emissions

Operational activities associated with Maid Marion project area will generate low levels of greenhouse gas emissions from diesel fuel consumption. Greenhouse gas emissions from the mining project are unlikely to cause any significant environmental impacts. The uninhabited nature of the region, small scale and short duration of the project will ensure that emissions will not directly impact any populated area.

6.2. Dust Emissions

High levels of dust generated from natural exposed land surfaces are typical in the Murchison region. During mining activities, fugitive dust is likely to be generated from light and heavy vehicle movements, mining activities including material loading and dumping, blasting and general project activities.

Fugitive dust emissions can impact on sensitive receptors, the health of vegetation and fauna and surface water quality. Visual amenity and nuisance effects could result from dust generated during project operation activities including traffic movements. These are considered very low risk.

The mining project is located in an area where the majority of wind speeds are mild (non-erosive), at less than 30 km/hr (BOM, 2019). Fugitive dust from the project is unlikely to cause any significant or unacceptable environmental impacts to sensitive receptors as separation distance and management measures will be implemented. The closest public receptors to the project is Sherwood station homestead 12km south of the proposed mining activity. Considering this distance between the nearest potential receptor and the activity, dust emissions from project operations are unlikely to impact Sherwood station.

6.3. Noise and Vibration

No sensitive receptors such as residential areas are within 12km of the proposed dewatering activity and therefore noise and vibration are considered not to be a major issue. The potential impact in regard to noise is considered minimal based on lack of sensitive receptors. However, during operation a diesel generator will be used. Noise and vibration may be caused by the following activities:

- Blasting
- Load and Haul activities
- Diesel generator; and
- Heavy and Light vehicles.

BBGO will ensure that noise levels meet the requirements of the *Environmental Protection (Noise) Regulations 1997*.

6.4. Stored Chemicals and Fuels

Due to the remote nature of the project a temporary workshop and fuel facility will be constructed to maintain and service project plant and equipment. Only minor volumes of chemicals and hydrocarbons will be stored on site associated with workshop and refuelling activities. All chemicals and hydrocarbons will be bunded to contain any unplanned releases.

All machinery and equipment undergoes regular servicing to reduce the occurrence of spills resulting from poor maintenance. Where accidental spills/leaks do occur, spill response materials will be available on service and refuelling equipment and BBGO employees and contractors trained in managing spills to ensure spills are contained, clean-and reported immediately. With these management measures implemented, the risk of hydrocarbon contamination of the local and surrounding environment is minimal.

Through implementation of existing project controls there is minimal risk of significant land contamination as a result of accidental spillage of fuels during operations.

6.5. Waste Management

The volume of domestic and industrial waste generated by the project will be relatively small given the scale of the project and number of the workforce. There will be no onsite putrescible waste disposal with all putrescible waste removed from site for disposal at the Shire of Meekatharra landfill.

All waste materials generated by the project will be removed and transported to the Paddy's Flat or Yaloginda project areas for disposal. Waste streams that may be produced, stored, handled and disposed of during the life of the project include general refuse, non-metal scrap (e.g., containers, pallets, wood, plastic and concrete), putrescible waste, sewage, tyres, batteries and wastewater.

BGGO considers that the potential impacts from the management of domestic and industrial wastes will not pose a significant risk to the environment if managed in accordance with the commitments in this mining proposal and existing operational waste management practices.

6.6. Light Emissions

The proposed mining project will be run on a continuous 24/7 basis with artificial lighting required for work periods outside daylight hours. Lighting plant will be appropriately positioned to ensure only those areas with activity are lit, with light positioned downwards towards the activity area.

6.7. Dewatering

BBGO plans to commence mining operations at Maid Marion in Q1 2019 and will require the Maid Marion pit to be dewatered. The dewatering of the Pit will be completed progressively with the rate of mining advance. During the gold exploration program, water was intersected between 20 and 45m. More permeable zones were typically found in fractured rock BIF units and some holes noted bogged rods or high water-flow. The most recent results near the pit typically put the water table at about 15mbgl. Overall, the drilling did not record excessive water-flow and appeared typical of a fractured rock aquifer.

Modelled inflow volumes were modelled with a lower (95,000m^3), average (190,000m^3) and upper (580,000m^3) range produced. The majority of this will be used for dust suppression, with the remainder being discharged into the evaporation pond/turkeys nest. The pond will be constructed with a minimum 0.5m freeboard to allow for a 1 in 100year, 72 hour rainfall event.

Given the mode of pit water disposal (used for dust suppression or discharged into evaporation pond), the risks associated with proposed dewatering of the Maid Marion pit are considered to be low.

Potential impacts from saline pit water and dewatering activities include:

- Death or decline in vegetation health:
- Impact to local fauna species:
- Increased metal, salt, nutrient and solid loads into the environment;
- Inundation/drawdown impacts (altered hydrological conditions and potentially soil salinities), which may impact on nearby receptors (i.e. borefield and water reserve); and
- Erosion/scouring effects associated with flow.

Potential Impacts will be minimised by implementation of recommended modes of disposal for pit water and via the implementation of management procedures for dust suppression activities listed in the risk assessment (Table 17). The evaporation pond will be shallow and large enough to promote evaporation (approximately 1.25 ha). The location of the evaporation pond close to the source of abstraction (~400m) further reduces the potential for any adverse impacts to the surrounding environment. While unlikely, any seepage or leakage will be restricted locally to mine areas.

In addition to this, a monitoring program will be undertaken that:

- Records the amount of water drawn and discharged monthly;
- Assesses discharge and surface water quality through sampling of field pH and electrical conductivity (EC),
- Sampling for laboratory analysis of major components (quarterly); and
- Daily inspections of pipeline.

Provided the above measures are implemented, the risk associated with the proposed dewatering and discharge from the Maid Marion pit is considered low.

6.8. Discharges to Land

Pit water has been modelled and measured to be marginal (<1,000mg/L TDS) with background levels reflective of the surrounding water quality. Water Storage tanks will be located in close proximity (~50m) to the pit water source. Monitoring will include visual inspection of pipes, other infrastructure and the vegetation near to the proposed infrastructure once per 12 hour shift. The location, alignment and gradient of the proposed water infrastructure will ensure any pipeline releases remain predominantly contained within the immediate area.

Any excess water encountered by the project will be placed within an evaporation pond, located south west of the proposed Maid Marion pit as discussed in Section 6.7.

Available databases and aerial imagery show that no permanent water bodies are present within the project area or immediate surrounds. Runoff following rain events is ephemeral. As is common throughout the Murchison region, most rainfall is lost by evaporation or surface runoff, with only a small portion infiltrating the soil and recharging groundwater. Existing soils are typical of the local area and are capable of supporting plant growth. The risks posed by proposed dewatering activities at Maid Marion is low.

6.9. Flora

A total of 11 Families, 17 Genera and 43 Species were recorded within the survey area. Two major vegetation groups were recorded in the survey area and are in “Good” to “Degraded” condition (using the scale of Keighery 1994). No areas of vegetation were assessed to be in “Pristine” condition. Disturbance occurring in the survey area included historic extensive exploration clearing. However, no weed species were recorded in the survey area.

No Threatened Flora, Threatened Ecological Communities (TEC) or Priority Ecological Communities, (PEC), or weed species were recorded in the survey area. Two plants of the Priority Flora Species *Calytrix verruculosa* (P3) was recorded at one location within the survey area (Table 10 and Figure 12).

Any proposed disturbance/clearing of vegetation will result in a loss of species from the survey area. However, given the size of the area and the extent of the Beard (1990) vegetation associations elsewhere, the impact on the vegetation and its component flora will not affect the conservation values of either, or create fragmentation or patches of remnant vegetation.

A clearing permit (CPS 8710/1) has been applied for with DMIRS to cover the proposed disturbance over M51/504 and M51/668. Impacts to flora and vegetation will be managed via implementation of management measures listed in the risk assessment (Table 17).

6.10. Vegetation

A total of 14 vegetation associations were recorded from the nearby studies. Vegetation was largely comprised of *Acacia* open woodlands and shrublands, *Hakea* open shrublands, Chenopod shrublands dominated by either *Maireana* species or *Salsola australis* and Samphire shrublands.

The vegetation associations recorded are representative of the dominant vegetation types throughout the region. None are analogous to any TEC or PEC and none are considered locally or regionally significant. The samphire communities are considered to be groundwater dependent ecosystems and are important as foraging and breeding habitat for migratory birds visiting Lake Annean.

Potential impacts on flora and fauna from the proposed activities include damage to vegetation and fauna habitats from:

- dust emissions and the over-spraying of brackish to saline water during dust suppression;
- leaks and spills of saline water or hydrocarbons

The pipeline will follow established routes constructed for the same purpose and will involve the upgrade of existing pipeline infrastructure. No vegetation associations or land systems present within the survey areas were unique or confined to the boundaries of the Project area. The potential impacts to vegetation are considered not to be significant.

6.11. Terrestrial Fauna

Three threatened species of bird were recorded as likely (1) or possibly (2) occurring in the desktop survey area as well as seven species of migratory birds (Table 11).

Introduced fauna species or species habitat recorded as occurring in the desktop survey area included one bird species (domestic pigeon) and seven mammal species (camel, domestic dog, goat, donkey, domestic cat, European rabbit and red fox). An opportunistic fauna sightings survey was conducted during the Maid Marion flora and vegetation field survey. No native or introduced species were sighted during this survey. However, evidence of the presence of cattle and rabbits was noted (scats). As the vegetation groups (and corresponding habitats) recorded in the flora and vegetation survey are well represented in the region, the majority of threatened and migratory species recorded in the desktop survey are highly mobile and the area to be cleared/disturbed is relatively small, proposed clearing/disturbance of vegetation is deemed not likely to impact on fauna conservation values.

The potential impacts to native fauna associated with this project are not expected to be significant.

6.12. Summary of Impacts and Mitigation Measures

Table 12 presents a summary of impacts and mitigation measures. Section seven presents risk assessment results.

Table 12: Summary of Impacts and Mitigation Measures

Environmental Factor	Potential Impact	Management measures	Monitoring
Air Quality, Gaseous Emissions	Low levels of greenhouse gas emissions due to fuel consumption from light vehicles and equipment including diesel generators	Only low levels of greenhouse gas emissions will be produced from light vehicle and equipment fuel consumption. The uninhabited nature of the region, small scale and fixed duration of the project will ensure that emissions will not directly impact any populated area.	Fuel consumption data will be recorded and reported to the National Pollutant Inventory and National Greenhouse and Energy Reporting.
Dust Emissions	Dust will be generated predominantly from natural occurrences. Minor fugitive dust is likely to be generated as a result of the proposed pit dewatering project due to the light vehicle movements from refuelling activities and infrastructure inspections.	Only minor fugitive dust is likely to be generated from light vehicle movements during refuelling activities and infrastructure inspections. Limit activities to minimise dust generation on cleared areas. Delay activities if weather conditions are likely to produce excessive dust. Utilise the water truck for dust suppression as required.	Visual monitoring for dust during construction and maintenance activities.
Noise Emissions	No sensitive receptors such as residential areas are within 12km of the proposed dewatering activity and therefore noise and vibration are considered not to be a major issue.	The potential impact from noise and vibration is considered minimal as the nearest population resides at the Bluebird mine site and accommodation facility, 12km south of the proposed dewatering activity. Ensure that noise levels meet the requirements of the *Environmental Protection (Noise) Regulations 1997*.	N/A
Light Emissions	Excessive light emissions causing decreased amenity for passing traffic along Great Northern Highway and an alteration in the behaviour of local fauna.	Dewatering and mining activity located 2km from Great Northern Highway. Lighting will be positioned to point towards mining activity. Refuelling activities will take place during daylight hours only.	N/A

Environmental Factor	Potential Impact	Management measures	Monitoring
Chemical and Hydrocarbon Management	Localised contamination of soil and groundwater.	A temporary fuel facility may be positioned at the project site. The infrastructure will comprise a self contained tank and cowling system to contain any uncontrolled release. A temporary workshop may be positioned at the project site. Any chemicals and hydrocarbons stored at the site will be bunded. A pontoon-mounted diesel powered pump and fuel pod will also be used for inpit and production bore dewatering. The diesel fuel line will be housed inside a system to ensure that fuel is contained if a leak or spill occurs. The bunded fuel line system will include a fuel collection pod at the pump unit on the pontoon. The collection pod is fitted with an automatic shut-off valve that prevents pooling when a leak occurs.	Pumps and other infrastructure will be regularly inspected shift and undergo regular maintenance and servicing to ensure efficient operation. Any spill event will be captured within the MGO incident reporting system.
Meekatharra Drinking Water Supply	Reduction in available water supplies	The short duration of the project combined with the distance to the water supply area limit the potential impacts to the Water Supply. Modelling completed by RPS has shown that groundwater drawdown will not extend into the Water Supply Protection boundary.	N/A
Dewatering	Reduced groundwater availability for dependent ecosystems and other users Pipeline leaks and spills	Discharge into evaporation pond; Monitor and inspect pipeline daily.	Visual monitoring of any impacts to bed, banks or vegetation will be undertaken following identification of any spills or leaks in the catchment of a drainage line
Waste	Contamination of the project area with domestic and industrial waste	All waste from pipeline and infrastructure installation and maintenance activities will be disposed at a licensed landfill facility.	Monthly environmental inspections
Native Vegetation	Loss of biological diversity and reduced regional representation of flora and vegetation communities.	Clearing and disturbance limited to project requirements.	Monthly environmental inspections

Environmental Factor	Potential Impact	Management measures	Monitoring
	Loss of conservation significant flora Increased weed distribution Loss or degradation of flora and vegetation due to dust deposition Increased movement of people and vehicles (damage to native flora via off road travel)	Clearing and disturbance utilises path of least resistance approach Evaporation pond constructed to a size equivalent to the volume of water requiring management. Implementation of BBGO weed management procedures; Restriction of vehicle movements to designated roads; Implement dust management practices.	
Flora	Potential impacts to vegetation surrounding areas undergoing dewatering	While it is considered that the dewatering phase will pose minimal risk to the environment, if any degradation to vegetation occurs an investigation will be commissioned to determine the actual cause.	Monthly environmental inspections
Flora	Impact to Priority 3 Flora species *Calytrix verruculosa.*	Relocation of 2 individuals outside the project footprint.	Visual fortnightly observation of flora health following relocation
Fauna	Alteration in behaviour of fauna due to dust, noise, vibration and light emissions. Fauna access to project infrastructure including the discharge point causing entrapment	There are no significant dust, noise, vibration and/or light emissions from dewatering activities. Installation of measures to reduce fauna access (such as fencing) where deemed necessary. Shallow depth of evaporation pond and construction materials will limit potential for fauna deaths resultant from becoming stuck or drowning.	Daily monitoring of the dewatering pump, pipeline and discharge point for trapped fauna
Discharges to Land	Contaminate surface water, groundwater and soil; and Impact on flora and fauna	Hydrocarbon spill kits will be stored in close vicinity to all diesel powered pumps and generators and refuelling areas. Pit water will be discharged into evaporation pond located <400 m from the pit; pipeline will be monitored and inspected daily.	Monitoring will include visual inspection of pipes, other infrastructure and the vegetation near to the proposed pipeline route once per 12 hour shift

7.0 ASSESSMENT OF ENVIRONMENTAL RISKS

The methodology used in this risk assessment was rating likelihood on a scale A to E (Table 13) and consequence on a scale of 1 to 5 (

Table 14). Table 15 shows the risk ranking and Table 16 the required analysis. The consequence of an environmental issue was assessed by determining the severity of the effect, the area/population to be affected, the permanence of effects and the capacity of the area to recover. Risk analysis results are presented in Table 17.

Table 13: Measure of Likelihood

Level	Descriptor	Frequency	Description	Probability
1	Rare	Once in 15 years	Highly unlikely, but it may occur in exceptional circumstances	0 – 10%
2	Unlikely	At least once in 10 years	Not expected, but there's a slight possibility it mat occur at some time.	11 – 40%
3	Possible	At least once in 3 years	The event might occur at some time as there is a history of infrequent occurences of similar issues with similar projects/activities	41 – 60%
4	Likely	At least once per year	There is a strong possibility the event will occur as there is a history of frequent occurrence with similar projects/activities	61 – 90%
5	Almost Certain	More than once per year	The event is expected to occur at sime time as there is a history of continuous occurrence with similar projects/activities	91 – 100%

Table 14: Measure of Consequence

Environmental Factor	Insignificant (A)	Minor (B)	Moderate (C)	Major (D)	Severe (E)
Biodiversity/ Flora/ Fauna/ Ecosystem	None or insignificant impact to ecosystem component (physical, chemical or biological) expected with no effect on ecosystem function	Moderate to minor impact to ecosystem component (physical, chemical or biological). Minor off-site impacts at a local scale.	Minor and short-term impact to high value or sensitive ecosystem expected. Off-site impacts at a local scale.	Long-term impact to significant high value or sensitive ecosystem expected. Long-term impact on a wide scale. Adverse impact to a listed species expected.	Irreversible impact to significant high value or sensitive ecosystem expected. Irreversible and significant impact on a wide scale. Total loss of a threatened species expected.
Water Resources	Low impact isolated area without affecting any use of the water.	Contained low impact with negligible effect on the use of the water.	Uncontained impact that will materially affect the use of the water, but able to be rectified in short-term.	Extensive hazardous impact requiring long-term rectification.	Uncontained hazardous impact with residual effect.
Land Degradation	Negligable impact to isolated area.	Contained low impact, not impacting on any environmental value.	Uncontained impact, able to be rectified in short-term without causing pollution or contamination.	Extensive hazardous impact requiring long-term rectification	Uncontained hazardous impact with residual effect.
Air Quality	No detectable impact.	Contained low impact, not impacting on any environmental value.	Uncontained impact, that will materially affect environmental value, be able to be rectified in short-term.	Extensive hazardous impact on an environmental value requiing long-term rectification	Uncontained hazardous impact with residual effect.
Mine Closure	Site is safe, stable a non-polluting and post mining land use is not adversely affected.	The site is safe, all major landforms are stable and any stability or pollution issues are contained and require no residual management. Post-mining land use is not adverselt affected.	The site is safe, and stability or pollution issues require minor, ongoing maintenance by end land-user.	The site cannot be considered safe, stable or non polluting without long term management or intervention. Agreed end land use cannot proceed without ongoing management.	The site is unsafe, unstable and/or causing pollution that will cause an ongoing residual affect. The post mining land use cannot be achieved.

Table 15: Risk Rank

	Insignificant	Minor	Moderate	Major	Severe
Rare	L	L	L	M	M
Unlikely	L	L	M	M	H
Possible	L	M	M	H	H
Likely	L	M	H	E	E
Almost Certain	L	H	H	E	E

Table 16: Required Analysis

Risk Rating		Level of Corrective Action Required
Extreme	E	Immediate action required, further reduction needed. If not possible, COO approval required
High	H	Senior management attention needed
Moderate	M	Management responsibility must be specified
Low	L	Manage by outline procedure

Table 17: Risk Assessment Results

Environmental factor	Potential environmental impact	Inherent risk			Control	Residual risk		
		L	C	R		L	C	RR
Dewatering	Reduced groundwater availability for dependent ecosystems and other users	3	C	M	Scheduled water quality monitoring. Modelling has demonstrated dewatering will not influence Meekatharra Water Supply. No other beneficial users within project area.	1	C	L
Flora/Native Vegetation	Localised loss of 2 individuals of P3 Flora species *Calytrix verruculosa.*	5	C	H	Relocation of 2 individuals to an area beyond extent of proposed disturbance footprint.	3	C	M
Hydrocarbon management	Localised contamination of soil and groundwater	4	B	M	Implementation of the CMGP Hydrocarbon Management Procedure and Spill and Clean-Up Procedure.	3	B	M
Waste management	Contamination of the project area with domestic and industrial waste	4	B	M	Implementation of the CMGP Waste Management Procedure. No waste to be stored at the project location.	3	B	M
Water leak caused by a pipeline fracture or leaking valves.	Soil erosion and contamination. Surface water contamination Vegetation loss/damage.	3	B	M	Monitoring of pipeline to detect pipeline failures. Pipeline to be contained and/or drain internally within the project site.	2	B	L
Air quality	Excessive greenhouse gas pollution	2	B	L	Regular maintenance of infrastructure and emission controls.	1	B	L
Dust Emissions	Generation of fugitive dust from light vehicle movements and maintenance work.	5	B	H	Water truck made available and utilised when required.	3	B	M

Environmental factor	Potential environmental impact	Inherent risk			Control	Residual risk		
		L	C	R		L	C	RR
Noise Emissions	Excessive noise generation causing alteration in the behaviour of local fauna	2	B	L	Daily maintenance and inspection of infrastructure.	1	B	L
Light emissions	Excessive light emissions causing alteration in the behaviour of local fauna.	2	B	L	Artificial lighting limited to requirements for safe mining activity only.	1	B	L
Stored Chemicals and Fuels	Localised contamination of soil and groundwater.	5	B	H	All Chemical and Hydrocarbons stored onsite will be bunded. Chemicals and Hydrocarbons stores onsite will be limited to basic project requirements. A pontoon mounted bunded diesel powered pump with a fuel pod will be used and spill kits made available.	3	B	M
Weeds	Introduction and increased prevalence of weeds	3	B	M	Implementation of CMGP Weed Management Procedure.	2	B	L
Fauna	Loss of fauna due to loss of habitat, clearing or vehicle movement.	5	B	H	Implementation of the CMGP Clearing Permit Procedure. Clearing limited to those areas required by the project. Posted vehicle speed limits within project area.	3	B	M
Dust Suppression	Water used for dust suppression causing loss or damage to vegetation.	3	B	M	Maid Marion water quality is fresh to marginal. Minimise spray drift into vegetation alongside roads by use of dribble bars.	2	B	L

Environmental factor	Potential environmental impact	Inherent risk			Control	Residual risk		
		L	C	R		L	C	RR
Disturbance to Sheet Water Flows	Disruption of surface water drainage along pipeline corridor. Vegetation loss/damage.	3	C	M	Project disturbance located outside main catchment influence. Containment of drainage within project area. No new disturbance has the potential to disturb water flows.	2	C	M

8.0 MONITORING PROGRAM

To monitor potential impacts associated with the planned dewatering, MGO propose to measure the volume of water abstracted during the project life and deposited within the evaporation pond for the duration of the abstraction period. The proposed monitoring program is presented within Table 18.

Table 18: Proposed Maid Marion Discharge Monitoring Program

Monitoring of Emissions to Land				
Monitoring Point Reference	**Parameter**	**Units**	**Averaging Period**	**Frequency**
Maid Marion Mine Void	Volume	m^3	Continuous	Monthly
	pH, EC, TDS, Aluminium, Arsenic, Cadmium, Chromium, Copper, Lead, Manganese, Mercury, Nickel, Selenium, Zinc, TRH, Major cations and anions	pH units	Spot Sample	Quarterly

9.0 REFERENCES

Beard, J. S. (1990). *Plant Life of Western Australia.* Kangaroo Press Pty Ltd, Kenthurst.

BoM, Bureau of Meteorology (2019) *Climate Data Online.* Available online at www.bom.gov.au./climate/data/index.shtml.

Curry, P. J., Payne, A. L., Leighton, K. A., Hennig, P. and Blood, D. A. (1994) An inventory and condition survey of the Murchison River catchment, Western Australia. Department of Agriculture Western Australia, Perth, W.A.

De Gand, D (2019). *Assessment of the Maid Marion Project Area, North of Meekatharra, in Western Australia.*

Desmond, A., Cowan, M. and Chant, A. (2001). *Murchison 2 (MUR2 - Western Murchison subregion). In: A Biodiversity Audit of Western Australia's Biogeographical Subregions in 2002.* Department of Conservation and Land Management, Kensington, W.A., pp 480-496

DotE&E, (2018). *Australia's Bioregions (IBRA 7).* ACT, Australia: Department of the Environment and Energy.

Jutson, J.T. (1950). *The Physiography (geomorphology) of Western Australia*. Bull. Geol. Surv. West, Aust. No 95, 3rd Edition.

Keighery, B 1994. *Bushland plant survey: a guide to plant community survey for the community,* Wildflower Society of Western Australia (Inc.), Nedlands.

NVS (2019). *Reconnaissance Flora and Vegetation Survey of the Maid Marion Mining Project – August 2019.*

Pringle, H J, Gilligan, S A, and van Vreeswyk, A M. (1994). *An inventory and condition survey of rangelands in the north-eastern Goldfields, Western Australia.* Department of Agriculture and Food, Western Australia, Perth. Technical Bulletin 87.

Thackway, R. and Cresswell, I. D. (1995) *An Interim Biogeographical Regionalisation for Australia.* Australian Nature Conservation Agency, Canberra, Australian Capital Territory.

Tille, P. (2006) *Soil-landscapes of Western Australia's Rangelands and Arid Interior,* Department of Agriculture and Food Resource Management Technical Report 313.

Timms, N., Hollingsworth, D., Culpan, N, Penkethman, A.,Vearncombe, S., and Gates, K. (2011). Geological Mapping Report, Yaloginda Area, Murchison Region, Western Australia.

Westgold (2019). *Maid Marion Material Characterisation Report.*

APPENDIX A – TENEMENT SUMMARY REPORTS

Government of Western Australia
Department of Mines, Industry Regulation and Safety

eMiTS MINERAL TITLES ONLINE

MINING TENEMENT SUMMARY REPORT

MINING LEASE 51/504

Status: Live

TENEMENT SUMMARY

Area:	181.90000 HA	**Death Reason :**	
Mark Out :	27/05/1994 11:47:00	**Death Date :**	
Received :	31/05/1994 09:45:00	**Commence :**	01/09/1994
Term Granted :	21 Years (Renewed)	**Expiry :**	31/08/2036

CURRENT HOLDER DETAILS

Name and Address
BIG BELL GOLD OPERATIONS PTY LTD
AUSTWIDE MINING TITLE MANAGEMENT PTY LTD, C/- AUSTWIDE MINING TITLE MANAGEMENT PTY LTD,
PO BOX 1434, WANGARA, WA, 6947, xxxxxxxxx@austwidemining.com.au, xxxxxxx400

DESCRIPTION

Locality: Meekatharra

Datum: Datum is situated 402.42 metres bearing 90 degrees 12 minutes from south west corner of late surveyed MC 819N

Boundary: THENCE: 1508.69 metres bearing 180 degrees 12 minutes to southern boundary of late surveyed MC 784N 1201 metres bearing 270 degrees 12 minutes along part of the southern boundary of late surveyed MC 784N and southern boundary of late surveyed MC 783N to its south west corner 1508.68 metres bearing zero degrees 12 minutes along western boundary of late surveyed MC 783N to its north west corner 1207 metres bearing 90 degrees 12 minutes along northern boundary of late surveyed MC 783N and part northern boundary of late surveyed MC 784N Back to datum Area applied for identical to P 51/1877

Area :

Type	Dealing No	Start Date	Area
Surveyed		25/08/2007	181.90000 HA
Granted		01/09/1994	183.00000 HA
Applied For		27/05/1994	183.00000 HA

SHIRE DETAILS

Shire	Shire No	Start	End	Area
MEEKATHARRA SHIRE	5250	27/05/1994		181.90000 HA

RENT STATUS

Due For Year End 31/08/2020: PAID IN FULL

Due For Year End 31/08/2021: $3,603.60

EXPENDITURE STATUS

Expended Year End 31/08/2019: No Expenditure Lodged
Current Year Commitment : $18,200.00

Government of Western Australia
Department of Mines, Industry Regulation and Safety

MINERAL TITLES ONLINE

MINING TENEMENT SUMMARY REPORT

MINING LEASE 51/668

Status: Live

TENEMENT SUMMARY

Area:	695.00000 HA	**Death Reason :**	
Mark Out :	06/05/1997 06:25:00	**Death Date :**	
Received :	09/05/1997 12:55:00	**Commence :**	05/06/2013
Term Granted :	21 Years	**Expiry :**	04/06/2034

CURRENT HOLDER DETAILS

Name and Address
BIG BELL GOLD OPERATIONS PTY LTD
AUSTWIDE MINING TITLE MANAGEMENT PTY LTD, C/- AUSTWIDE MINING TITLE MANAGEMENT PTY LTD, PO BOX 1434, WANGARA, WA, 6947, xxxxxxxxx@austwidemining.com.au, xxxxxxx400

DESCRIPTION

Locality: SHERWOOD
Datum: Datum situated at ZONE 50: AMG CO-ORDINATES: 658054 east and 7073343 north
Boundary: FROM DATUM: THENCE: 780 metres bearing 185 degrees 1200 metres bearing 089 degrees 0700 metres bearing 177 degrees 1020 metres bearing 178 degrees 260 metres bearing zero degrees 4530 metres bearing 34 degrees 1510 metres bearing 180 degrees 0410 metres bearing 093 degrees 820 metres bearing 271 degrees 2590 metres bearing 270 degrees 740 metres bearing 269 degrees BACK TO DATUM

Area :

Type	Dealing No	Start Date	Area
Granted		05/06/2013	695.00000 HA
Applied For		06/05/1997	695.00000 HA

SHIRE DETAILS

Shire	Shire No	Start	End	Area
MEEKATHARRA SHIRE	5250	06/05/1997		695.00000 HA

RENT STATUS

Due For Year End 04/06/2020: PAID IN FULL
Due For Year End 04/06/2021: $13,761.00

EXPENDITURE STATUS

Expended Year End 04/06/2019: EXPENDED IN FULL

Current Year Commitment : $69,500.00

Government of **Western Australia**
Department of **Mines, Industry Regulation and Safety**

MINING TENEMENT SUMMARY REPORT

MINING LEASE 51/669

Status: Live

TENEMENT SUMMARY

Area:	869.00000 HA	**Death Reason :**	
Mark Out :	06/05/1997 06:45:00	**Death Date :**	
Received :	09/05/1997 12:55:00	**Commence :**	05/06/2013
Term Granted :	21 Years	**Expiry :**	04/06/2034

CURRENT HOLDER DETAILS

Name and Address
BIG BELL GOLD OPERATIONS PTY LTD
AUSTWIDE MINING TITLE MANAGEMENT PTY LTD, C/- AUSTWIDE MINING TITLE MANAGEMENT PTY LTD,
PO BOX 1434, WANGARA, WA, 6947, xxxxxxxxx@austwidemining.com.au, xxxxxxx400

DESCRIPTION

Locality: SHERWOOD
Datum: Datum situated at ZONE 50: AMG CO-ORDINATES: 655890 east and 7068194 north
Boundary: FROM DATUM: THENCE: 1300 metres bearing 269 degrees 1690 metres bearing 32 degrees 740 metres bearing 89 degrees 260 metres bearing 180 degrees 2590 metres bearing 90 degrees 1130 metres bearing 178 degrees 1200 metres bearing 270 degrees 1500 metres bearing 180 degrees 790 metres bearing 264 degrees 1440 metres bearing 180 degrees 970 metres bearing 272 degrees 2950 metres bearing 1 degrees BACK TO DATUM

Area :

Type	Dealing No	Start Date	Area
Granted		05/06/2013	869.00000 HA
Applied For		06/05/1997	869.00000 HA

SHIRE DETAILS

Shire	Shire No	Start	End	Area
MEEKATHARRA SHIRE	5250	06/05/1997		869.00000 HA

RENT STATUS

Due For Year End 04/06/2020: PAID IN FULL
Due For Year End 04/06/2021: $17,206.20

EXPENDITURE STATUS

Expended Year End 04/06/2019: EXPENDED IN FULL
Current Year Commitment : $86,900.00

Government of **Western Australia**
Department of **Mines, Industry Regulation and Safety**

MINERAL TITLES ONLINE

MINING TENEMENT SUMMARY REPORT

MINING LEASE 51/670

Status: Live

TENEMENT SUMMARY

Area:	860.00000 HA	**Death Reason :**	
Mark Out :	06/05/1997 06:45:00	**Death Date :**	
Received :	09/05/1997 12:55:00	**Commence :**	05/06/2013
Term Granted :	21 Years	**Expiry :**	04/06/2034

CURRENT HOLDER DETAILS

Name and Address
BIG BELL GOLD OPERATIONS PTY LTD
AUSTWIDE MINING TITLE MANAGEMENT PTY LTD, C/- AUSTWIDE MINING TITLE MANAGEMENT PTY LTD, PO BOX 1434, WANGARA, WA, 6947, xxxxxxxxx@austwidemining.com.au, xxxxxxx400

DESCRIPTION

Locality: SHERWOOD
Datum: Datum situated at ZONE 50: AMG CO-ORDINATES 655890 east and 7068194 north
Boundary: FROM DATUM: THENCE: 3920 metres bearing 181 degrees 2100 metres bearing 270 degrees 2000 metres bearing zero degrees 960 metres bearing 274 degrees 30 minutes 950 metres bearing zero degrees 1825 metres bearing 87 degrees 740 metres bearing zero degrees 1300 metres bearing 89 degrees BACK TO DATUM

Area :

Type	Dealing No	Start Date	Area
Granted		05/06/2013	860.00000 HA
Applied For		06/05/1997	860.00000 HA

SHIRE DETAILS

Shire	Shire No	Start	End	Area
MEEKATHARRA SHIRE	5250	06/05/1997		860.00000 HA

RENT STATUS

Due For Year End 04/06/2020: PAID IN FULL
Due For Year End 04/06/2021: $17,028.00

EXPENDITURE STATUS

Expended Year End 04/06/2019: EXPENDED IN FULL
Current Year Commitment : $86,000.00

APPENDIX B – REPORT ON AN ABORIGINAL ASSESSMENT OF THE MAID MARION PROJECT AREA

REPORT ON AN ABORIGINAL HERITAGE ASSESSMENT OF THE <u>MAID MARION PROJECT AREA</u> NORTH OF MEEKATHARRA, IN WESTERN AUSTRALIA

FOR

WESTGOLD RESOURCES

MEEKATHARRA GOLD OPERATIONS
Big Bell Gold Operations Pty Ltd

OCTOBER 2019

Daniel de Gand – Anthropologist

of

Daniel de Gand & Associates Pty Ltd

<u>Daniel de Gand & Associates Pty Ltd</u>

EXECUTIVE SUMMARY

This Report details the results and the recommendations of an Aboriginal Heritage Survey (the Survey) conducted on the **Maid Marion Project Area** located north east of Meekatharra for Westgold Resources. The Survey was designed to fulfil Westgold Resources statutory obligations under the *Aboriginal Heritage Act 1972* (the Act).

Aboriginal Heritage Consultants of the *Yugunga Nya* Native Title Claim Group were involved in all the aspects of the Field Component and the Consultation of the Aboriginal Heritage Assessment. The Survey this report refers to was conducted on Thursday 10th October 2019. Daniel de Gand, ethnographer of Daniel de Gand & Associates Pty Ltd, was commissioned to conduct the Surveys on behalf of Westgold Resources. The objectives of the Field Survey were to:

- Examine the designated Project Area in order to locate any Aboriginal Ethnographic and/or Archaeological Sites or Heritage Places, as defined by *Section 5* of the *Aboriginal Heritage Act 1972* (*the Act*);
- Provide descriptions of any Sites or Heritage Places located (if applicable); and,
- Recommend avoidance and/or management strategies, where applicable.

The Field Survey and Consultation with Aboriginal Heritage Consultants of the *Yugunga Nya* Native Title Claim Group the resulted in the following recommendations;

- It is **recommended** that Westgold Resources ensure that its operations and contractors are advised that as the result of the Field Survey and the Aboriginal Consultations **no** Sites under *Section 5* (a, b, and c) of the *AHA 1972* or locations containing Aboriginal Heritage Significance are located on, or near, the Maid Marion Project Area.
- **It is recommended** that Westgold Resources ensure that its operations and contractors are advised that after a Site Search at the DPLH on the tenements **M51/504** and **M51/668** which constitute the Maid Marion Project Area **no**

previously registered Aboriginal Sites or places of Heritage Significance are located on or near the Maid Marion Project Area.

- It is **recommended** that Westgold Resources and its operations and contractors be informed about the potential heritage significance of the ephemeral creeks that traverse the Maid Marion Project Area and that the banks of these creeks, up to a distance of 50m, are locations were evidence of Aboriginal occupation may be found and that such locations may constitute Aboriginal Sites under *Section 5* of the AHA 1972.
- It is **recommended** that Westgold Resources and its operations and contractors are informed that the Aboriginal Heritage Consultants stipulated that because of the possibility of the presence of Aboriginal Sites buffer zones of a minimum of 25 m be maintained from the banks of the creeks traversing the Maid Marion Project Area as a management strategy to ensure that potential Aboriginal Sites are not be impacted.
- It is **recommended** that Westgold Resources and its operations and contractors be informed that the Aboriginal Heritage Consultants stipulated that proposed Exploration works and Mining development may proceed as planned.
- It is **recommended** that Westgold Resources and its operations and contractors be informed that Westgold Resources can proceed with their proposed works on the designated Maid Marion Project Areas.

- It is **recommended** that should Westgold Resources and its operations and contractors come upon an Aboriginal Site or significant cultural material during any stage of the implementation of the proposed Works, all work in the vicinity of this Site must come to a halt and the location of the Site noted and the Aboriginal Heritage Consultants and other relevant parties, such as the *Yugunga Nya* Native Title Claim Group and the Department of Planning Land and Heritage (DPLH), notified. The Site must remain undisturbed until such time that heritage clearance of the relevant parties is obtained. If human remains or skeletal material are discovered or unearthed during the implementation of the Work Program, the WA Police and the DPLH need to be contacted.

- It is **recommended** that if Westgold Resources intend to extend or alter their Proposed Works program (as stipulated in this Report) or their Project Area, or propose any new work programs or project areas in the region, then these should be discussed, prior to any ground disturbing activity, with the *Yugunga Nya* Aboriginal Heritage Consultants who participated in this Survey and Consultation and further heritage surveys conducted where deemed necessary.

- It is **recommended** that Westgold Resources be advised that if there should be an extension, any further development, or new work programs which exceed the Proposed Works or Project Areas delineated in this Report, these may be subject to a new Heritage Survey, and should be discussed prior to any activity with representatives of the *Yugunga Nya* Native Title Claim Group and the *Yugunga Nya* Heritage Consultants.

GEOGRAPHIC CO-ORDINATE INFORMATION

The author of this report advises that all co-ordinates for newly recorded sites quoted in this document were obtained with a hand held Garmin 76CSX unit using the WGS 84 Datum – Zone 51 (similar to the GDA 94 Datum). The manufacturer states that these devices are accurate to within 10 m on average.

DISCLAIMER

The author of this Report is not accountable for omissions and inconsistencies that may result from information which may become known in the future but which was not forthcoming at the time of this research.

ACKNOWLEDGEMENTS

The Author would like to acknowledge the following people in this Report:

- The Aboriginal Heritage Consultants of the *Yugunga Nya* Native Title Claim Group: Bill Shay, Leroy Shay, Clarrie Shay and Andrew Gentle jnr.

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INTRODUCTION

This Report details the results and the recommendations of an Aboriginal Heritage Survey (the Survey) conducted on the **Maid Marion Project Area** located north east of Meekatharra for **Westgold Group**. The Survey was designed to fulfil Westgold Resourcesstatutory obligations under the *Aboriginal Heritage Act 1972* (the Act).

Aboriginal Heritage Consultants of the *Yugunga Nya* Native Title Claim Group were involved in all the aspects of the Field Component and the Consultation of the Aboriginal Heritage Assessment. The Survey this report refers to was conducted on Thursday 10th October 2019. Daniel de Gand, ethnographer of Daniel de Gand & Associates Pty Ltd, was commissioned to conduct the Surveys on behalf of Westgold Group. The objectives of the Field Survey were to:

- Examine the designated Maid Marion Project Area in order to locate any Aboriginal Ethnographic and/or Archaeological Sites or Heritage Places, as defined by *Section 5* of the *Aboriginal Heritage Act 1972* (*the Act*);
- Provide descriptions of any Sites or Heritage Places located (if applicable); and,
- Recommend avoidance and/or management strategies, where applicable.

The Field Survey and Consultation with Aboriginal Heritage Consultants of the *Yugunga Nya* Native Title Claim Group the resulted in the following recommendations;

PERSONNEL

The following people and organisations participated in the Survey.

Daniel de Gand & Associates Pty Ltd.

Daniel de Gand; Ethnographer

Aboriginal Consultants of the *Yugunga Nya* NT Group;

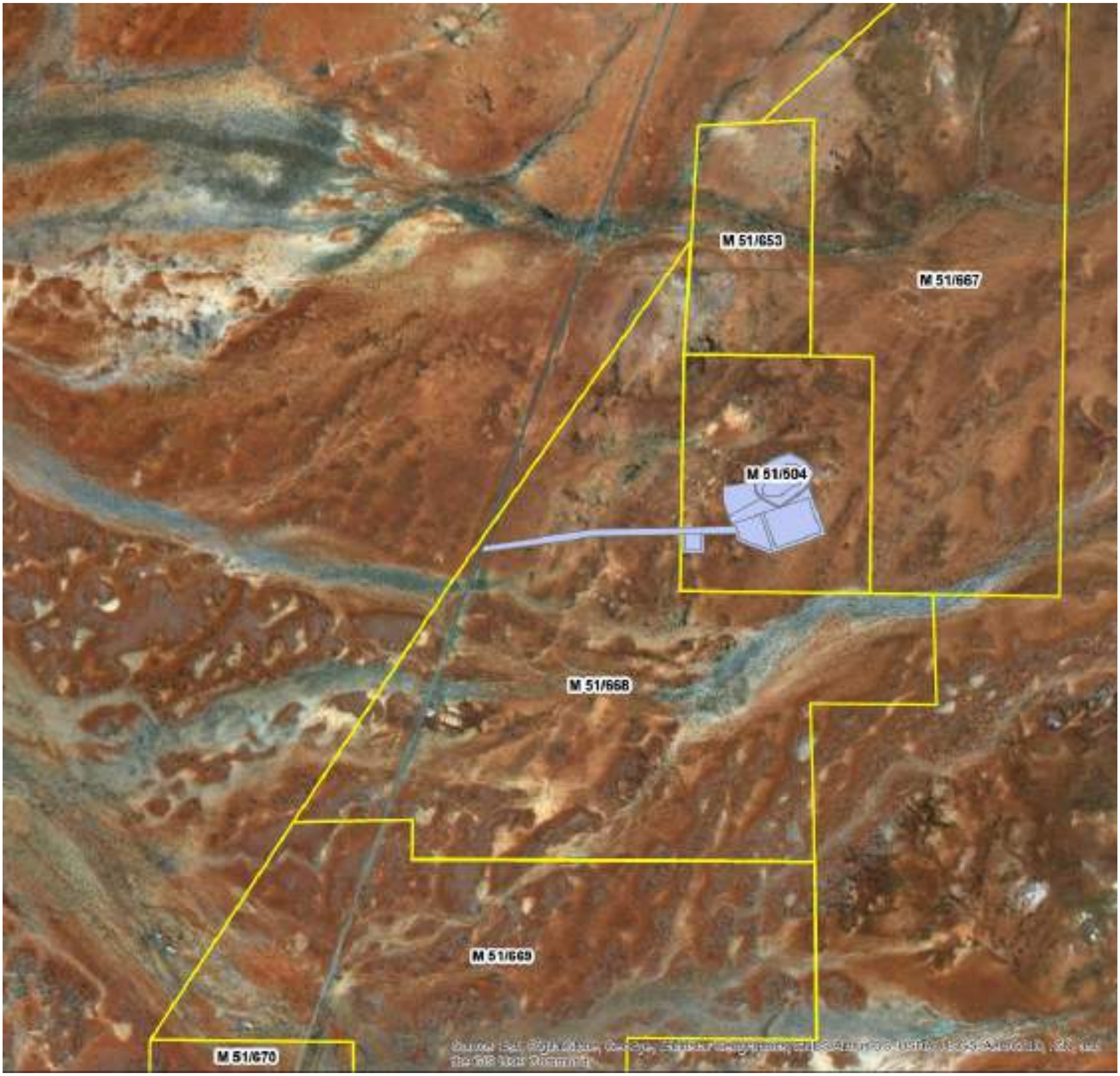
1. Bill Shay,

2. Leroy Shay,
3. Clarrie Shay, and;
4. Andrew Gentle Jnr.

THE PROJECT AREA AND THE PROPOSED WORKS

The Maid Marion Project Area, the subject of this Report, the Aboriginal Consultation and the Survey, is located approximately 15 km north of the town of Meekatharra. The area is characterised by mining and exploration tenements overlapping pastoral leases. The Maid Marion Project Area is located on the Sherwood pastoral Station within exploration and mining tenements. The region is characterized by open alluvial flats and areas of undulating plains that formed low lateritic and shale hills and rises. Numerous seasonal creeks and ephemeral drainage lines crisscross the Project Area. Many areas are susceptible to waterlogging after periods of prolonged rain. The ground surface varies across the area from alluvial sands with a sparse overlay of iron-rich pisolite and ravels to wide expanses of dense quartz gravels. Vegetation is typically open Acacia spp. woodland, although the creek zones are densely vegetated with Acacia spp. and seasonal grasses and tall Eucalypt spp. groves occur along the more substantial watercourses.

Ground surface visibility is determined by vegetation density and was consistently very good across the survey area.



Map 1: The Maid Marion Project Area the subject of the Heritage Assessment containing tenements M51/504 and M51/668

ETHNOGRAPHIC BACKGROUND

There is scant ethnographic information about the pre-European contact social and cultural organisation of the Aboriginal groups belonging to the region of Maid Marion Project Area. Existing information about Aboriginal groups of the region of the ethnographic assessment is generally limited to the ethnocentric observations and summary notes of colonial administrators and government officials such as those of Travelling Inspectors of Aborigines, Native Welfare and police officers.

By the time professional ethnographic research was conducted in frontier regions of Australia, European impact had already altered the social and cultural fabric of traditional Aboriginal society in those regions. Early anthropologists, such as Daisy Bates who conducted interviews and fieldwork in the region early in the twentieth century, stated that the integrity of the social and cultural organisation of Aboriginal people was so fundamentally affected by European impact, that at the beginning of the 20th century there were but '*few remnants of traditional Aboriginal society'* (Bates 1985).

Some of these early observations of the colonial administrators, and others, at the frontier regions shed some light upon the social and cultural organisation of Aboriginal groups at the time of contact in the context of subsequent professional historical, linguistic, archaeological and anthropological research that was, and is, conducted in Australia. Such professional research has also allowed for the development of anthropological models of traditional Aboriginal society.

This section entitled *Ethnographic Background* begins by addressing the region of the Maid Marion Project Area. as a culturally and socially distinct constellation of Aboriginal groups that is in anthropological texts commonly referred to as the *Western Desert Cultural Bloc.* A brief description is given of anthropological models pertaining to the local organisation, or, the ways in which the Aboriginal groups traditionally related to land, of Aboriginal groups that belong to the *Western Desert Cultural Bloc*

Secondly, this section addresses some of the anthropological findings in the region of the Project Areas that resulted from primary research by early professional anthropologists in the region such as Daisy Bates, Norman Tindale, and more recently Ronald Berndt, and Robert Tonkinson. Finally, this section briefly looks at the European impact on the Aboriginal groups who inhabited the region of the Project Area.

The 'Western Desert'

Ethnographers who conducted ethnographic research in Western Desert regions have identified similarities in the organisational, linguistic and socio-cultural aspects of Western Desert Aboriginal groups to such an extent that it can be said that the Aboriginal groups of the Western Desert region belong to a *Cultural Bloc* (Berndt 1980:7, 8, 11).

The Maid Marion Project Area is located in the western region of the *Western Desert Cultural Bloc* (See Map 2 below). The area has been inhabited by a number of Aboriginal groups, which share cultural, linguistic and societal similarities and which are commonly referred to as Mardu. Primary and secondary research has confirmed the Mardu's cultural and linguistic affiliation to the *Western Desert Culture Bloc* ((Berndt (1959:88), Berndt (1980), Tindale (1974:143), de Gand (2000); de Gand & Vachon (2001)).

The *Western Desert Culture Bloc* 'model' of Aboriginal groups in Western Desert regions of Australia involves principles of local organisation, size of the family group and bands, occupational orbits, the significance of cultural knowledge during transmigration, knowledge of the cultural geography specific to the group, social organisation, types of food, knowledge of mythological landmarks, socio-cultural responses to environmental factors such as climate, geomorphology, topography, surface hydrology, vegetation and fauna, and language.

Local organisation refers to the ways in which Aboriginal people and groups relate to land. The nature of traditional local organisation is at the present difficult to determine, however, it is crucial when considering claims made by Aboriginal people with regard to land ownership.

To understand the contemporary situation of Aboriginal groups on Western Desert fringes, it is necessary to examine issues such as tribes, socio-dialectical units, land tenure, migration, dislocation, and the rights and the responsibilities of owners and custodians. A number of researchers such as Daisy Bates, Norman B. Tindale, Ronald and Catherine Berndt, Robert Tonkinson, Richard Gould and Frederic Meyers have commented on these aspects of Aboriginal society in the Western Desert. The anthropological models these researchers propose in respect of Western Desert fringes will be briefly illustrated.

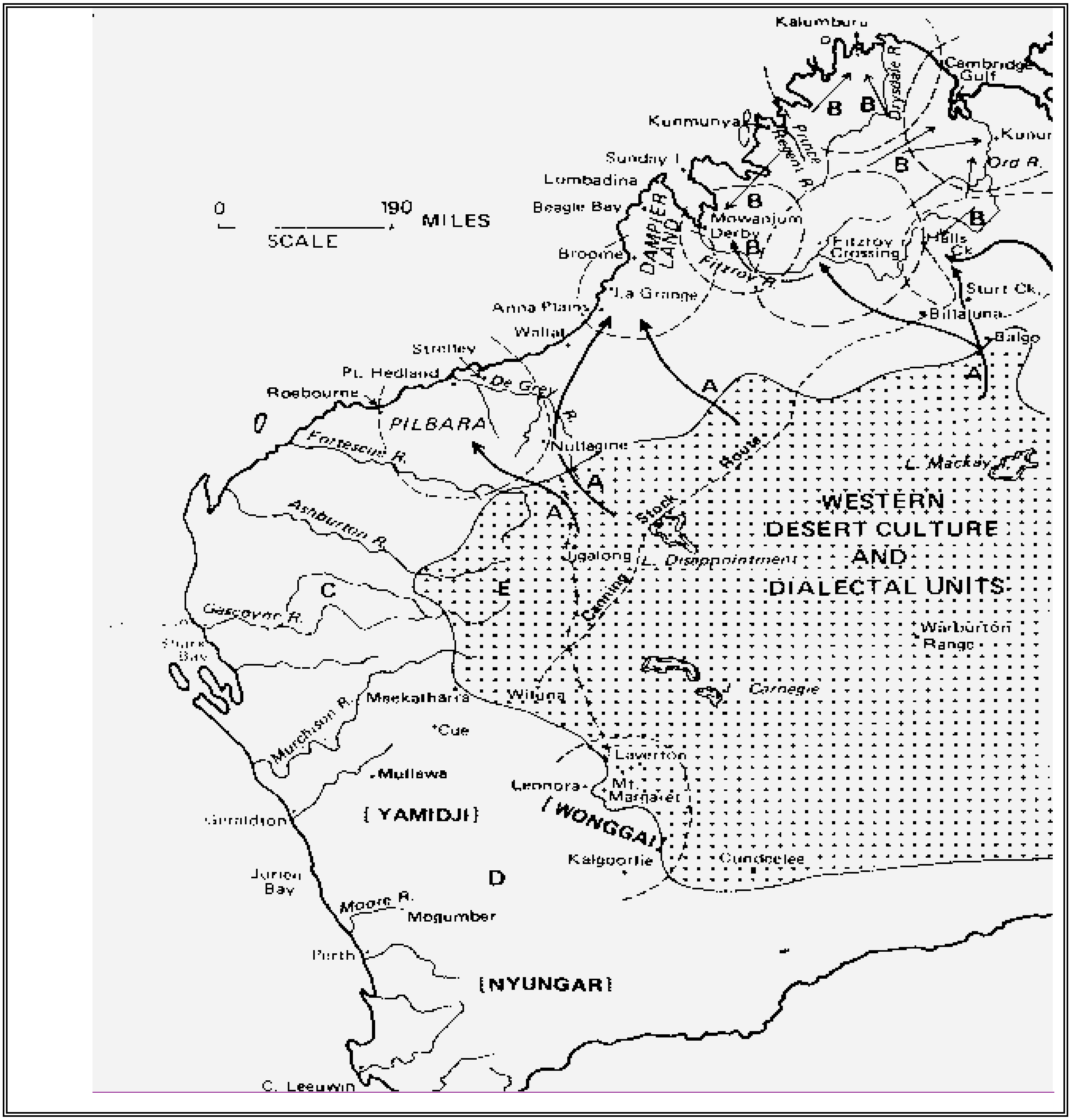
Ecological factors, patterns of aggregation and dispersal

Norman B. Tindale (1976) discusses a causal link between social factors, cultural factors, the environment, and the physical needs for survival (Peterson 1976: 2; Anderson 1988: 143). Tindale (1976) saw Aboriginal *tribes* as amenable to physiographical definition and considered ecological factors as pre-eminent in determining the size and nature of tribes and the area of their territories (Tindale 1976: 14, Anderson 1988: 142).

Tindale also contends that the food resource levels and the water supplies are the most significant factors in human patterns of aggregation and dispersal (Tindale 1974: 31, 35, 62, 114). Tindale (1974: 236) further states that territorial limits 'are usually at places least likely to sustain life for long periods of time'. Tindale's *Tribal Map of Australia* (1974) has clearly defined boundaries among desert Aboriginal people. The names on his map indicate defined territorial boundaries suggesting discrete tribes that, according to Tindale, imply a clear territorial identity (1974).

‘Cultural and Linguistic Blocs’, Permeable Boundaries and Socio-cultural Interaction.

In contrast to Tindale, Ronald and Catherine Berndt (1959: 91) contend that Western Desert Aboriginal groups ‘*are not “tribes*”, that there are no strict boundaries, that movement was relatively frequent, and what researchers are faced with is ‘*a cultural and a social bloc’*. Rather than using Tindale’s concept of *‘tribe’, as a clearly bounded, basic social and spatial unit of traditional Aboriginal society’* (Peterson 1976: 1), Ronald Berndt speaks of a ‘*cultural bloc’* (Berndt 1959; 1980). Berndt further remarks that using the notion 'tribe' ‘suggests a hardening effect in relation to the unit’s boundaries’. Instead of using the notion of ‘tribe’, Berndt proposes the use of ‘*language buffers or barriers’*, which implies permeability, and communication between contiguous units, which are in reality partially separate but also partly overlapping ‘*spheres of communication’* (Berndt 1976: 134).



Map 2: Traditional Cultural Variations and socio cultural movement (Berndt 1980).

Berndt (1959: 102) notes that differences in dialect are the primary factor in distinguishing Aboriginal groups. Consequently, because these groups speak a specific dialect and are land possessing, there is a territorial perspective. However, Berndt states that these dialect groups are not to be equated with Tindale's concept of '*tribe'* because '*dialect*' is, according to Berndt, *'incidental'* (Gould 1969: 271). Dialects were sufficiently distinctive from each other to distinguish between groups and hence connect specific stretches of country to particular Aboriginal groups.

With regard to language in the Western Desert regions, Berndt (1980), states that the Western Desert Aboriginal groups shared one language complex. He further noted that economic, social and cultural interaction between groups in the region was common. Berndt (1980) indicates that because of this economic, social and cultural interaction between Aboriginal people belonging to the *Western Desert Bloc* (1959:84), people have been and were still - in 1959 at the time of Berndt's fieldwork in the region - spreading north-west, west, south, and south-west. This is consistent with Tindale's proposition (1974) of a westward movement of Aboriginal groups in the south-western part of the Western Desert.

Significantly, Berndt (1980: 7) states that a westward movement occurred long before European settlement in the Western Desert Bloc regions. However, because of the establishment of settlements and Ration depots on the desert fringe areas, such as; Meekatharra, Mt. Margaret Mission, Warburton Mission, Wiluna and Leonora, and ration depots such as Jigalong, Mt Vernon ration depot, Cosmo Newbury and Mulga Queen, such migratory movements gained considerable momentum. Because of this movement towards the desert fringes, cultural differentiation between the groups of the Western Desert Bloc further diminished as these groups recognised their dialectical, social and cultural affiliations (Berndt 1980).

Domain, Estate and Range

Ronald Berndt (1959: 102) uses W.H. Stanner's concept of *estate* as the territorial anchorage of families. According to Stanner (1965: 2), *estate* is the traditionally recognised locus (*country, home, dreaming place*) of a descent group forming the core of the territorial group. This, however, does not prevent them from temporarily foraging and visiting distant areas near the *estates* of other people, usually those of wives and/or in-laws. This temporary foraging beyond ones *estate* concurs with Stanner's concept of *range*, which was the tract over which the group ordinarily hunted in order to ensure subsistence. Both *Estate* and *range* constitute a *domain* that is the ecological life space of the group.

Stanner's notions of *estate* and *range* remain useful concepts in regards to Aboriginal territoriality (Tonkinson 1974; Gould 1969; Berndt 1959). In particular, the notion of *range* suggests flexibility and permeability between territorial boundaries. However, under all circumstances each Aboriginal maintains proprietary rights to their *estate* as an intrinsic part of their identity, even when temporarily foraging in a *range* different from that surrounding their *estate* (Gould 1969:268). It is clear that Berndt suggests a much less exclusive group membership than Tindale, which is a proposition that is confirmed by most recent studies (Berndt 1976; Christensen 1980; Myers 1986; Tonkinson 1978; de Gand 2000; de Gand/Vachon 2001).

Risk Minimisation through Reciprocal Rights in Territories other than one's own

More recent ethno-archaeological research conducted by Richard Gould indicates risk minimisation as one of the most important adaptive processes amongst the Aborigines of the Western Desert (Anderson 1988: 136, 137). In this regard, Gould's 'model' (1982) stresses a functional relationship between socio-cultural institutions and ecological variables. For example, Gould (1969) argues that ceremonies have utilitarian functions by inculcating discipline in the initiate and facilitating the learning of sites' names that are associated with waterholes. Hence, according to Gould (1969), Aboriginal ceremonial life is not dissociated from the practicalities of ensuring subsistence.

Gould (1969) also notes the importance of *range* as intrinsic to risk minimising behaviour and he considers *sharing behaviour* as a way of *minimising risks in an inherently risky environment* (Gould 1982: 73). Thus, Aborigines establish and maintain a kin-sharing network over long distances that enable people to move freely to favoured areas during drought. Similarly, exogamous marriages are, according to Gould, instrumental in establishing reciprocal usage rights in territories other than one's own (Anderson 1988: 136).

The Social Emphasis on Mobility

As noted, to avoid the connotations of the term 'tribe', the terms linguistic/dialectic units or socio-dialectic groups are often used by researchers. However, these terms are also not entirely adequate. Other important aspects which affected local organisation of Western Desert Aboriginal groups such as the use of multiple dialects were also the norm. Robert Tonkinson (1989) notes that the contemporaries between dialect, country and people originated in the Dreamtime. A specific dialect is related to particular territory regardless of what the people actually speak on the ground. People are linked to certain places not only through a particular language, but also through a range of affiliations such as, marriage, descent, totemic connection or whatever other affiliatory connection that is recognised (Myers1986).

Tonkinson states that the linguistic unit was named based on the dialect that was spoken by its members and was composed of several connected groups related by marriage. Such a group occupied a specific area with known, but not precisely defined borders (Tonkinson 1974: 18). He also suggests that the social emphasis was on mobility, flexibility and permeable boundaries between groups with a resulting lack of exclusiveness in-group membership (Tonkinson 1978; 1989).

More recent studies of Western Desert people in Goldfields towns which were conducted by Will Christensen indicate that there is a continuous contradiction in Western Desert groups between parochialising tendencies and mutual dependencies in the form of networks of interdependence, through marriage, kinship and ritual. Christensen also refers to the fact that local group or *tribal* names are now not commonly used, as there is a tendency to use generic labels such as *Wongi*, *Yamadji*, or *Martu*. These and other terms, such as *Jigalong mob* or *Mt. Margaret mob,* have implications for land tenure. On a local level, Christensen (1990: 5) reports, each group had its own relatively delimited social and geographic horizons with intense loyalties concentrated within a narrow range.

This importance of localism has also been pointed out by Basil Sansom, who states that what Aboriginal groups have in common is a tendency to gravitate to the local, the particular and the familiar. Sansom (1982: 135-137), points out that traditional and contemporary Aboriginal society is small scale and that: '…the Aboriginal commonality is at once an extensive and distributed sharing in understanding, and a limited and constricted vision of those others who may be admitted to one's own known world made up of trusted and established persons'.

Frederic Myers (1986:60), in relatively recent studies in remote Western Desert regions, uses, what he calls *'the geographically based narrative'* as a way of classifying *'places into potentially larger systems'*. He explains that such *'systems'* establish;*' …a framework for the theory and the politics of 'ownership' in which claims about rights may be based on the geographical continuity of a single Dreaming'*. However, Meyers (1986:60) is careful to note that such systems of geographically based narratives are not immutable but are until the present day, reworked and recreated systems of stories which constitute '*a changing political charter of who and what are identified at different levels'* (Myers 1986:60).

On a societal level this results in 'landownership' being dependent upon members of the group knowing the cultural traditions and mythology (i.e. The Dreaming) that is specific to the places that make up 'country'. Yet determining who 'holds the country', and hence 'speaks for the country', transforms persons and arranges these persons within the group into an enduring 'structure' (Myers 1986:127,128) (Sansom 1980:20). This 'structure' is also open to change as the identification and the standing of persons who know cultural traditions and mythology (i.e. senior men and woman) is an ongoing process that is dependent on claim and counterclaim and upon validation and acceptance or non-validation and non acceptance.

Frederic Myers (1986) suggests that definite social boundaries between groups are generally very difficult to establish. This is so because when 'country' is described and discussed by members of a group, the 'places' those members might refer to as being part of 'their country' are likely to be similar but they will not be identical. However, living together as a group is an assertion of identity and unity, and such an assertion of identity and unity is based upon sharing cultural tradition and mythology, and as a consequence 'country'.

Even though the rights over places (such as sacred sites) are acquired through political activity, as briefly discussed above, claims to belonging to a 'place', or for referring to a place as one's own can be made for a number of reasons. Myers (1986) suggests the following possibilities for such claims;

1. Conception at a place (A);
2. Conception at a place (B) made by and/or identified with the same Dreaming as (A);

3. Conception at a place (B) whose Dreaming is associated mythologically with The Dreaming at (A);
4. Initiation at (A)(For a male);
5. Birth at (A);
6. Father conceived at (A), or conditions 2-5 apply for the father;
7. Mother conceived at (A) or conditions 2, 3, or 5 apply for the mother;
8. Grandparents (*Tjammu*, *Kaparli* including all kin types so classified) conceived at (A) or conditions 2-5 apply;
9. Residence around (A);
10. Death of a close relative at or near (A);

Such extended relationships require ways of establishing relatedness within a region, and ways of maintaining this relatedness. This occurs by means of established social processes, such as initiation ceremonies, which involves 'giving' of wives and which results in subsequent enduring reciprocal relationships, affinity and responsibilities between the parties involved. Myers (1986:229) relates how 'initiation' is part of a larger social process that helps reduce 'difference' and 'distance' between groups, and how; *'The symbolic action of the initiatory process, prescriptively including people from 'far away', converts difference in relatedness'*.

Hence, identification with 'country', or 'claims to country' refers to an entire set of possible relationships that can be asserted by a person, between himself or herself and 'country'. Myers (1986) notes that because of the multiple bases upon which country can be 'claimed', land-holding groups are essentially bilaterally descending kin relations. Group membership in the Western Desert is, because of this type of kin relations, very extensive and makes 'groups', as such, very difficult to determine and for fluid boundaries between groups.

Tjukurpa **(the Dreaming),** ***Yiwarra*** **(Dreaming Tracks) and Ritual.**

An essential aspect of land tenure in traditional Aboriginal societies is based on the notion of The Dreaming. The Dreaming *(Tjukurpa)* refers to a creative epoch in which ancestral beings formed the world, people, animals and plants, as well as establishing the relationships that exist within and between them.

In traditional Aboriginal Australia, specific localities and sites are linked by Dreaming Tracks, and are associated with specific species and groups of humans. These Dreaming Tracks, and the ensuing contemporaries of specific places, and groups of humans and species, were made by the ancestral beings that criss-crossed the country performing heroic deeds, hunting and fighting. The ancestral beings left memorials of their activities in the landscape in the form of geological, geographical or vegetative features that are imbued with the creative force of these ancestral beings.

Hence, The Dreaming underlies every feature of the traditional Aboriginal worldview, to the extent that the country and its people are thought of as being 'from The 'Dreaming' *(tjukurtjanu)* (Myers 1986:48). Because The Dreaming affects so many different, but related, aspects of Aboriginal life, it is impossible to give a single undifferentiated significance to the concept 'Dreaming'. However, one can arrive at an understanding of the social significance of The Dreaming when this concept is applied to specific circumstances of those who use it.

In traditional Aboriginal society, 'country' cannot be considered without considering the mythological contemporaries this 'country' invokes. This is because whenever particular 'country' is referred to, references are made to Dreamtime events that made 'country' what it is. Hence, places cannot be referred to without giving considerations to their mythological contemporaries. Since traditional Aboriginal mythology consists mainly of narratives of the deeds and the travels of ancestral beings, all places are simultaneously discrete, separate and contain their own meaning, as well as being a part of a continuum of places linked by a larger story or myth.

It is pertinent to note that in Western Desert language the term *Yiwarra* indicates a Dreaming Track that is associated with the exploits of one or more ancestral beings as well as to the tracks, or routes, that people use between places. The relationship between these two is significant since it is a feature of the movement of Western Desert people that they refer to the Dreaming Tracks and the exploits of the ancestral beings as a practical guide when travelling in the desert (Berndt 1980:21).

The Post Contact period

Recent research in the Western Desert consolidates some of the previous researchers' observations and findings about the regions' widely flung Aboriginal groups in the arid interior of Australia regarding their laws their customs and their language. Recent research not only finds that these groups are part of the 'Western Desert cultural bloc', but also consolidates Berndt's findings regarding a cultural basis for a regional system within this 'bloc' and the indigenous means by which individuals come to identify with this system and acquire interest in it. (de Gand (2000); de Gand & Vachon (2001))

High mobility in response to local or regional environmental conditions does not mean random wandering in order to alleviate stress. Movement would have relied on kinship ties, past relationships formed during ritual gatherings, knowledge of resources over a large area and common beliefs and ideas. Data gathered during primary and secondary research shows that the previous occupiers and the Aboriginal heritage consultants shared laws, customs and knowledge of the cultural geography of country extended over very large areas. At the present the breadth of many senior claimants genealogical knowledge is extensive as is the number of people to whom they assert a kinship relationship. In regards to ceremonial practice Inspector Bailey – The Travelling Inspector of Aborigines – found that in 1897 Aboriginal people in the Goldfields would come together regularly for ceremonial meetings walking up to 160 Km. Such events are still observed in a number of ceremonial centres in Jigalong, Cotton Creek, Wiluna and Warburton. The knowledge of country of Western Desert people is extensive. For example Bates' informant *Turada* knew place names, their locations and associated resources. The social history of such places (those named persons connected with these places) and their mythological associations are within an area of 14,000 square km. In 1934 Tindale found that men in Warburton could detail ceremonial Dreaming Tracks that extended over a distance of more than 750 km. For leading experts on Desert Aboriginal such as Tindale and Berndt, ecological factors not only demanded such cultural responses but also provide the explanation for the similarities of laws and customs throughout the Western Desert.

Pre contact Aborigines moved sometimes to the desert margins or to areas with available food and water, as it was an established response to a regular and quite unremarkable cycle of scarcity and plenty. When the conditions improved the distribution of people over the land changed and dispersal took place. However, the social, cultural, and linguistic framework that made movement possible occasionally prompted it without the environmental pressure to do so. Regional ceremonies, distant marriages and exchanges, and post-initiatory travel need not have to be always tied to environmental concerns.

The Europeans arrival impacted unintentionally, in the beginning at least, upon the Aborigines' patterns of occupation. However, the Europeans at the frontier located themselves within the occupational orbits of the Aborigines. Mining camps, towns and settlements were incorporated in pre-contact patterns of occupation. Over time the Aboriginal occupation became increasingly tethered to these centres. Hence, the imposition of European economic, administrative and political structures did not replace the pre-existing indigenous one. A pattern of regular aggregation and dispersal of indigenous groups persisted. This is still the case today where Aboriginal people regularly come together for regional ceremonies, funerals and other social events; they gather resources widely and it is quite common that Aboriginal people shift their residence within a network of Western Desert communities.

The *Mardu* or *Martu* people

The Martu Aborigines are part of the Western Desert cultural bloc, which encompasses one-sixth of the continent of Australia, and is notable for its social, cultural and linguistic homogeneity. The term "Martu," meaning "man" or "person," is a generic label comprising dialect-name groupings including the Gardujarra, Manyjilyjarra, Gurajarra, Giyajarra, and Budijarra.

The territories of the Martu straddle the Tropic of Capricorn between 122° and 125° E in one of the world's harshest environments. Rainfall, the crucial ecological variable, is very low and highly unpredictable. Permanent waters are rare, and both daily and seasonal temperature ranges are high (-4° C to over 54° C). Major landforms include: Parallel, red-colored sand ridges with flat interdunal corridors; stony and sandy plains (covered in spinifex); rugged hilly areas with narrow gorges; and acacia scrub thickets and creek beds lined with large eucalyptus trees. Animal life includes kangaroos, emus, lizards, birds, insects, and grubs, which Together with grass seeds, tubers, berries, fruits, and nectars formed the basis of the traditional Aboriginal diet.

It is impossible accurately to estimate the pre-contact populations of the groups that together comprise the 'Martu'. These groups were scattered in small bands and population densities were very low: about 1 Person per 91 square kilometers. Today there are about 1,000 Mardu, most of whom live either in the settlement of Jigalong or in a number of small outstation communities that have been established in the desert homelands within the past decade. Both the general population size and the ratio of Children to adults have grown greatly since migration from the desert.

Martu people traditionally lived around the southern end of the Canning Stock Route, which ran through the Great and Little Sandy Deserts from the towns of Halls Creek to Wiluna. With a history stretching back more than 25,000 years, the Martu occupation of the Western Desert area has nearly a dozen language groups and the indigenous population did not come into contact with Europeans' until the turn of the century (1905-06) when the "Canning Stock Route" wells were being established and a year later the construction team for the 'Rabbit Proof Fence' set up a rations store at the site which was later to become 'Jigalong'.

In the 1920s there was an extensive drought in the desert and Martu people were suffering, some made their way to the Jigalong Rations Depot set up on the Rabbit Proof Fence. They walked back to their homelands and informed other families of the food available at the depot. The local reliance on this rations store built up and was increased by the establishment of a camel breeding facility in the 1930's and building of a Protestant Mission at the site in 1946. A number of Martu men also spent several generations as valued stockmen and pastoralists in the region.

Jigalong Aboriginal Community (Shire of East Pilbara) became an Incorporated Body in 1973 and while the inhabitants are all inter-related; other communities in the area including Parngurr, Kunawarritji, Punmu and Irrungadji are managed within their own structure.

Martu Wangka is the contemporary name for the language of Jigalong, which is made up of Kartujarra, Putijarra and Manjiljarra. There are a number of language groups listed under Martu Wangka languages such as; Manjiljarra; Kartujarra; Kiyajarra; Putijarra; Nyiyaparli; Warnman; Ngulipartu; Pitjikala; Kurajarra; Jiwaliny; Mangala; and Nangajarra. The Martu people are found mainly in Jigalong, but also at Wiluna, and Aboriginal communities at Punmu, Parnngurr and Kunawarritji.

Bates and Radcliffe-Brown record the term “madu/mardoo” in the Pilbara and other parts of Western Australia. For example, Bates (1985:67) records that Marduwonga was used by Wajjari from the region west of the Peake Hill District in the Gascoyne-Murchison. In the word list she records from Turada, she writes that “Mardu wonga is spoken at Cue, Nannine, Tuckanarra” (Bates MS 365, 4:56/55).

Tindale’s ethnographic research in the 1970s mapped out the Tribal boundaries for groups present at the time. His research, unlike Bates’ work, provided examples of Tribal-specific cultural variations and examined the breakdown of tribal boundaries based around prominent landscape features or changes.

Tindale, in his “glossary” of Western Australian Tribes, provides information on the *Ngaiawongga* (Tindale 1974: 251), the *Ngarlawongga* (Tindale 1974: 252) and the *Wadjari* (Tindale 1974: 257-8) Tribes, referring to the *Ngaiawongga* as being “still one of the least understood tribal areas in Western Australia” (Tindale 1974: 251).

The *Wadjari* (or *Wadjarri*) Tribe seemed to have at one stage had a large population (in excess of 500 individuals), having the benefit of a reliable food source in the form of wet-milled grass seeds area (Tindale 1974: 102). Tindale indicated in his research that the *Wadjari* people had developed a method of storing the grass seeds in animal skins to extend the product life by up to 6 months (Tindale 1974: 110). After white settlement in the area and with the onset of sheep farming during the early white occupation in the Murchison, the local *Wadjari* Tribes moved into the Sanford River area (Tindale 1974: 102).

ARCHAEOLOGICAL BACKGROUND

The earliest evidence for human occupation of the inland Murchison to date is some 9000 years ago (Bordes et al. 1983). All other available radiocarbon dates are more recent and typically date to the mid to late Holocene (Bordes et al. 1983, Webb 1996). In contrast, in the coastal Gascoyne (Morse 1999, Przywolnik 2005), adjacent Pilbara (Law et al. 2010; Morse 2009; Slack et al. 2009) and inland desert regions (Smith 1989; Thorley 1998), Aboriginal occupation was established more than 30,000 years ago and in the north eastern Goldfields and semi arid central west of Western Australia by at least 23,000 years ago (O'Connor et al 1998; O'Connor and Veth 2006).

In this context it is likely that the comparatively recent evidence from the inland Murchison - Gascoyne region is simply a function of the small amount of archaeological work that has been undertaken, than a real absence of Pleistocene age sites.

Stone artefact scatters dominate the archaeological record of the central west of Western Australia. Determining the age of surface scatters of archaeological material is however problematic. Recent archaeological survey work undertaken in the Weld Range some 110 km southwest of Meekatharra has documented over 300 new Aboriginal sites of which over 45% are stone artefact scatters and quarry sites. These sites vary in size, density and content, the largest and most diverse typically being found in association with sources of fresh water such as rock holes or creeks.

Other sites recorded include scarred trees, occupied rock shelter sites, engraving sites, painting sites, caches, burials, stone arrangements and other man made structures, confirming that the Weld Range was a focus of Aboriginal occupation.

The available archaeological evidence indicates that sites in the inland Murchison-Gascoyne, particularly rock shelters, were occupied sporadically by small highly mobile groups (Bordes et al 1983; Morse 2009; Slack et al. 2009, Veth 2005). From mid Holocene times new flaked artefact and grinding technologies appear (Marwick 2009,Veth 1995) as well as bone points recorded some 1100 years ago at the ochre quarry site Wilgie Mia (Eureka 2011). Ochre from this site, located some 85 km south west of Meekatharra, was widely traded across Western Australia and perhaps as far as Queensland (Winton et al 2009). Archaeological research further to the east near Wiluna suggests that the use of this area also dates to at least 4,000 BP (Bindon 1986:140).

European historical records from the early stages of colonisation indicate that most Aboriginal campsites were located within or adjacent to creeks, with long term seasonal camps located where reliable sources of water could be easily accessed (Brown 1987). The inland lakes system in the central west Goldfields region was similarly a significant feature of patterns of human occupation of Australian's semi arid zone. The available archaeological record of Australia's arid inland lakes indicates intermittent and low level occupation in middle Holocene period with an increase in occupation intensity during the late Holocene (Thorley 1998; O'Connor et al 1998; O'Connor and Veth 1996; McNiven 1998). While the saline nature of many arid zone lakes probably means they were of limited use as sources of fresh water, it is likely that the surrounding clay pans and drainage systems feeding the lakes were the primary source of water for Aboriginal hunter-gatherers (McNiven 1998).

Archaeological sites recorded around salt lakes are typically small, low density stone artefact scatters suggesting opportunistic occupation by small groups of people at times when freshwater and other resources, such as the seasonal migration of large colonies of birds, were plentiful (Mattner 2000; Williams 1998). The location of freshwater sources is then clearly a key determinant of site location in the arid central western region. Creeks, springs, waterholes and clay pans are more likely to be associated with archaeological materials than other locations.

The patterning of archaeological sites within this landscape reflects the environmental context. In brief, it is anticipated that archaeological sites in the survey area is dominated by stone artefact scatters found primarily in the least disturbed areas of remnant bush, adjacent to drainage lines and freshwater sources. Quarry sites may occur in areas of outcropping stone suitable for the manufacture of stone tools. Despite being uncommon in the area, engravings, art, and grinding patches may be found on relatively flat and smooth stone outcrops or boulders in a variety of locations, usually adjacent to semi-permanent or permanent water sources. Rock shelters and caves will only be found in locations with the requisite geological formations, such as cliffs, gorges or breakaways.

rocky outcrops that yielded stone materials suitable for stone tool manufacture. This model confirmed a standing conservation policy that Yugunga-Nya traditional owners have had about these landscape elements namely that exploration and mining activities should avoid such places.

ETHNOGRAPHIC SURVEY METHODOLOGY

The Ethnographic Survey component consisted of the following methods;

1. Consultation with Aboriginal heritage consultants who are recognised as being the appropriate people to speak for Aboriginal interests in the area.

The *bona fides* of the Aboriginal Heritage Consultants of the Yugunga Nya Native Title Claim Group who assisted in the field survey, was assessed on the basis of their;

1. Ancestry to Aboriginal people and Aboriginal families who have longstanding, and documented, connections to the region of the Maid Marion Project Area.
2. Length of residence in the region of the Maid Marion Project Area.
3. Knowledge of country, e.g. through either living or working in the region and/or being told about the region of the Maid Marion Project Area by their ancestors and /or elders.
4. Knowledge of genealogical information of the Aboriginal families affiliated with the region of the Maid Marion Project Area.
5. Knowledge of the oral history of the region of the Maid Marion Project Area.

6. Initiation in traditional Aboriginal Law pertaining to the region of the Maid Marion Project Area.

7. Knowledge of areas within the Maid Marion Project Area, which have mythological, traditional, historical or biographical significance for the Aboriginal people of the region.

Consultation with Aboriginal people also occurred on the basis that those Aboriginal heritage consultants who participated in the survey are recognised as the appropriate people to speak for the Aboriginal heritage and native title interests in the area by relevant Aboriginal groups such as the *Yugunga Nya* Native Title Claim Group and Aboriginal organisations such as the *Yamatji Malba Aboriginal Corporation (YMAC)*, the *Central Desert Native Title Services* and the *Department of Planning, Land and Heritage (DPLH).*

All the Aboriginal people who were consulted on heritage matters during the Survey have an interest in the land that comprises the proposed Project Areas. The Yugunga Nya Native Title Claim evidences this interest. This Native Title Claim entirely encompasses the Maid Marion Project Area, which is the subject of this Report.

All the Aboriginal heritage consultants who participated in the Survey are either applicants or claimants on these Native Title Claim Groups, or, are genealogically and/or culturally affiliated with members of this Native Title Claim Group.

All the Aboriginal heritage consultants who participated in the heritage Survey have long-term historical, traditional and ancestral affiliations with the region within which the Project Area are located.

Briefing the Aboriginal heritage consultants about the Proposed Works in the Project Areas.

David conducted the pre Survey briefing for the *Yugunga Nya* Aboriginal Heritage Consultants at the Maid Marion Project Area prior to the field Survey.

During this briefing maps were utilised to illustrate the location, the nature and the extent of the Proposed Works on the Maid Marion Project Area. After this presentation the nature and the extent of the Proposed Works were discussed with the *Yugunga Nya* Aboriginal heritage consultants. Maps were made available to the Aboriginal heritage consultants for their use during the field Survey. The directions and suggestions from the Aboriginal Heritage Consultants, regarding Aboriginal heritage in the region of the Project Areas were recorded in a field notebook.

2. Interviews and discussions with the Aboriginal heritage consultants during a field Survey of the Maid Marion Project Area.

After discussions with the Aboriginal Heritage Consultants and representatives of Westgold, it was decided that the field Survey would follow a *Work Area Clearance Model* as delineated in the *Guidelines for Aboriginal Heritage Assessment in Western Australia (Department of Aboriginal Sites - 1993).*

In this type of Survey, the proponent provides details of the proposed Work Area to the Aboriginal Heritage Consultants and the ethnographer. The ethnographer then consults with the Aboriginal Heritage Consultants as to wether there are areas within this proposed Work Area that are precluded because of the presence of Aboriginal Heritage sites. No information about the cultural significance of the landscape and the sites is given to the developer. However, such cultural information may be lodged in confidence with the DPLH.

After the presentation and discussion of the Proposed Works on the Maid Marion Project Area, the Aboriginal Heritage Consultants participated in the field Survey. The Maid Marion Project Area was inspected by four-wheel drive by the Aboriginal Heritage Consultants and Daniel de Gand – ethnographer. Areas of specific significance to the Aboriginal Heritage Consultants and areas, which were conforming to the predictive model of archaeological and ethnographic sites of the region, were inspected on foot by the Survey team. Pedestrian investigations were conducted on areas, which had potential for archaeological Sites. The Survey Team also surveyed proposed access tracks within the Maid Marion Project Area. Ethnographic and ethno-historical information about the region of the Maid Marion Project Area was recorded in a field notebook. Genealogical and biographical information establishing the longstanding associations of the Aboriginal Heritage Consultants to the region of the Project Area was also recorded.

3. Post Survey meetings.

At the completion of the field Survey with the *Yugunga Nya* Aboriginal Heritage Consultants, a debriefing was conducted by Daniel de Gand which was attended by all the Aboriginal Heritage Consultants in order to allow them to discuss the recommendations and the heritage management strategies that they provided during the field Surveys. At the completion of this briefing, the Aboriginal heritage consultants stated that they were satisfied with the heritage methodology utilised during the field survey and stated that they had no further comments or suggestions on the results of the field work component of the Survey and the heritage recommendations discussed and recommended during the debriefing.

ETHNOGRAPHIC RESULTS

Previously recorded Registered Aboriginal Sites on the Maid Marion Project Area.

A search of the DPLH Site Register indicated that there are **no previously Registered Aboriginal Sites** as per *Section 5* of the *AHA (1972)*, or, Heritage Places that are located on the **tenements M51/504 and M51/668** which constitute Westgold ResourcesMaid Marion Project Area and which are the subject of the Aboriginal Consultation, the Survey and this Report.

The results of the Site Search are stipulated below.

M51/504

Department of Planning, Lands and Heritage

Aboriginal Heritage Inquiry System

List of Registered Aboriginal Sites

For further important information on using this information please see the Department of Planning, Lands and Heritage's Disclaimer statement at

Search Criteria

No Registered Aboriginal Sites in Mining Tenement - M 51/504

Disclaimer

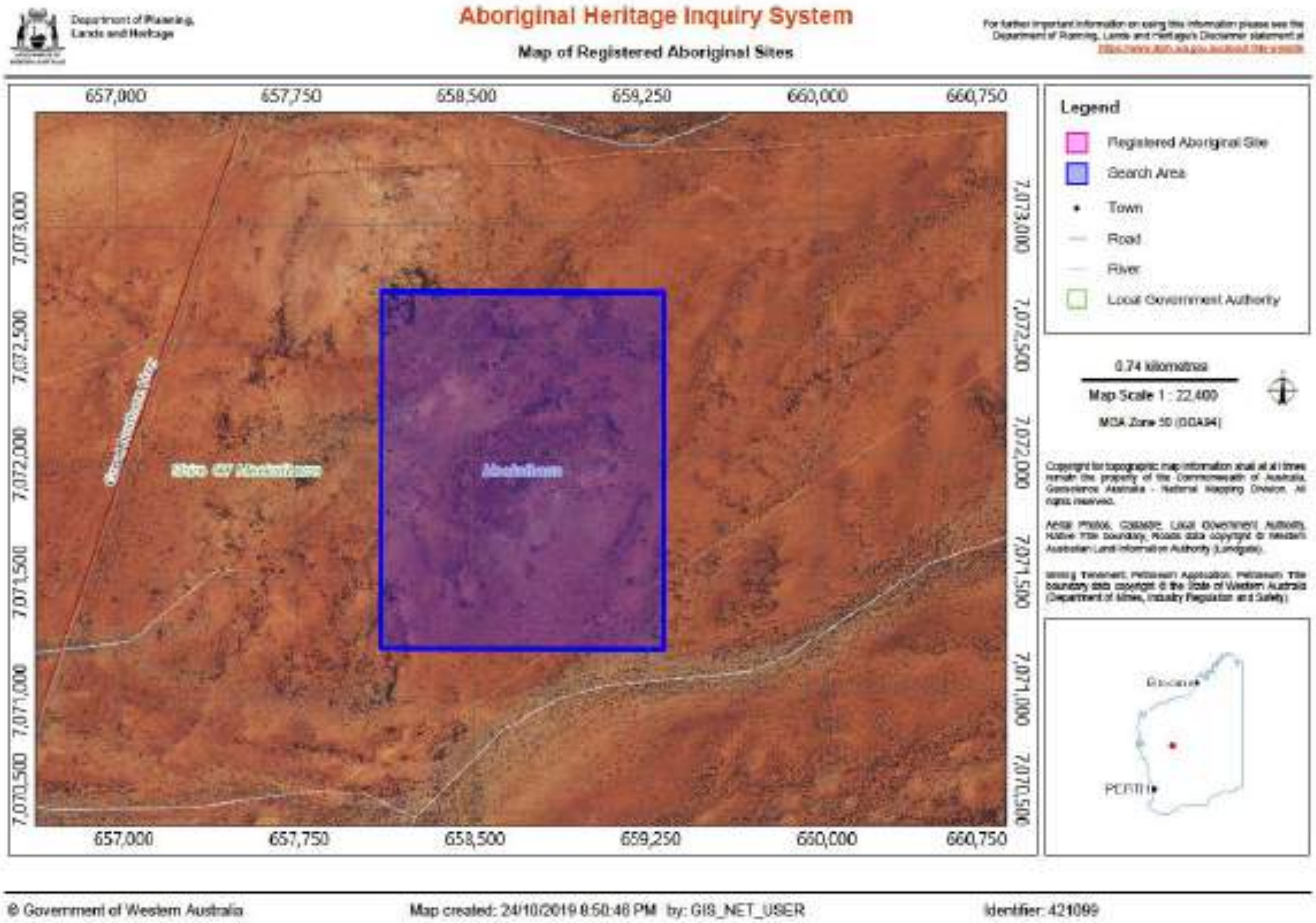
The *Aboriginal Heritage Act 1972* preserves all Aboriginal sites in Western Australia whether or not they are registered. Aboriginal sites exist that are not recorded on the Register of Aboriginal Sites, and some registered sites may no longer exist.

The information provided is made available in good faith and is predominately based on the information provided to the Department of Planning, Lands and Heritage by third parties. The information is provided solely on the basis that readers will be responsible for making their own assessment as to the accuracy of the information. If you find any errors or omissions in our records, including our maps, it would be appreciated if you email the details to the Department at heritageenquiries@dplh.wa.gov.au and we will make every effort to rectify it as soon as possible.

Copyright

Coordinate Accuracy

Coordinates (Easting/Northing metres) are based on the GDA 94 Datum. Accuracy is shown as a code in brackets following the coordinates.



Department of Planning, Lands and Heritage
Aboriginal Heritage Inquiry System
Map of Registered Aboriginal Sites
657,000
657,750
658,500
659,250
660,000
660,750
7,073,000
7,072,500
7,072,000
7,071,500
7,071,000
7,070,500
Legend
Registered Aboriginal Site
Search Area
Town
Road
River
Local Government Authority
0.74 kilometres
Map Scale 1 : 22,400
PERTH
© Government of Western Australia
Map created: 24/10/2019 8:50:46 PM by: GIS_NET_USER
Identifier: 421099

M51/668

Department of Planning, Lands and Heritage

Aboriginal Heritage Inquiry System

List of Registered Aboriginal Sites

For further important information on using this information please see the Department of Planning, Lands and Heritage's Disclaimer statement at

Search Criteria

No Registered Aboriginal Sites in Mining Tenement - M 51/668

Disclaimer

The *Aboriginal Heritage Act 1972* preserves all Aboriginal sites in Western Australia whether or not they are registered. Aboriginal sites exist that are not recorded on the Register of Aboriginal Sites, and some registered sites may no longer exist.

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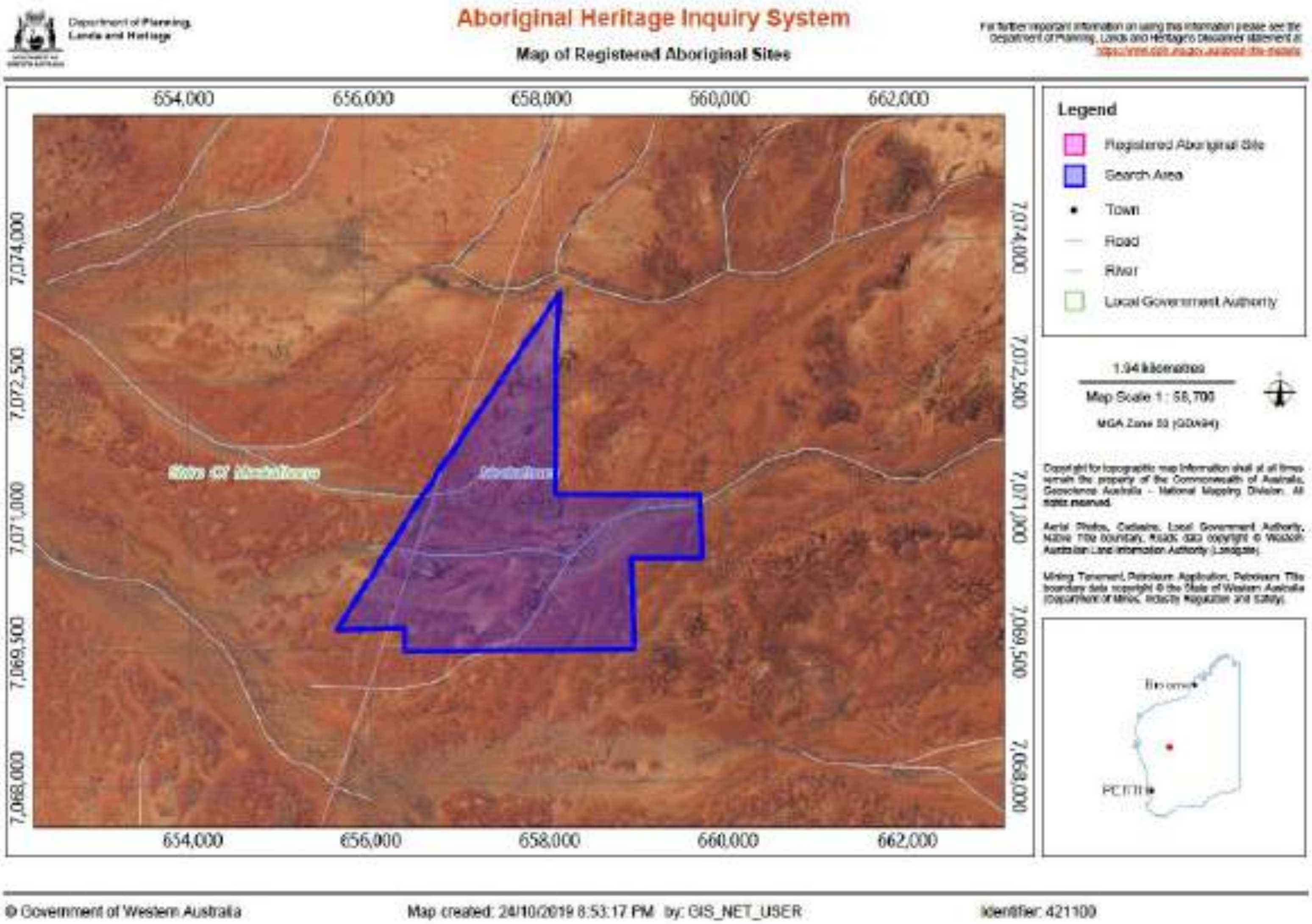

Department of Planning, Lands and Heritage
Aboriginal Heritage Inquiry System
Map of Registered Aboriginal Sites
654,000
656,000
658,000
660,000
662,000
7,074,000
7,072,500
7,071,000
7,069,500
7,068,000
Legend
Registered Aboriginal Site
Search Area
Town
Road
River
Local Government Authority
Map Scale 1 : 58,700
Broome
PERTH
© Government of Western Australia
Map created: 24/10/2019 8:53:17 PM by: GIS_NET_USER
Identifier: 421100

ETHNOGRAPHIC FIELD SURVEY RESULTS

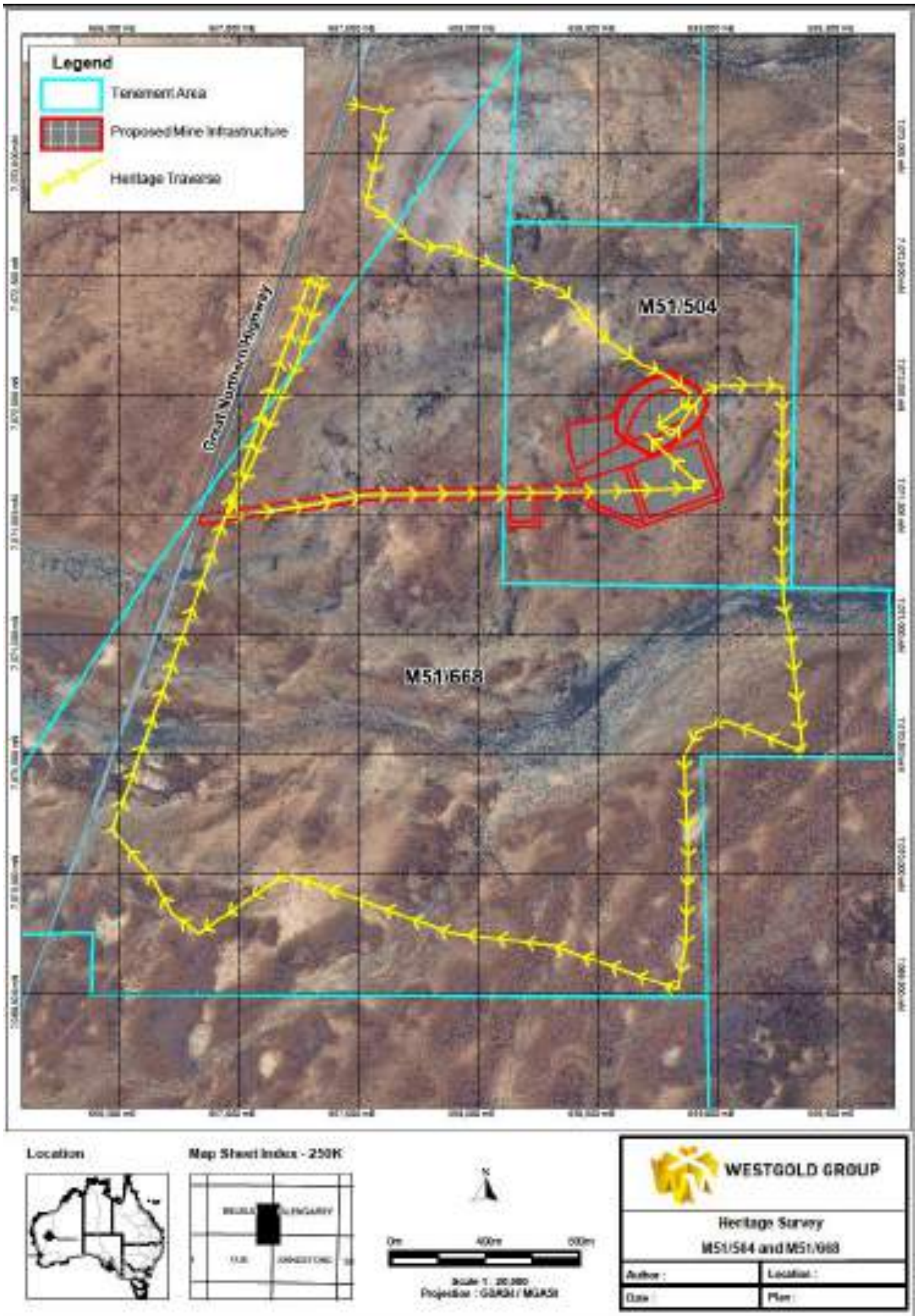
The Maid Marion Project Area was accessed by four-wheel drive by the Aboriginal Heritage Consultants and Daniel de Gand – ethnographer. For the purpose of the Survey the Maid Marion Project Area was divided in sections to facilitate the Survey. The Survey Team accessed the Project Area utilising existing fence lines and drill lines that provided access to the Project Area. The ground visibility was usually very good. The Maid Marion Project Area showed evidence in certain areas of previous exploration as evidenced by existing gridlines, drill holes, base lines and sumps as well as the clearing of vegetation. It is understood that these activities were at least partially conducted by the previous owners of the tenements and conducted after previous heritage programs were conducted.

The *Yugunga Nya* Aboriginal heritage consultants were briefed about the proposed works intended on the Project Area throughout the field Survey. During the Survey, areas of specific significance to the Aboriginal Heritage Consultants and areas, which conformed to the predictive model of archaeological and ethnographic sites of the region, were inspected on foot by the Survey team.

The Survey Team encountered a number of ephemeral creeks that traversed the flood plain generally in an east - west direction and which characterised the Project Areas. Some of these creeks and their banks were investigated on foot as they correspond to the predictive model of archaeology in the region. Surprisingly no evidence of Aboriginal occupation in the form of artefact scatters was encountered at these locations.

No artefact scatters were encountered near the ephemeral creeks and there was no evidence of isolated artefacts near the banks of the creeks.

Plate 1: Typical topography and vegetation on the Maid Marion Project Area



Map 3: The Maid Marion Project Area and the itinerary of the Field Survey Team

CONCLUSION AND RECOMMENDATIONS

SITE MANAGEMENT RECOMMENDATIONS

Site Management Recommendations for the ethnographically significant areas recorded during the Survey were established through consultation with the all the Aboriginal Heritage Consultants who were consulted during the field survey. The *Site Management Recommendations* for the ethnographic sites were determined by the size, the location and the relative significance of the sites to the Aboriginal custodians who suggested that different types of management recommendations were required for particular sites.

These are as follows:

Exclusion zone

An exclusion zone implies a protected area around the boundary of the site. Within this area, free access remains possible on existing tracks and roads. It is **recommended**, however, that for any work that needs to be undertaken within the specified exclusion zone, consultation prior to such works occurs with the Aboriginal custodians who consulted in the field survey.

Anonymity

Anonymity serves to protect particular sites by ensuring that knowledge of the location of the site is known only to those parties who have a need to know (eg. Aboriginal Custodians, Westgold Resources and the DPLH) or where it is considered inappropriate to draw undue attention to the site through the erection of fences and signs. This type of recommendation is most appropriate for sites of 'secret sacred' significance.

SUMMARY OF RECOMMENDATIONS

- It is **recommended** that Westgold Resources ensure that its operations and contractors are advised that as the result of the Field Survey and the Aboriginal Consultations **no** Sites under *Section 5* (a, b, and c) of the *AHA 1972* or locations containing Aboriginal Heritage Significance are located on, or near, the Maid Marion Project Area.

- **It is recommended** that Westgold Resources ensure that its operations and contractors are advised that after a Site Search at the DPLH on the tenements **M51/504** and **M51/668** which constitute the Maid Marion Project Area **no** previously registered Aboriginal Sites or places of Heritage Significance are located on or near the Maid Marion Project Area.
- It is **recommended** that Westgold Resources and its operations and contractors be informed about the potential heritage significance of the ephemeral creeks that traverse the Maid Marion Project Area and that the banks of these creeks, up to a distance of 25m, are locations were evidence of Aboriginal occupation may be found and that such locations may constitute Aboriginal Sites under *Section 5* of the AHA 1972.
- It is **recommended** that Westgold Resources and its operations and contractors are informed that the Aboriginal Heritage Consultants stipulated that because of the possibility of the presence of Aboriginal Sites buffer zones of a minimum of 25 m be maintained from the banks of the creeks traversing the Maid Marion Project Area as a management strategy to ensure that potential Aboriginal Sites are not be impacted.
- It is **recommended** that Westgold Resources and its operations and contractors be informed that the Aboriginal Heritage Consultants stipulated that proposed Exploration works and Mining development may proceed as planned.
- It is **recommended** that Westgold Resources and its operations and contractors be informed that Westgold Resources can proceed with their proposed works on the designated Maid Marion Project Areas.

- It is **recommended** that should Westgold Resources and its operations and contractors come upon an Aboriginal Site or significant cultural material during any stage of the implementation of the proposed Works, all work in the vicinity of this Site must come to a halt and the location of the Site noted and the Aboriginal

Heritage Consultants and other relevant parties, such as the *Yugunga Nya* Native Title Claim Group and the DPLH, notified. The Site must remain undisturbed until such time that heritage clearance of the relevant parties is obtained. If human remains or skeletal material are discovered or unearthed during the implementation of the Work Program, the WA Police and the DPLH need to be contacted.

- It is **recommended** that if Westgold Resources intend to extend or alter their Proposed Works program (as stipulated in this Report) or their Project Area, or propose any new work programs or project areas in the region, then these should be discussed, prior to any ground disturbing activity, with the *Yugunga Nya* Aboriginal Heritage Consultants who participated in this Survey and Consultation and further heritage surveys conducted where deemed necessary.

- It is **recommended** that Westgold Resources be advised that if there should be an extension, any further development, or new work programs which exceed the Proposed Works or Project Areas delineated in this Report, these may be subject to a new Heritage Survey, and should be discussed prior to any activity with representatives of the *Yugunga Nya* Native Title Claim Group and the *Yugunga Nya* Heritage Consultants.

ETHNOGRAPHIC REFERENCES

Anderson, C 1988. Anthropology and Australian Aboriginal economy. In Berndt, R.M. and Tonkinson, R. (eds) *Social Anthropology and Australian Aboriginal Studies - A contemporary overview*. National Library of Australia, Victoria: 125-188.

Beard J.S. 1976, Murchison – The vegetation of the Murchison Region. Nedlands, W.A. UWA Press.

Bates D. 1985. The Native Tribes of Western Australia. Edited by White, I. National Library of Australia, Canberra.

Berndt, R.M. 1942. *Social And Cultural Change in Aboriginal Australia.* Proceedings of the 3rd Pan Indian Ocean Science Congress, Section E.

Berndt, R.M. 1959. The Concept of the Tribe in the Western Desert of Australia. *Oceania* 30(2): 81-117.

Berndt, R.M. 1976. Territoriality and the Problem of Demarcating Socio Cultural Space. In Peterson, N. (ed) *Tribes and Boundaries in Australia*. Australian Institute of Aboriginal Studies, Canberra: 133-161

Berndt, R.M. **and Berndt, C.H**. (eds) 1980, *Aborigines of the West Their Past and Present*, University of Western Australia Press, Perth.

Christensen, **W.J.K.** 1980 'Aborigines of Kalgoorlie-Boulder'. In Berndt, R.M. and C.H. (eds) *Aborigines of the West Their Past and Their Present*. University of Western Australia, Perth.

de Gand, D. 1998A. (*Unpublished*) Report of an Anthropological Research Project in the North Western Goldfields (Western Australia) - Stage 1 - for The Goldfields Land Council. Kalgoorlie. W.A.

de Gand, D. 1998B. (*Unpublished*) Report on Territorial Boundaries in the North West Goldfields. The Goldfields Land and Sea Council. Kalgoorlie. W.A.

de Gand, D. 1998C. (*Unpublished*) Report of an Ethnographic and Archaeological Site Survey Demonstrating Evidence of Native Title *'Connection to Country'* in the North West Region of the Goldfields (Wiluna Area). The Goldfields Land and Sea Council. Kalgoorlie. W.A..

de Gand, D. 2000. (*Unpublished*) Ethnographic Report on the *Mantjintjarra Ngalia* Claim Areas. The Goldfields Land and Sea Council. Kalgoorlie.

de Gand, D. & Vachon ,D 2001. Expert Anthropological Report – *Mantjintjarra Ngalia* Native Title Determination WC96/20.

Elkin, A.P. 1930. Field Note Book VII Item 1/2/8 & Field Note Book VIII – Mount Margaret Notebook. Series 2. Item 1/2/9. Elkin Collection ANU Canberra.
. Elkin Collection ANU Canberra.

Finlayson, J. & Curthoys, A. 1997. The Proof of Continuity of Native Title. Issue Paper No. 18 of *Land, Rights, Laws: Issues of Native Title*, Pyle, Ann (ed.). Native Titles Research Unit, Australian Institute of Aboriginal and Torres Strait Islander Studies.

Gould, R.A. 1969. Subsistence Behaviour Among The Western Desert Aborigines. *Oceania* 39(4): 253-274.

Gould, R.A. 1982. To Have and Have Not: The Ecology of Sharing Among Hunters and Gatherers. In Williams, N.M. and Hunn, E.S. (eds), *Resource Managers: North American and Australian Hunters and Gatherers*. Westview Press, Boulder, Colorado: 69-92.

Gravestock P.C. 1937. Report for the Aboriginal Department. AAD993: 144/1937.

Heydon, P.A 1996. Wiluna place of Wind. Hesperian Press. Western Australia

Liberman, K. 1980. The Decline of the Kuwarra People of Australia's Western Desert: A Case Study of Legally Secured Domination. Ethnohistory 27 (2)

Myers, F.R.1986: *Pintupi Country, Pintupi Self*. Australian Institute of Aboriginal studies, Canberra.

Peterson, N. Introduction. In Tribes and Boundaries in Australia. N. Peterson (ed) Australian Institute of Aboriginal Studies, Canberra.

Petri, J. 1957. Movements in the Western Desert. Paper for VIIIth Congress of Anthropological and Ethnological Sciences in *Social and Cultural Change.*

Sansom, B. 1982. The Aboriginal Commonality. In R.M. Berndt (ed*) Aboriginal Sites, Rights and Resource Development*. Academy of Social Sciences in Australia, Canberra: 135-137

Stanton, J. 1983 'Old business, new owners; sucession and 'the Law' on the fringe of the Western Desert' in Peterson, N. and Langton, M. (eds) 1983, *Aborigines, Land and Land Rights*. Australian Institute of Aboriginal Studies, Canberra.

Stanner, W.E.H. 1965. Aboriginal territorial organisation: estate, range, domain and regime. *Oceania* 36(1): 1-26.

Sutton, P. 1994, *Country Aboriginal boundaries and land ownership in Australia*. ANU Central Printery, Canberra.

Tindale, N.B. 1938-39. Notebooks of fieldwork from the *Harvard and the Adelaide Universities Anthropological Expeditions of 1938 and 1939.*

Tindale, N.B. 1974 The Aboriginal Tribes of Australia.

Tindale, N.B. 1966 *Notes of Trip to Western Australia in Search of Tribal Data*

Tindale, N.B. 1976. Some ecological bases for Australian tribal boundaries. In *Tribes and Boundaries In Australia* (N. Petersen ed.) Australian Institute of Aboriginal Studies, Canberra.

Tonkinson, R. 1974. *Aboriginal Victors of the Desert Crusade*. Menlo Park, California.

Tonkinson, R. 1978. *The Mardudjara Aborigines*. Holt, Rinehart and Winston, New York.

Tonkinson, R. 1989. Local Organisation and Land Tenure in Karalmilyi (Rudall River) Region. In *The Significance of the Karlamilyi Region to the Martutjarra of the Western Desert*. The Western Desert Working Group, Department of Conservation and Land Management.

ARCHAEOLOGICAL REFERENCES

Bordes, F, Dortch, C, Thibault, C, Raynal, J.P. & Bindon, P 1983, Walga Rock and Billibilong Spring: two archaeological sequences from the Murchison Basin, Western Australia, Australian Archaeology vol. 17, pp. 1-26.

Brown, S. 1987 Toward a Prehistory of the Hamersley Plateau, Northwest Australia. Occasional Papers in Prehistory 6, Department of Prehistory, Research School of Pacific Studies, Australian National University: Canberra.

Crawford, IM 1980, „Aboriginal studies at the Western Australian Museum", in Aborigines of the West, in RM Berndt & CH Berndt University of Western Australia Press, Perth, pp. 461–77.

Department of Indigenous Affairs. 2010 Guidelines for preparing Aboriginal Heritage Survey Reports. http://www.dia.wa.gov.au/en/Section-18-Applications/Heritage-management/Aboriginal-heritage-surveys/Guidelines-for-preparing-Aboriginal-heritage-survey-reports/. [Date Accessed: 1 November 2011].

Winton, V , Brown, V, Williams, K, Cameron, R, Reynen, W, Rea-Cunningham, A & Reynolds, J 2011, „Aboriginal Archaeological report for outstanding survey, Site Identification (section 18) level recording and Site Avoidance recording, Weld Range, Murchison Region, Western Australia." Unpublished report for Ethical Engagement Consultancy and Sinosteel Midwest Corporation. (October).

Law, W.B., Cropper, D. N., Petchey, F. 2010 „Djadjiling Rockshelter: 35,000 14C years of Aboriginal Occupation in the Pilbara, Western Australia." Australian Archaeology 70:

Mattner, J. 2000. Salt Lakes and Aboriginal settlement: a case study at Lake Carey, southeastern Western Australia. MA thesis at the University of New England.

Marwick, B. 2009 „Change or Decay? An interpretation of Late Holocene archaeological evidence from the Hamersley Plateau, Western Australia." Archaeology in Oceania Vol 44 Supplement : 16-22

McNiven, I. J. 1998. Aboriginal settlement of the saline lake and volcanic landscapes of Corangamite Basin, Western Victoria. The Artefact 21:63.94.

Morse, K. 1999 Coastwatch: Pleistocene resource use on the Cape Range peninsula, pp.73-78 in Hall, J. and McNiven, I. Australian Coastal Archaeology. Research papers in Archaeology and Natural History No. 31 ANU Canberra

Morse, K. 2009 „Introduction emerging from the abyss – archaeology in the Pilbara region of Western Australia." Archaeology in Oceania Vol 44 Supplement : 1-5

O"Connor, R. 1989. Report on a survey for Aboriginal sites at the proposed Plutonic project area, Meekatharra. Unpublished report held by the Department of Indigenous Affairs.

O"Connor, S., Veth, P. and Campbell, C. 1998 Serpent"s Glen rockshelter: Report of the first Pleistocene occupation sequence from the Western Desert. Australian Archaeology 46

O"Connor , S and Veth, P. 2006 revisiting the past: Changing interpretations of Pleistocene settlement, subsistence and demography in Northern Australia. In Lilley, I (ed). Archaeology of Oceania, Australia and the Pacific Islands. Blackwell Publishing

Przywolnik, K. 2005. Long –term transitions in Hunter gatherers of coastal northwestern Australia. In Veth, P., Smith, M., and Hiscock, P. (eds), Desert Peoples: Archaeological Perspectives. Blackwell Publishing: Carlton.

Quartermaine, G. 2000. Report on an Archaeological Survey of a possible archaeological site, Bream Project area. Unpublished report held by the Department of Indigenous Affairs.

Quartermaine, G. 2003. Report on an archaeological investigation of Aboriginal sites, Plutonic Gold Mine M52/259 and M52/229 and associated areas. Unpublished report held by the Department of Indigenous Affairs.

Slack, M., Fillios, M., Fullagar, R. 2009 „Aboriginal Settlement during the LGM at Brockman, Pilbara Region, Western Australia", Archaeology in Oceania. vol. 44

(Supplement), pp. 32-39.

Smith, M.A. 1989 „The case for a resident human population in the central Australian ranges during full glacial aridity." Archaeology in Oceania 24:93-105.

Thorley, P 1998 Pleistocene settlement in the Australian arid zone: Occupation of an inland riverine landscape in the central Australian ranges. Antiquity 72:32-45

Veth, P. 2005 „Cycles of Aridity and Human Mobility: Risk Minimization Among Late Pleistocene Foragers of the Western Desert, Australia." In Veth, P., Smith, M., and Hiscock, P. (eds), Desert Peoples: Archaeological Perspectives. Blackwell Publishing: Carlton.

Webb, R.E 1996, The problem of verifying isolated radiocarbon dates: more can be less confusing, Australian Archaeology, vol. 42, pp. 19-24.

Williams, E. 1988. The archaeology of lake systems in the middle Cooper Basin, northeastern Australia. Records of the South Australian Museum 22:53-62

Winton, V., Brown, V., Cameron, R., E. 2009. Mind the gap: recent results of a survey for Aboriginal archaeological sites in the Weld Range, Murchison region, Western Australia. Antiquity Project Gallery http://www.antiquity.ac.uk/projgall/winton325/

APPENDIX ONE

WHAT IS A SITE?

The WA *Aboriginal Heritage Act* 1972 (AHA) makes provision 'for the preservation, on behalf of the community, of places and objects customarily used by or traditional to the original inhabitants of Australia'. The AHA applies to both places (s.5) and objects (s.6) which are of "significance and importance" in traditional or contemporary cultural life, including sacred, ritual or ceremonial sites, as well as places of scientific, aesthetic or social significance (s.39).

For the purpose of the survey described in this report, an archaeological site is defined as a place where 'significant traces of human activity are identified'. In other words, a site is a place where there is a quantity of *in situ* objects or materials that are evidence of past Aboriginal occupation or activity. This is a scientific definition. Archaeological sites may also have cultural or historical significance to Aboriginal people.

A place or feature identified as an archaeological site <u>might</u> or <u>might not</u> constitute an Aboriginal heritage site under the criteria of the AHA. The decision whether a recorded archaeological site (or reported ethnographic site) will qualify as a heritage site under s.5 and/or s.39 of the AHA is made by the Aboriginal Cultural Material Committee (ACMC) at the Department of Aboriginal Affairs (DAA). That decision is based on a number of factors, of which the viewpoints of Aboriginal spokespersons, anthropologists and archaeologists are only a part.

Recent changes in the administration of the AHA and management of the Register of Aboriginal Sites included a reclassification of Aboriginal sites on the Register into 2 status categories:

i) 'Registered Aboriginal Sites' are those that have been considered and assessed by the ACMC to meet the criteria of s.5 or s.39 of the AHA. As such, they are registered Heritage Sites protected by the AHA.

ii) ‘Other Heritage Places’ are reported sites which are either lodged with the DAA, but have not yet been assessed by the ACMC, or for which the ACMC considers there is insufficient information to reach an assessment.

In addition, there is the sub-category of ‘Stored Data’ which includes reported sites which the ACMC has determined do not meet s.5 or s.39 of the AHA, as well as sites which may no longer exist because consent was given for them to be destroyed (pursuant to s.18 of the AHA). Such places are not considered to be heritage sites and are not protected by the AHA.

It is important to note that until they are assessed, all Aboriginal sites or places are protected under the AHA, whether known or not and whether reported or not. It is an offence to disturb or conceal a heritage site, or remove artefacts, without consent from the Minister for Aboriginal Affairs (obtainable through lodging a s.18 Notice).

SITE SIGNIFICANCE

The heritage significance of an archaeological site, material or object is determined by several factors. Principal among these will be the archaeological or scientific significance and Aboriginal viewpoints. Public, educational or aesthetic values may also be considered.

The degree of disturbance and the environmental context will also influence the assessment of archaeological significance, as will the presence of esoteric components, such as art or rare artefacts (Coutts 1982). Significance is a mutable quality, changing as more sites and locations are recorded or new directions in research arise (Bowdler 1984).

Assessments of archaeological significance are typically based on 2 criteria: representativeness and research potential. Representativeness refers to the frequency of occurrence of sites or archaeological material. The more commonplace something is, the less significant it will be, while unique sites will be highly significant. In making this assessment, it is appropriate to consider the known occurrence as well as the likely occurrence of sites with a view to retaining a “sample of sites and landscapes for future research purposes” (Brown 2008: 25). Research potential refers to the likelihood that study of an archaeological site or material will answer scientific questions or add new or pertinent information to the corpus of archaeological knowledge.

Much of the current research in the Goldfields region, and other arid and semi-arid zones of Australia, focuses on the timing of initial colonisation and subsequent changes in the patterns of settlement. In particular, there are questions of changes in occupation and subsistence patterns during the very arid phase of the last Ice Age, and during the last few millennia, when an ‘intensification’ of site use and resource usage has been noted across many parts of the continent. Answering such questions requires stratified and dateable sites, which generally means rock shelters.

The range of sites found, such as artefact scatters, knapping centres or quarries, are all open surface sites that are not dateable by standard archaeological dating techniques. This lack of potential for reliable dating is an impediment to the understanding of the region’s archaeological material. It limits the research potential and significance of any such sites.

While assessments of significance of individual sites are important for management purposes, it is also pertinent to remember that archaeological sites are the remnants of complex cultural and subsistence systems. Such systems produce a range of site types and do so repeatedly, making patterns of sites. Furthermore, any cultural system involves an interrelationship between subsistence and non-subsistence activities, between mundane and esoteric places, between foci of activity and locations peripheral to the group.

This means that assessments of the significance of heritage sites can be made of individual sites and also can be attributed to a group of sites, or to a site-complex. When considering a group of sites, the significance may derive from them being an uncommon or a special grouping of sites, or a site-complex may have significance because it provides a sample of the full range of subsistence and cultural activities practiced by a group.

RELEVANT LEGISLATION

Relevant legislations for the purpose of the Aboriginal Heritage Assessment of the Project includes:

- WA *Aboriginal Heritage Act* 1972;
- Commonwealth *Aboriginal and Torres Strait Islander Heritage Protection Act* 1984;
- Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999.

The WA *Aboriginal Heritage Act* 1972 (AHA) provides automatic protection for all places and objects in Western Australia that are important to Aboriginal people because of connections to their culture. These places and objects are referred to as *Aboriginal Sites*. *Section 5* of the AHA defines the places to which it applies as:

a) any place of importance and significance where persons of Aboriginal descent have, or appear to have, left any object, natural or artificial, used for, or made or adapted for use for, any purpose connected with the traditional cultural life of the Aboriginal people, past or present;

b) any sacred, ritual or ceremonial site, which is of importance and special significance to persons of Aboriginal descent;

c) any place which, in the opinion of the Committee, is or was associated with the Aboriginal people and which is of historical, anthropological, archaeological or ethnographic interest and should be preserved because of its importance and significance to the cultural heritage of the State;

d) any place where objects to which this Act applies are traditionally stored, or to which, under the provisions of this Act, such objects have been taken or removed.

Under *Section 17* of the AHA, it is an offence to:

a) Excavate, destroy, damage, conceal or in any way alter any Aboriginal site;

b) In any way alter, damage, remove, destroy, conceal, or deal with in a manner not sanctioned by relevant custom, or assume possession, custody or control of, any object on or under an Aboriginal site; unless it has been authorised by the Registrar of Aboriginal Sites under sections 16 or 18 of the AHA.

The Commonwealth *Aboriginal and Torres Strait Islander Heritage Protection Act* 1984 protects places of significance to Indigenous Australians and is administered through the federal Department of Environment, Water, Heritage and the Arts. The Act offers protection for significant places or objects through ministerial decision. Aboriginal people who believe that a place or object is threatened and that state government processes offer inadequate protection can apply to the Australian Government Environment Minister to protect the place or object.

The Commonwealth *Environment Protection and Biodiversity Conservation* Act 1999 protects the environment, particularly matters of National Environmental Significance. It streamlines national environmental assessment and approvals process, protects Australian biodiversity and integrates management of important natural and cultural places.

ABORIGINAL HERITAGE MANAGEMENT PLAN (AHMP)

An AHMP generally outlines a company's cultural heritage obligations and assets, and identifies any required administrative and physical controls, e.g. policies, procedures, training, monitoring and physical barricading, to ensure appropriate management and protection of any cultural heritage within a work area. Identified controls need to be adequately rolled out to all company and contractor personnel conducting ground-disturbing activities.

Specifically, it is recommended that the Westgold NL AHMP include:

1. Information for operators on identifying archaeological and cultural material;

2. A procedure for operators to be followed in the event that any archaeological or cultural material is identified; and

3. A procedure for identification of skeletal remains.

The following procedure should be followed if *any* person (staff, contractor, sub-contractor or visitor) has reason to suspect the presence of any previously reported non-skeletal archaeological material.

1. If a suspected Aboriginal Site is encountered, work must stop immediately. The area is to be demarcated by non-intrusive methods (e.g. flagging tape, caution tape or bunting) to locate the site and prevent unauthorised entry.
2. The Site Manager (or responsible person) is to be informed immediately. The Site Manager is to contact DAA Heritage and Culture Division Perth or heritage consultant if appointed.
3. The company is to arrange for a suitably qualified archaeologist to conduct an assessment of the potential site or object, in consultation with the relevant Aboriginal communities.
4. Details of the potential site are to be recorded on a DAA site recording form and a report prepared on the assessment of the site. Both are then to be submitted to DAA.
5. Any mitigation recommended as a result of the assessment may require Section 18 consent under the AHA.
6. A suitably qualified archaeologist in consultation with the relevant Aboriginal communities should conduct any mitigation activities.

If any person has reason to suspect the presence of *human skeletal remains*, the following process must be followed. (See also http://www.DAA .wa.gov.au/Heritage--Culture/Heritage-management/Aboriginal-SkeletalAncestral-Remains/#Procedures).

1. If suspected human skeletal material is located, work must stop immediately. The area is to be demarcated by non-intrusive methods (e.g. flagging tape, caution tape or bunting) to locate the site and prevent unauthorised entry.
2. The Site Manager (or responsible person) is to be informed immediately.
3. The Site Manager is to contact the Police and the Registrar of Aboriginal Sites at DAA.
4. The Police will investigate the remains as soon as possible. The Registrar will liaise with the Police to ensure that the minimum amount of disturbance takes place before determination of whether the remains are of Aboriginal origin and not a matter for further police involvement.
5. Upon notification that the remains are of Aboriginal origin and not a matter for further police involvement, the Registrar will seek the immediate involvement of relevant Aboriginal people.
6. The Company will develop an appropriate action plan for the management of the remains, in consultation with relevant Aboriginal people and the Registrar.
7. The Registrar will ensure that the burial place is recorded and placed on the Register of Aboriginal Sites and is reported to the Commonwealth Minister for Indigenous Affairs, in accordance with the legal requirements under the *Aboriginal and Torres Strait Islander Protection Act* 1984.

If Westgold wishes to carry out further development activities on the location after a site has been located; *Section 18* consent under the AHA is required.

APPENDIX C – MAID MARION MATERIAL CHARACTERISATION REPORT

WESTGOLD
RESOURCES LIMITED

BIG BELL GOLD OPERATIONS PTY LTD

ACN 090 642 809

MEEKATHARRA GOLD OPERATIONS

MAID MARION

MATERIAL CHARACTERISATION REPORT

NOVEMBER 2019

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Appendix

EXECUTIVE SUMMARY

Westgold Resources Limited is the sole owner of the Meekatharra Gold Operation (MGO) through its subsidiary Big Bell Gold Operations Pty Ltd (BBGO). MGO covers four mining projects (Yaloginda, Paddy's Flat, Reedy and Nannine) located in the Mid-West region of Western Australia within the Murchison Mineral Field. Mining is proposed for the Maid Marion Pit located within the Paddy's Flat project area. The Maid Marion deposit and associated infrastructure is located within mining tenement M51/504.

The soil and mine waste assessment was conducted to develop a greater understanding of the chemical and physical properties of the soil materials present within the Maid Marion Project area, to identify potentially problematic soil and mine waste characteristics and to assist in the development of landform design and rehabilitation recommendations.

A summary of the physical and chemical characteristics of soil present within the Maid Marion Project area is detailed in Table ES1. A summary of the acid base accounting, physical and chemical characteristics of waste rock present within the Maid Marion Project area is detailed in Table ES2. It is intended that the information and recommendations detailed within this report be used to facilitate the development of rehabilitation and closure plans for the waste landform and other disturbance areas within the maid Marion Project area.

Soil Physical Characteristics

The soil materials within the Maid Marion Project area exhibited soil textures ranging from loamy sand to silty loam. The majority of soil materials were classed as sandy loams. Coarse material content was variable, ranging between 7.7% and 97%. The base of the weathered BIF and topsoil colluvium had the highest coarse material content.

The majority of the soil materials from the Maid Marion Project area were identified as being partially dispersive, indicating a potential susceptibility to erosion. The drainage class (saturated hydraulic conductivity) for soil material samples ranged from 'very slow' to 'moderately slow'.

Soil Chemical Characteristics

Soil pH values ($CaCl_2$) ranged between pH 4.0 (very strongly acid) and pH 6.4 (neutral). The majority of the soil materials were classed as acidic. Soil samples ranged from moderately saline to non-saline with the majority non-saline. The majority of soil materials sampled were low in organic carbon content and had low-to-moderate levels of plant-available nutrients.

50% of the soil materials assessed from the Maid Marion Project area were classified as non-sodic, with exchangeable sodium percentage (ESP) values less than 6%. However, 40% were slightly sodic and 10% moderately sodic.

Two soil samples exceeded the NEPM Ecological Investigation Limit (EIL) (National parks and areas of high conservation value) for chromium but were within the EIL for urban residential and open public spaces and commercial and industrial limits. One soil sample exceeded the National parks and areas of high conservation value EIL for nickel but was within urban residential and open public spaces and commercial and industrial limits. Some soil soils were slightly enriched in arsenic.

Waste Rock Acid Base Accounting

Maid Marion waste rock is predicted to:

- Contain negligible amounts of sulphur (<0.005 to 0.006%);
- Contain low acid neutralising capacity (ANC) (<0.5 to 14 kg H_2SO_4/t);
- The test work results indicate that under the strongly-oxidising conditions of the NAG-test work, the Maid Marion samples did not acidify; and
- All samples ae classified as Non-Acid Forming (NAF) with Net Acid Producing Potential (NAPP) values -32 to -13.45 H_2SO_4/t.

Waste Rock Physical Characteristics

Drill core samples from five different waste lithologies were assessed as part of the mine waste material assessment from the Maid Marion Project area; these were: undifferiated mafic, chert, BIF, undifferiated ultra mafic and ulta mafic schist. The Maid Marion mine waste material exhibited a range of soil textures; ranging from loamy sand (approximately 5% clay) to loams (approximately 25% clay). The majority of the mine waste material from the Maid Marion Project area was identified as being partially dispersive.

Waste Rock Chemical Characteristics

All samples are non-saline but have sodicity ranging from non-sodic to moderately sodic. Calcium and potassium levels (meq/100g) range from very low to moderate. Magnesium levels range from very low to high. The CEC ranged from very low to moderate.

One sample significantly enriched in chromium with a Global Abundance Index (GAI) of 4 and the same sample exceeding the EIL. However, the leachate of this sample is below the ANZECC

2000 Livestock Guideline Limit for all metals. Leachates from the NAF waste rock are circum-neutral to alkaline and low salinity.

Due to the low ARD risk no special management requirements would be required for ARD control of the waste rock. However, if any unexpected waste rock types or alteration types become exposed during mining further geochemical assessment would be required;

Topsoil Management

The assessment of the surface soil materials has indicated that the all soils are likely to be suitable as components of rehabilitation prescriptions. Soils within areas of disturbance should be stripped to a maximum of 0.3 m below ground level and stockpiled for rehabilitation. The key recommendations for soil stripping, handling, stockpiling and rehabilitation Include:

Soil Stripping and Handling:

Given the soil characteristics indicate that top soils may be prone to structural decline on disturbance, it is recommended that handling is minimised during stripping and stockpiling. To help maintain soil structure during stripping, the following actions are recommended:

- retain vegetation debris, rock fragments and other coarse material within upper soil profile;
- avoid soil stripping prior to or following heavy rainfall;
- machinery operators should minimise the frequency and intensity of disturbance so they do not compromise the structural integrity of the material (i.e. minimise double handling and relocation of materials during mine life); and
- soil stripping should occur as close as possible to the time when the proposed disturbance is scheduled to commence.

Soil stockpiling:

To assist in the preservation of topsoil resources during mine life, the following actions are recommended for soil stockpiling:

- stockpile dump height should be a maximum of two meters above ground level, with piles separated by an adequate distance such that a series of mounds and troughs are created and the crossover of soil between the piles are up to approximately 1 m depth;
- depending on the rate of volunteer germination of the topsoil seed store following stockpile construction, stockpiles can be re-seeded with local provenance species to further improve soil structural stability and biological function; and

- minimise trafficking and disturbance of the stockpiles to prevent compact and erosion of the stockpiled soils.

Use of Soil Resources in Rehabilitation

Waste rock landforms should ideally be designed to emulate natural processes of the landscape as best as possible. This will help that the soil profiles effectively regulate the transfer and storage of water and nutrients within different areas of the landform, minimise erosion and promote the establishment of vegetation within target areas. The extent to which this can be practically achieved will be dependent on the nature and placement of the mine waste materials and design of the waste rock landforms.

It is recommended that available soil resources are concentrated on the flat surfaces of waste landforms, e.g. upper surface and berms. Application of soils to constructed slopes should be armoured with competent fresh waste rock and contour ripped to minimise erosion as far as practicable.

In summary, the waste rock to be removed as part of the mining of Maid Marion has been classified as NAF, but with the potential to contain some dispersion. Landform design is a critical element in minimising the incidence of erosion. Erosion occurs when energy of raindrop impact and lateral surface water movement is sufficient to dislodge and transport soil particles down slope. The likelihood of erosion is strongly correlated with slope length and slope angles and is affected by soil properties. Critical soil physical properties include the capacity to accept infiltration and the soil's structural strength that can provide resistance to dislodgement. Therefore, the focus of the landform design in reconstructing the Maid Marion topography will be to minimise slope length and angle. As part of this approach, soil and waste materials most likely to resist erosion, while providing acceptable growth medium for vegetation, will be selected for outer surfaces.

The waste units considered most likely to offer erosion resistance, together with adequate retention of soil water and the capacity to support vegetation growth will be selected for placement on the outer surface of the backfilled landforms prior to topsoil placement. Important parameters to be assessed will include the proportion of coarse rock material in the as-mined waste and the particle size distribution of the fine fraction, the sodicity and associated degree of clay dispersion, pH and electrical conductivity.

In constructing the waste rock landform, key elements will be to reconstruct a soil profile that not only has suitable physical and chemical fertility to support vegetation cover, but one that is also resistant to erosion. This will be achieved through selection of appropriate waste materials to make up the growth medium on the outer surface of the landforms and through salvaging local topsoil where practicable and re-spreading it as the final layer. Material selection for outer layers of the landform will especially focus on waste materials that have a substantial competent coarse fraction and where sodicity of the fine fraction is as low as possible.

TABLE ES1

Soil ID	Physical characteristics					Chemical characteristics							
	Soil Texture	Gravel content (%)	Colour	Emerson Class	Hydraulic conductivity (mm/hr)	pH	Salinity class (dS/m)	Organic Carbon (%)	Organic matter	Nutrient status	CEC	ESP (%)	Metals
CGC08926	Sandy loam	53	Red orange	2	Very low	Strongly acid	Non-saline	Extremely low	Extremely low	Adequate N, P, K, S	Very low	Non-sodic	
CGC08927	Sandy Loam	18	Red orange	2	Extremely low	Very strongly acid	Non-saline	Extremely low	Extremely low	Adequate N, P, K, S	Very Low	Slightly sodic	
CGC08928	Sandy Loam	33	Red orange	2	Very low	Very strongly acid	Non-saline	Very low	low	Adequate N, P, K, S	Very Low	Non-sodic	
CGC08929	Sandy Loam	97	Red orange	ns	Very low	Moderately acid	Non-saline	Extremely low	Extremely low	Adequate N, P, K, S	Very Low	Slightly sodic	
CGC08930	Sandy Loam	18	Red orange	1	Very low	Neutral	Non-saline	Extremely low	Extremely low	Adequate N, P, K, S	Very Low	Slightly sodic	
CGC08931	Silty Loam	23	Red orange	2	Very low	Neutral	Moderately-saline	Extremely low	Extremely low	Adequate N, P, K, S	Very Low	Slightly sodic	
CGC08934	Sandy Loam	11	Pale green	2	Very low	Neutral	Slightly -saline	Extremely low	Extremely low	Adequate N, P, K, S	Low	Non sodic	High Ni
CGC08935	Sandy Loam	7.7	Red orange	2	Very low	Strongly acid	Non-saline	Extremely low	Extremely low	Adequate N, P, K, S	Very Low	Non sodic	
CGC08936	Sandy Loam	15	Red orange	2	Low	Moderately acid	Non-saline	Extremely low	Extremely low	Adequate N, P, K, S	Very Low	Slightly sodic	
CGC08937	Sandy Loam	15	Red orange	2	Very low	Slightly acid	Non-saline	Extremely low	Extremely low	Adequate N, P, K, S	Very Low	Moderately sodic	
CGC08938	Sandy Loam	16	Red orange	2	Very low	Very strongly acid	Non-saline	Extremely low	Extremely low	Adequate N, P, K, S	Very Low	Non sodic	High Cr
CGC08939	Sandy Loam	12	Red orange	2	Low	Very strongly acid	Non-saline	Extremely low	Extremely low	Adequate N, P, K, S	Very Low	Non sodic	High Cr

Table ES2

Sample ID	Paste pH	EC	Total S %	ANC	NAPP	NAG pH	ABA classification	Enriched	Emerson	Hydraulic conductivity	Sodicity	CEC	Dispersion
CMR84961	Neutral	Non-saline	negligible	Low	-2.35	6.0	NAF		2(1)	slow	Moderately sodic	Very low	Class 1
CMR84963	Neutral	Non-saline	negligible	Low	-0.35	6.0	NAF		2(1)	very slow	Slightly sodic	Very low	Class 2A
CMR84965	Moderately acid	Non-saline	negligible	Low	-0.32	5.2	NAF		6	slow	Moderately sodic	Very low	Class 1
CMR84967	neutral	Non-saline	negligible	Low	-0.35	6.1	NAF		2(1)	extremely slow	Slightly sodic	Very low	Class 2A
CMR84969	neutral	Non-saline	negligible	Low	-2.85	7.5	NAF		2(1)	very slow	Non-sodic	Low	Class 2A
CMR84971	Moderately alkaline	Non-saline	negligible	Low	-2.35	6.2	NAF		3(1)	very slow	Non-sodic	Low	Class 2A
CMR84973	Moderately alkaline	Non-saline	negligible	Low	-13.85	8.0	NAF	Cr	3(1)	slow	Non-sodic	Moderate	Class 2A
CMR84975	neutral	Non-saline	negligible	low	-1.15	6.4	NAF		3(1)	moderately slow	Slightly sodic	Very Low	Class 1

1.0 INTRODUCTION

Westgold Resources Limited is the sole owner of the Meekatharra Gold Operation (MGO) through its subsidiary Big Bell Gold Operations Pty Ltd (BBGO). MGO covers eight mining projects (Yaloginda, Paddy's Flat, Reedy and Nannine) located in the Mid-West region of Western Australia within the Murchison Mineral Field (Figure 1).

Mining is proposed for the Maid Marion Pit located at Meekatharra North. The Maid Marion deposit and associated infrastructure is located within mining tenement M51/504. Proposed site layout presented (Figure 2).

1.1 Objectives

Objectives of this study were to:

- Compile a material characterisation report as part of an ongoing requirement for progressive waste and soil characterisation as part of the project's Mine Waste Management Plan;
- Evaluate the potential for acid, neutral and metalliferous drainage (AMD) to form in various waste materials;
- Evaluate the potential for waste material examined to be dispersive; and
- Classify waste types based on their potential to generate AMD according to procedures published by the Federal Department of Industry, Tourism and Resources (DITR, 2007).
- Characterise the undisturbed surface soil materials (to 0.22m depth) within the Maid Marion project area to identify problematic soil materials that may require targeted management strategies during completion of rehabilitation activities.

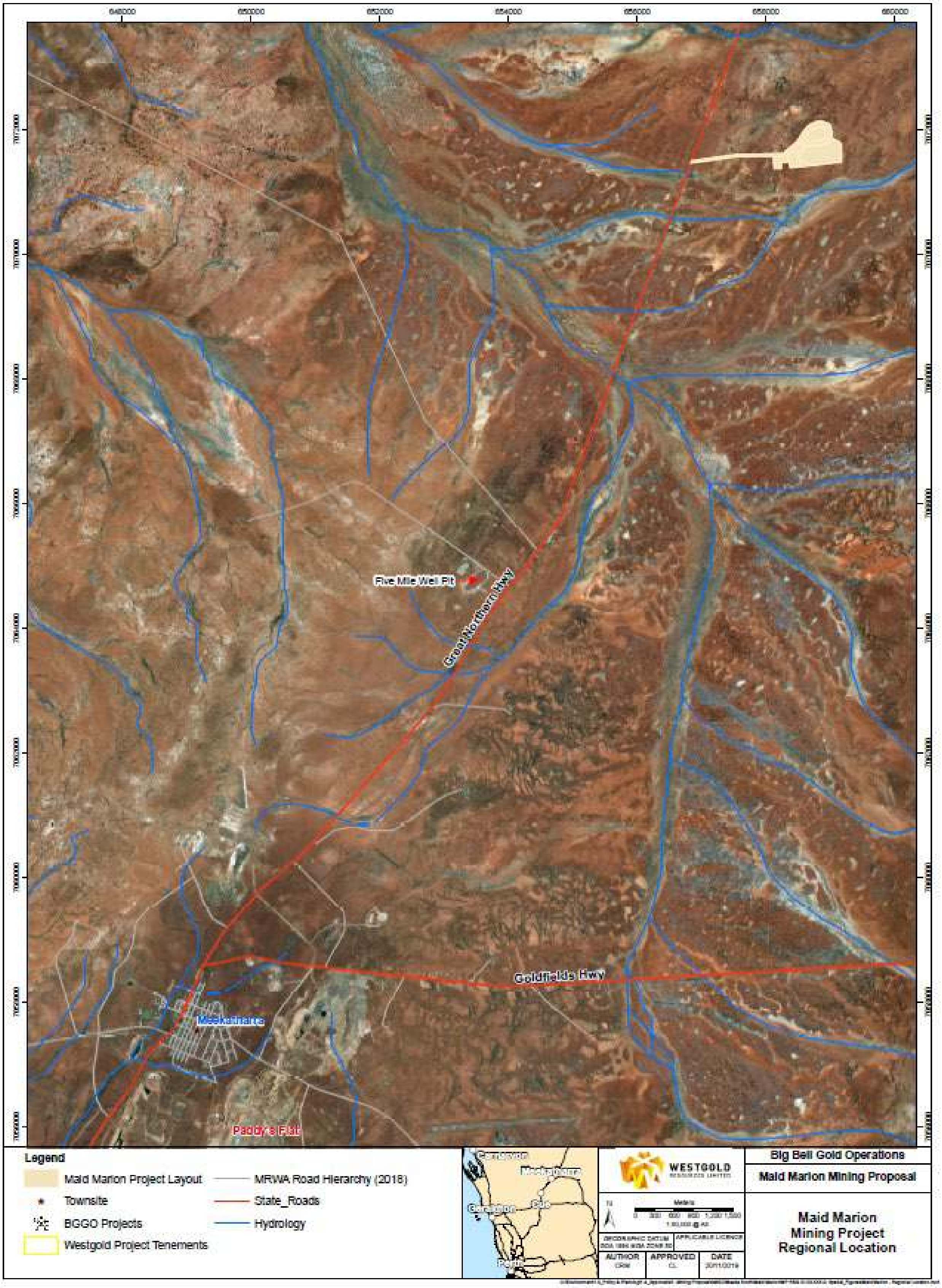

Figure 1: Maid Marion Regional Location

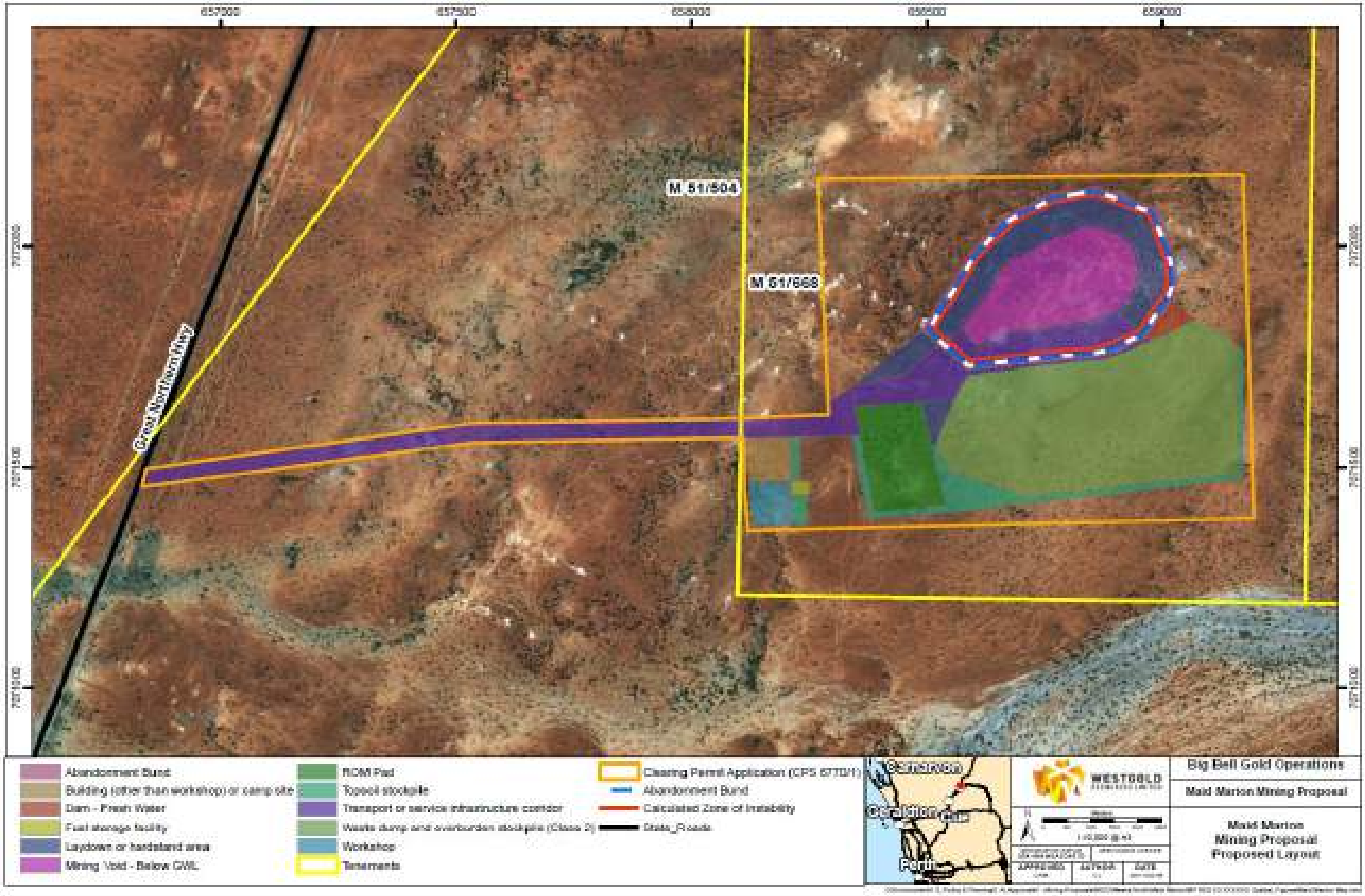

Figure 2: Maid Marion Proposed Site Layout

2.0 ENVIRONMENTAL SETTING

2.1 Climate

The Murchison region is described as an arid climate characterised by summer and winter rainfall with annual totals rarely exceeding 200 millimetres (mm) (Beard 1990). The nearest weather station that collects relevant climate data is Meekatharra Airport (station number 007045), located 4.5 km east of Meekatharra (BoM 2019). The weather station has been operational since 1944.

The average annual rainfall for Meekatharra is 237.9 mm per annum, while the median is 218.4 mm per annum. The majority of the rain falls between January and August, although it is sporadic with annual monthly totals rarely exceeding 30 mm. The rainfall during the winter months is considered to be more reliable and is associated with cold fronts moving from the south of the State. The rainfall during the summer months is more sporadic, although heavier resulting in large flooding events across the landscape. The summer rainfall is associated with thunderstorm bands and ex-tropical cyclones that influence the Pilbara coastline and move in a south-easterly direction across the State (BoM 2019).

The hottest months are from November to March, with average maximum temperatures exceeding 29°C, while minimum temperatures exceed 15.9°C (BOM, 2019). The coldest months are June to August, where the average minimum temperatures fall below 10°C, while the maximum daily temperatures rarely exceed 25°C (BoM 2019). The long term climatic conditions at the Meekatharra Airport weather station are provided in Figure 3.

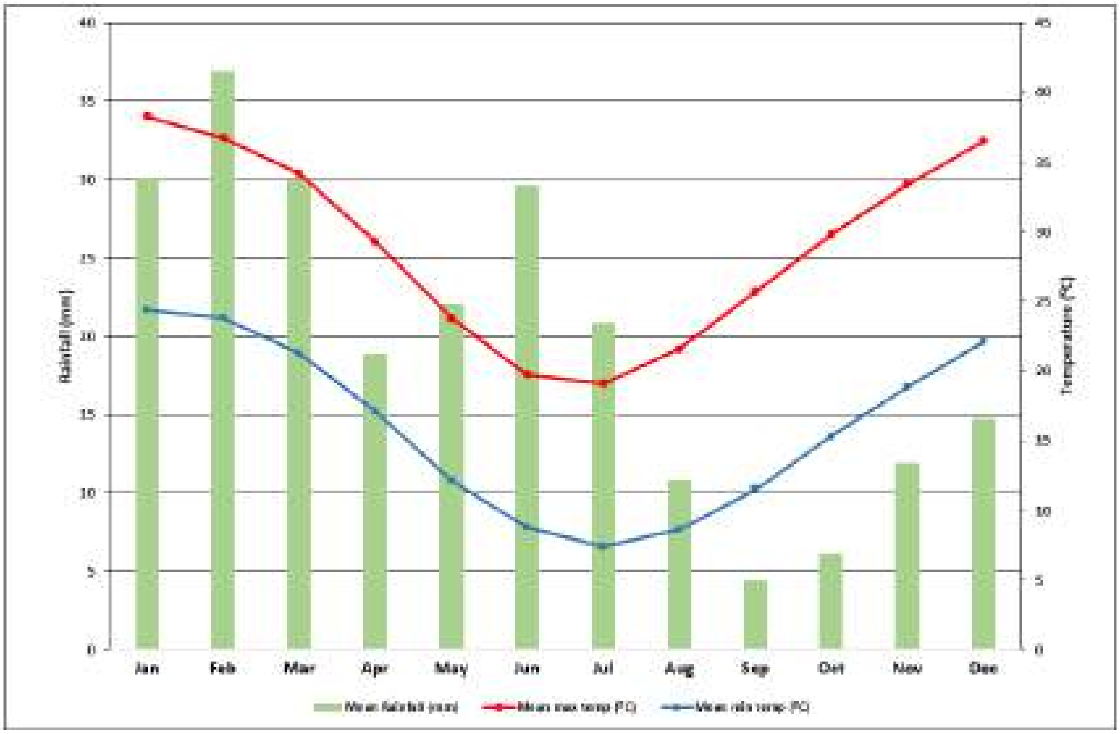

Figure 3: Meekatharra Airport Weather Station (007045) Long Term Climatic Conditions

2.2 Geology

The Maid Marion project is situated within the Meekatharra – Wydgee Greenstone Belt and is located in the Murchison domain of the Youanmi Terrane, in the north-western part of the Yilgarn Craton of Western Australia. The province is about 100,000km^2 in area, less than 5% of which is exposed rock. Much of the outcrop is affected by deep weathering and the landscape is generally flat and monotonous with a semi-arid climate.

The Murchison Domain (Figure 4) is comprised of narrow Archaean greenstone belts surrounded by large granitoid and gneissic complexes (Van Kranendonk and Ivanic, 2009, Watkins and Hickman, 1990). Abundant mafic dykes of predominantly Mesoproterozoic age crosscut major structures (Wingate and Pirajno, 2004). Recent geochronological studies undertaken in the Murchison Domain show that most felsic intrusive and granitic rocks were emplaced or deposited between C.3000 and 2600 Ma (Pidgeon and Hallberg, 2000; Timms, 2007; Van Kranendonk and Ivanic, 2009). Many of the granitoids in the area are covered by moderate to thick alluvium and lacustrine sediments. The remainder of the area has a thin transported cover.

The Maid Marion area lies on the western limb of a regional north-plunging synform; the Pollele Syncline (Timms *et al.*, 2011) and rocks typically dip steeply to the east. The large NNE–SSW

Meekatharra Shear Zone runs along the western side of the Project area and bounds the greenstone belt from granitoid rocks to the west.

The local geology has been deformed in the nose of a smaller antiform within the larger Pollele Syncline. The antiform swings from a NE orientation to a distinctly E–W orientation where the inferred antiform is heavily faulted. The Project area features high-Mg basalts, BIF, talc schist, various metasedimentary rocks and is bounded to the west by granitic rocks. Quartz veining is common throughout the area.

Weathering in the area is commonly deep, except around cherty BIF and quartz veins that outcrop in the western part of the Project. Exploration drilling shows that the base of oxidation extends to more than 100m depth in some areas. The deep weathering appears most intense south of a jog in the Meekatharra Shear Zone through the centre of the project area. The immediate pit area features weathered BIF and Mafic schist.

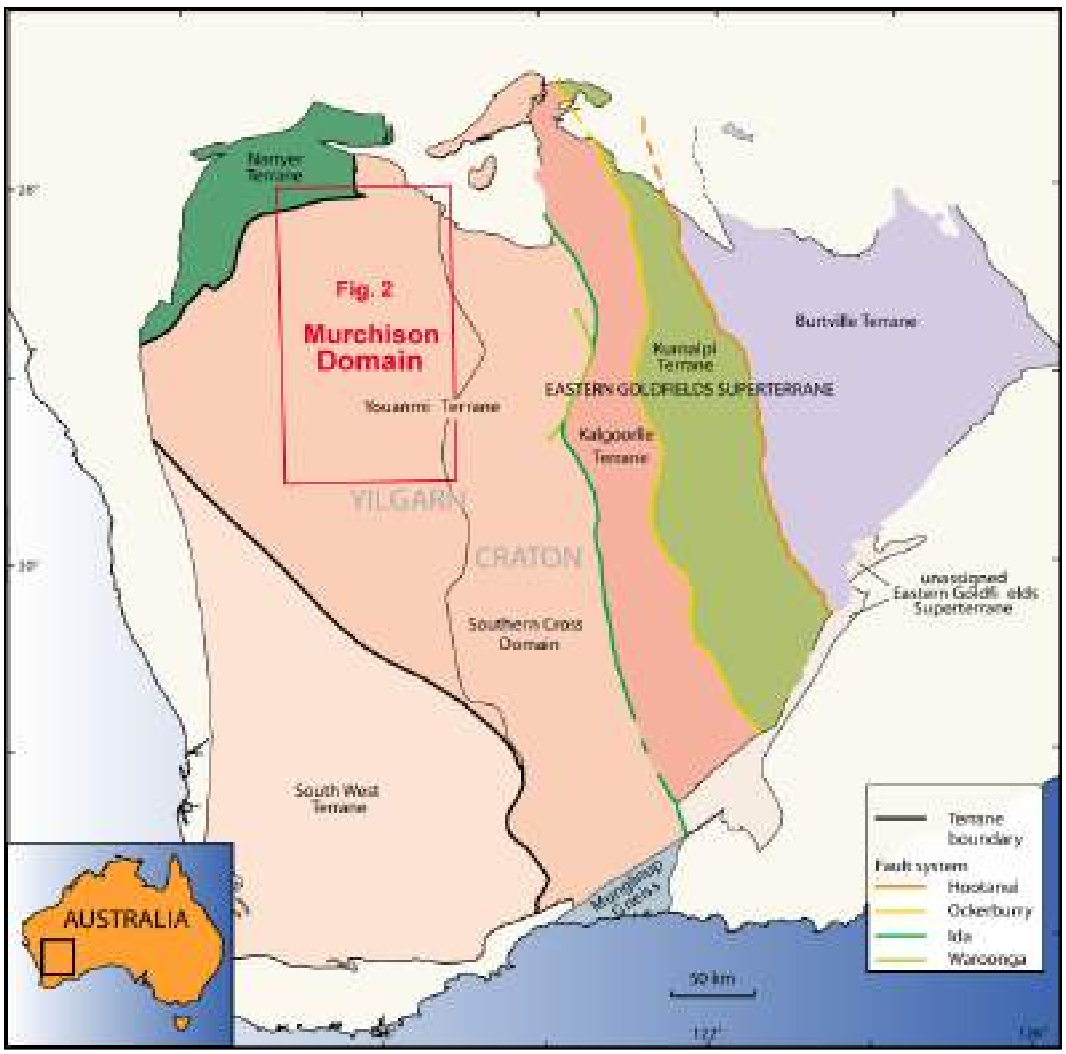

Figure 4: Regional Geology

2.3 Hydrogeology

2.3.1 Geology and Hydrogeology

Maid Marion is part of the Meekatharra–Wydgee Greenstone Belt that features high-Mg basalts, BIF, talc schist, and various metasedimentary rocks (Figure 5). Exploration drilling has shown that weathering in the area is frequently deep (>50m deep). RPS (2019) interpreted the Base of complete oxidation (BOCO) data to create an interpreted weathering surface for the project area (Figure 6).

The geology and weathering profile are typical of a fractured-rock aquifer in the Goldfields. This aquifer is developed in secondary porosity formed in otherwise impermeable rock. Highest yields from the aquifer are found towards the base of the weathering profile in the lower saprolite and saprock. The geology also tends to influence yield, with fractures tending to stay clean and open in granitic rocks and in mafic/ultramafic areas the fractures tend to fill with clay and are less productive. Importantly, BIF can be impermeable and low-yielding (where fresh) or highly permeable and high-yielding (where weathered or fractured). The interpreted weathering surface in Figure 6 suggests that weathering in the pit area extends to the pit floor throughout much of the pit.

This interpretation shows that the pit area features potentially high-conductivity BIF adjacent to low-conductivity weathered mafic schist. The BIF is likely to release water easily, but the thick clay beds associated with the weathered mafic schist will not release water as quickly.

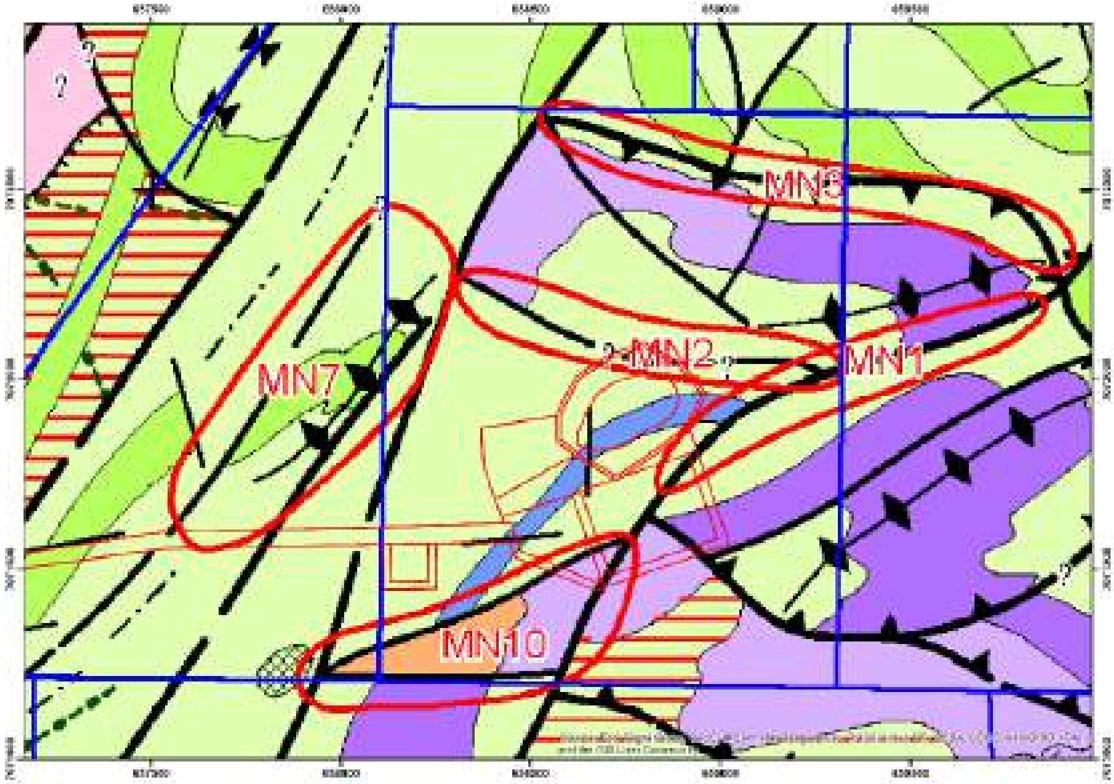

Figure 5: Maid Marion Geology

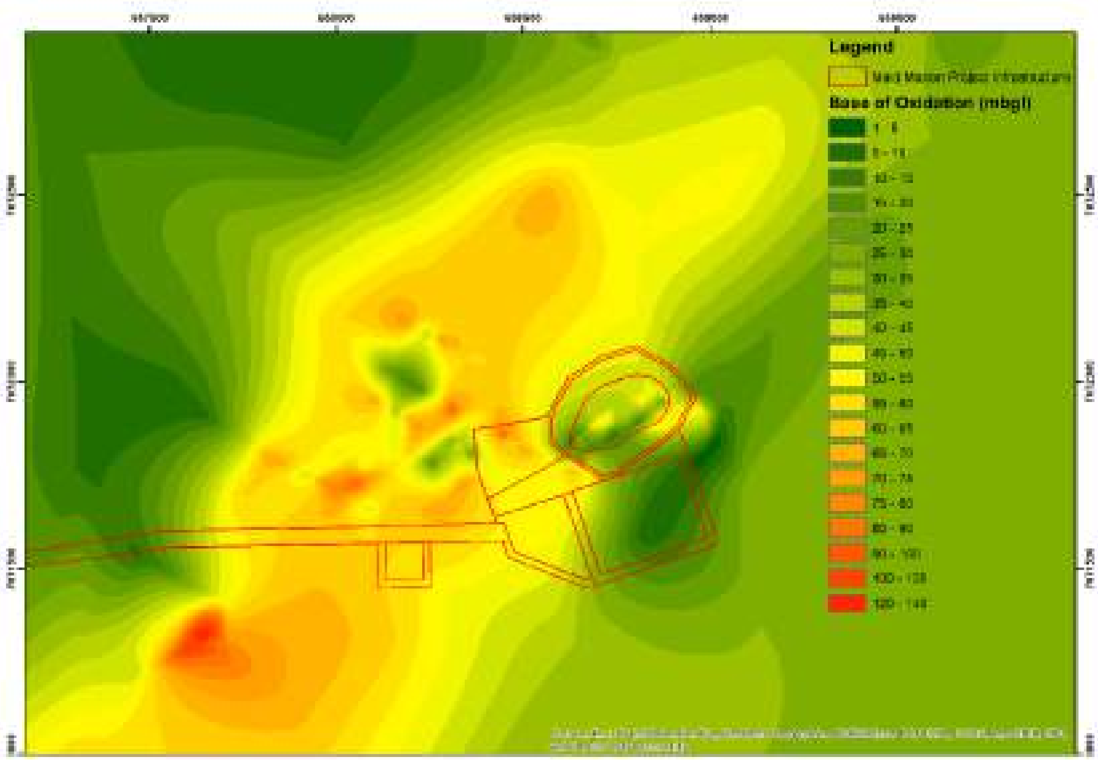

Figure 6: Interpreted Base of Complete Oxidation

2.3.2 Surface Water

The terrain is generally a flat undulating area and drainage within the infrastructure areas can be characterised as sheet flow towards the west. A creek 400m south of the infrastructure areas flows west and beneath Great Northern Highway via culverts. The mine site is in a generally flat area and is not subject to impact from significant external runoff. The project area lies at the top of the catchments and as such surface flows will be localised and small.

2.3.3 Groundwater

Groundwater is alkaline, fresh to marginal and dominated by sodium-chloride ions (Figure 7). Nitrate, aluminum, cadmium, iron, lead, manganese and mercury are the level of reporting (Figure 8).

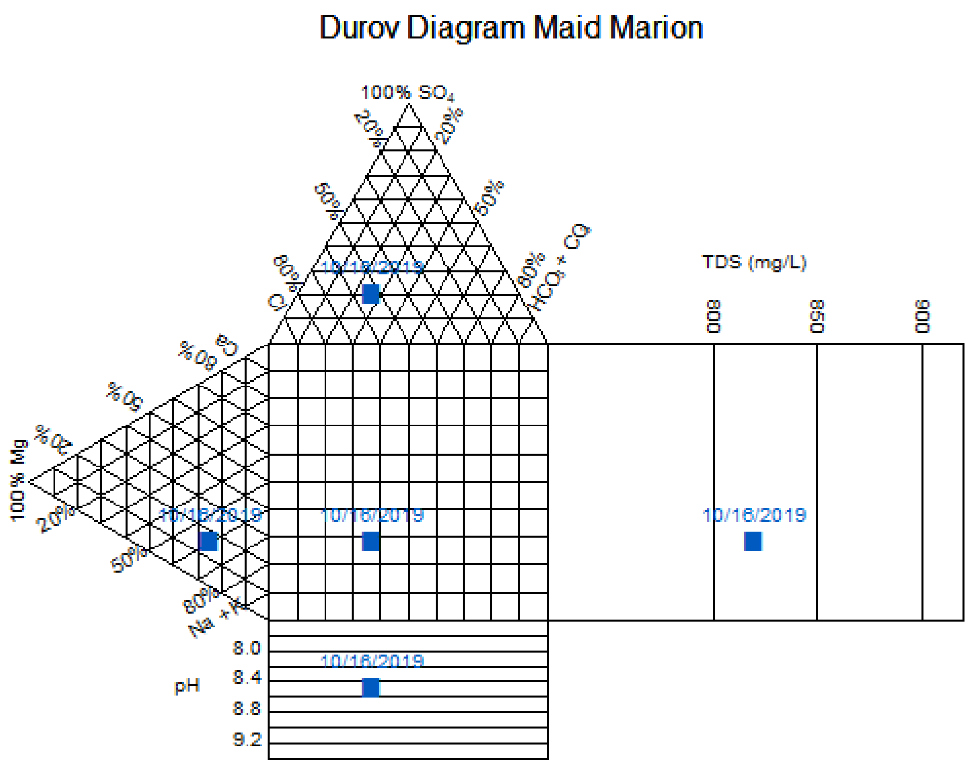

Figure 7: Durov Diagram Maid Marion Groundwater

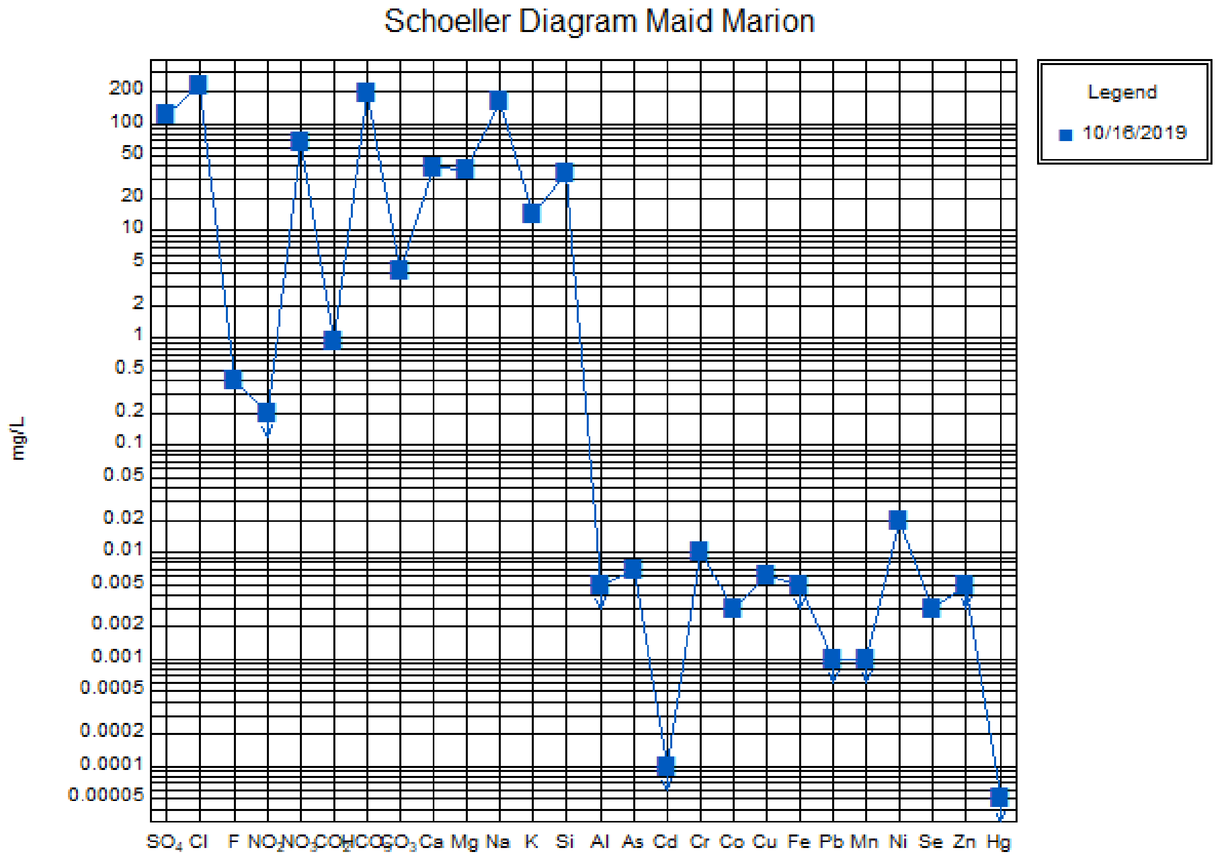

Figure 8: Schoeller Diagram Maid Marion. Arrow denotes detection limit

3.0 METHODOLOGY

3.1 Acid Forming Waste Classification Methodology

There is no simple method to define whether mine waste containing small quantities of Sulphur will produce sulphuric acid. Sulphide minerals are variable in their behaviour under oxidising conditions and not all forms will produce sulphuric acid (H_2SO_4). Instead, a combination of approaches is often applied to more accurately classify mine waste. These approaches are listed below in order of increasing data requirements (and therefore increased reliability):

- The “Analysis Concept”, which only requires data for total sulphur content. Its adoption is based on long term experience of wastes from Western Australian mine sites in arid and semi-arid conditions. Experience has shown that waste rock containing very low Sulphur contents (less than 0.2 to 0.3%) rarely produces significant amounts of acidic seepage. The climatic conditions experienced at Maid Marion are similar to several mine sites in the northwest of Western Australia;
- The “Ratio Concept” which compares the relative proportions of acid neutralising minerals (measured by the Acid Neutralising Capacity (ANC)) to acid generating minerals (measured by the Maximum Potential Acidity (MPA)). Experience has shown that, the risk of generating acidic seepage is generally low when this ratio (the Neutralisation Potential Ratio – NPR) is above a value of two;
- Acid-Base Accounting, in which the calculated value for Net Acid Producing Potential (NAPP) is used to classify the acid generating potential of mine waste. NAPP is equal to MPA minus ANC;
- Procedures recommended by AMIRA (2002), which take into consideration measured values provided by the Net Acid Generation (NAG) test and calculated NAPP values;
- Kinetic leaching column test data, which provides information for the relative rates of acid generation under controlled laboratory conditions, intended to simulate those within a waste rock stockpile or tailings storage facility.

Classification of wastes undertaken in this report uses procedures recommended by AMIRA (2002) based on NAPP and NAG pH results. However results are also compared to the Analysis Concept (total sulphur) and Ratio Concept models by determination of the following:

- Analysis for total Sulphur;
- Analysis for Acid Soluble Sulphur (SHCL);
- Analysis for ANC (quoted in kg H_2SO_4/t);

- Calculation of MPA = [(Total Sulphur) * 30.6] kg H_2SO_4/t;
- Calculation of NAPP = [MPA – ANC] kg H_2SO_4/t;
- Analysis for NAG (quoted in kg H_2SO_4/t);
- Analysis for NAG pH; and
- Calculation of NPR = ANC/MPA.

This AMIRA approach is more conservative than either the Analysis Concept or the Ratio Concept alone, but assumes the absence of barium sulphate sulphur. The AMIRA approach of using NAG testing is particularly useful for PAF-LC materials or where there is very low ANC in the host rock. A combined acid generation classification scheme based on NAPP and NAG determinations is presented in Table 1.

Table 1 is based on the Australian Government's Guidelines on Managing Acidic and Metalliferous Drainage (DITR 2007) and is in turn based on an earlier classification system included within the AMIRA ARD Test Handbook (AMIRA 2002), which is advocated by the Global Acid Rock Drainage Guidelines (GARD) published by the International Network for Acid Prevention (INAP 2009). This classification system, based on static acid base accounting procedures and used in conjunction with geological, geochemical and mineralogical analysis can still leave materials classified as 'uncertain' where there is conflicting NAG pH and NAPP results. Uncertain materials demonstrating a NAG pH above 4.5 may be tentatively assigned as potentially NAF and those below pH 4.5 as potentially PAF. However, in such cases, further assessment, such as the use of kinetic leaching columns may be required to provide a definitive classification.

Table 1: Classification Criteria

Classification	NAPP (kg H_2SO_4/t)	NAG pH	Sulphide %
Potentially Acid Forming (PAF)	≥10	<4.5	≥0.3%
Potentially Acid Forming – Low Capacity (PAF-LC)	0 to 10	<4.5	0.16 to 0.3%
Uncertain (UC)	0 to 5	>4.5	Not important
Uncertain (UC)	-10 to 0	<4.4	Not important
Non Acid Forming (NAF)	-100 to 0	>4.5	Not important
Acid Consuming Materials (AC)	>-100	>4.5	Not important

3.2 Elemental Composition

Environmentally significant metals and metalloids were measured following digestion of a finely ground sample with a mixture of nitric and hydrochloric in a ratio of 3:1 (reverse aqua regia) which is a near total determination for the elements measured. Digest solutions were analysed for a general suite of potential toxicants determinable via ICP-OES). Samples were analysed for arsenic (As), chromium (Cr), copper (Cu), lead (Pb), nickel (Ni), and zinc (Zn). From this data, the global abundance index (GAI) for each element was calculated by comparison to the average earth crustal abundance (Bowen 1979 and AIMM 2001). The main purpose of the GAI is to provide an indication of any elemental enrichment that could be of environmental significance. The GAI (based on a log-2 scale) is expressed in integer increments from zero to six (GARD Guide). A GAI of zero indicates that the content of the element is less than or up to three times the average crustal abundance; a GAI of one corresponds to a three to six fold enrichment; a GAI of two corresponds to a six to 12 fold enrichment and so forth, up to a GAI of six which corresponds to a 96-fold, or greater, enrichment above average crustal abundances. A GAI of more than three is considered significant and may warrant further investigation.

Site contamination assessments in all Australian states and territories are conducted in accordance with guidelines and methodology provided in the 1999 National Environment Protection Measure (NEPM), Assessment of Site Contamination (NEPC 2013). An important component of the Measure is inclusion of guideline values for assessing soil, sediment and water quality based on Australian and reputable international ecotoxicology and human health data.

An amendment of the 1999 NEPM Contaminated Sites Schedules was undertaken in 2013. The amended NEPM for soils does not assume fixed criteria for each metal as per the earlier 1999 version, but rather for metals with available toxicology and bioavailability data, calculates an EIL based on an added contaminant level (ACL) plus the ambient background concentration (ABC). The ABC determination requires measurement of appropriate background reference samples, which recognise that soil from naturally mineralised areas, especially minesites, may contain elevated concentrations of metals and metalloids that do not adversely impact endemic vegetation and fauna. An ACL value is then calculated for each metal on the basis of soil characteristics including cation exchange capacity (for copper, nickel and zinc) and/or soil pH (for copper and zinc) and thus varies with each soil type. The ACL for lead (and arsenic) is fixed for each land-use type (three categories) and associated levels of environmental sensitivities. This calculation is outlined in NEPM 2013, Schedule B1 (NEPC 2013). EILs thus vary with analyte, soil properties and assigned land use category (ecological significance, urban areas/public open space or commercial/industrial).

Leachate tests employed in this study are based on accepted procedures for the characterisation of mine wastes, including leaching using de-ionised water in accordance with Australian Standard Leaching Procedures (ASLP). Leach solutions were analysed for metals (Zn, As, Cr, Ni, Cu, Pb).

3.3 Physical Stability

The structural stability of a material and its susceptibility to structural decline is complex and depends on the net effect of a number of properties, including the amount and type of clay present, organic matter content, material chemistry and the nature of disturbance. Material aggregates that slake and disperse indicate a weak material structure that is easily degraded. These materials should be seen as potentially problematic when used for the reconstruction of material profiles for rehabilitation, particularly if left exposed at the surface.

The Emerson Aggregate Test identifies the potential slaking and dispersive properties of material aggregates. The dispersion test identifies the properties of the materials under a worst case scenario, where severe stress is applied to the material. Generally, samples allocated into Emerson Classes 1 and 2 are those most likely to exhibit dispersive properties and therefore are the most problematic.

3.4 Laboratory Analysis

A NATA Accredited Laboratory (SGS Perth Environmental) was engaged for sample analysis. The methods of measurement for each parameter are described in Table 2.

Table 2: Laboratory Analysis

Parameter	Method	Methodology Summary
Acid Neutralising Capacity (ANC)	AN212	Samples are initially evaluated to determine the strength of reagents needed using a ` 'fizz' test. Samples are then subjected to an excess of hydrochloric acid followed by alkaline back titration to pH 7. Results are expressed in kg $H2SO_4$/tonne or kg $CaCO_3$/tonne after correction for moisture content if applicable.
Total Sulphur (%), Sulphate-Sulphur (SO_4-S) (%)	AN014	This method is for the determination of soluble sulphate (SO_4-S) by extraction with hydrochloric acid. Sulphides should not react and would normally be expelled. Sulphur is determined by ICP.
Metals: As, Ni, Pb, Zn, Cu, Cr	AN320, AN321	Samples are preserved with 10% nitric acid for a wide range of metals and some non-metals. This solution is measured by Inductively Coupled Plasma. Solutions are aspirated into an argon plasma at 8000-10000K and emit characteristic energy or light as a result of electron transitions through unique energy levels. The emitted light is focused onto a diffraction grating where it is separated into components.

Parameter	Method	Methodology Summary
		Photomultipliers or CCDs are used to measure the light intensity at specific wavelengths. This intensity is directly proportional to concentration. Corrections are required to compensate for spectral overlap between elements. Reference USEPA3050, USEPA6010C and APHA 3120 B.
Exchangeable cations: Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}	AN122	Exchangeable Cations, CEC and ESP: Soil sample is extracted in 1M Ammonium Acetate at pH=7 (or 1M Ammonium Chloride at pH=7) with cations (Na, K, Ca, Mg) then determined by ICP OES/ICP MS and reported as Exchangeable Cations. For saline soils, these results can be corrected for water soluble cations and reported as Exchangeable cations in meq/100g or soil can be pre-treated (aqueous ethanol/aqueous glycerol) prior to extraction. Cation Exchange Capacity (CEC) is the sum of the exchangeable cations in meq/100g. The Exchangeable Sodium Percentage (ESP) is calculated as the exchangeable sodium divided by the CEC (all in meq/100g) times 100. ESP can be used to categorise the sodicity of the soil as: • ESP < 6% non-sodic • ESP 6-15% sodic • ESP >15% strongly sodic Method is referenced to Rayment and Lyons, 2011, sections 15D3 and 15N1.
pH 1:2, pH 1:5, pH ($CaCl_2$)	AN101	pH is measured electrometrically using a combination electrode and is calibrated against 3 buffers purchased commercially. For soils, sediments and sludges, an extract with water (or 0.01M $CaCl_2$) is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+
Electrical Conductivity (EC) and Total Dissolved Solids (TDS)	AN106	Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos/cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Salinity can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. Reference APHA 2510 B. Resistivity of the extract is reported on the extract basis and is the reciprocal of conductivity. Salinity and TDS can be calculated from the extract conductivity and is reported back to the soil basis.
Total Organic Carbon	CSA03V	Carbon is determined via infra-red absorption of the evolved CO_2 gases after heating the sample in a carrier gas of oxygen. The IR cal output is calibrated against the value of the known standards to provide the total carbon value of the unknown sample.
Iron (Fe) by Aqua Regia	ICP12S	Sample solutions (from Aqua Regia digest) are analysed by Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) against matched standards.

Parameter	Method	Methodology Summary
Net Acid Generation (NAG) and NAG pH to 4.5 and 7	AN216	Pulverised sub-sample of a waste rock or an as received sample of filter cake, soil or sludge is subjected to an oxidising digest with 15% hydrogen peroxide adjusted to pH 4.5. The pH and EC of the NAG suspension is recorded at various stages in the digest. The acid produced (if any) is titrated using standardised NaOH to pH 7.0. NAG results are reported to 0.5 kg $H2SO_4$/tonne.
Emmerson Aggregate Test	AN009	The method follows AS1289 3.8.1 - 2006. Soils are divided into seven classes on the basis of their coherence in water, with one further class being distinguished by the presence of calcium-rich minerals. • Class 1: Air-dried crumbs of soil show a strong dispersion reaction, i.e., a colloidal cloud covers nearly the whole of the bottom of the beaker, usually in a very thin layer. The reaction should be evident within 10min. In extreme cases all the water in the beaker becomes cloudy, leaving only a coarse residue in a cloud of clay. • Class 2: Air-dried crumbs of soil show a moderate to slight reaction. A moderate reaction consists of an easily recognisable cloud of colloids in suspension, usually spreading in thin streaks on the bottom of the beaker. A slight reaction consists of the bare hint of cloud in water at the surface of the crumbs. • Class 3: The soil remoulded at the plastic limit disperses in water. • Class 4: The remoulded soil does not disperse in water. Calcium carbonate (calcite) or calcium sulphate (gypsum) is present. • Class 5: The remoulded soil does not disperse in water and the 1:5 soil/water suspension remains dispersed after 5 min. • Class 6: The remoulded soil does not disperse in water and the 1:5 soil/water suspension begins to flocculate within 5 min. • Class 7: The air-dried crumbs of soil remain coherent in water and swells. • Class 8: The air-dried crumbs of soil remain coherent in water and do not swell.
Australian Standard Leaching Procedure (ASLP) for As, Ni, Pb, Zn, Cu, Cr, pH, EC	AN007	Contaminants of interest in a waste material are leached out of the waste with a selected leaching solution under controlled conditions. The ratio of sample to extraction fluid is 100 g to 2 L (1 to 20 by mass). The concentration of each contaminant of interest is determined in the leachate by appropriate methods after separation from the sample by filtering. Based on AS4439.3.
% clay, % sand, %silt	AN005	The particle size distribution of a soil is determined by wet sieving, using a maximum of 900 mL of deionised water to sieve all fractions down to 75 µm. Referenced to AS1289.3.6.1 and AS1141.11.

Parameter	Method	Methodology Summary
Saturated Hydraulic Conductivity (Ksat mm/hr)	AN036	The <10mm sieved soil is lightly compacted in a plastic cylinder which has a drainage mesh at the bottom. The soil is saturated overnight and then the permeability (cm/hr) is measured under a constant head of 6 cm of water. The permeability is calculated using Darcy's law for saturated vertical flow.
% Moisture	AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.

3.5 Sample Descriptions

3.3.1 Waste Samples

Waste sample description and location shown Table 3 and Figure 9.

Table 3: Waste rock samples descriptions

Sample ID	Depth (m)	Colour	Weathering	Regolith	Lithology
CMR84961	3 - 4	Brown	Oxidised	Saprolite	Undifferiated mafic
CMR84963	46 - 47	Purple	Oxidised-transitional	Saprock	Chert
CMR84965	4 - 5	Dark grey	Transitional	Saprock	BIF
CMR84967	55 - 56	Olive	Oxidised	Clay	Undifferiated ultra mafic
CMR84969	39 - 40	Olive	Oxidised-transitional	Saprock	Undifferiated ultra mafic
CMR84971	16 - 17	Brown yellow	Oxidised	Saprolite	Mafic volcanic
CMR84973	71 - 72	Green	Transitional	Saprock	Ultra mafic schist
CMR84975	26 - 27	Brown	Transitional	Saprock	BIF

Figure 9: Maid Marion Waste Rock Sample Locations

3.3.2 Soil Samples

Soil sample description provided Table 4 to Table 7 and locations provided Figure 10.

Table 4: Description Maid Marion Soil 1

Image	Description			
	**MAID MARION SOIL 1**	**Coordinates**	658,672E 7,071,899N	
	Depth	**Material**	**Sample ID**	**Description**
	0 – 40 mm	Topsoil colluvium	CGC08926 CGC08947	Red/Orange topsoil partially layered texture. Angular gravels at about 5%. Root abundances classified as 'few' and 'fine', loose, non- binding roots present, 1mm in thickness.
	40 – 100mm	Sandy gravels	CGC08927 CGC08948	Red/Orange sub soil. Unconformed angular gravels (70%). Moderate root systems, semi binding, 3mm thick.
	100 -135mm	Coarse gravels	CGC08928 CGC08949	Red/orange coarse angular gravels (90%). Moderate roots systems, semi binding, 3 mm thick.
	135 – 185mm	Saprolite BIF	CGC08929 CGC08950	Base of soil. Weathered BIF.
	**Surface Description**			
	BIF rubble with sands, gravels and colluvium. Moderate slope to the west, minor erosion			
	Vegetation Description			
	Moderate coverage of small mulga trees			
				

Table 5: Description Maid Marion Soil 2

Image	Description			
	**MAID MARION SOIL 2**	**Coordinates**	658,787E 7,071,877N	
	Depth	**Material**	**Sample ID**	**Description**
	0 – 60 mm	Topsoil colluvium	CGC08930 CGC08951	Red/Orange topsoil partially layered texture. Angular gravels at about 20%. Root abundances classified as 'few' and 'fine', loose, non- binding roots present, 1mm in thickness.
	60 – 160mm	Sandy gravels	CGC08931 CGC08952	Red/Orange sub soil. Unconformed anguar gravels (50%). Moderate root systems, semi binding, 3mm thick.
	160 -200mm	Weathered saprolite	CGC08934 CGC08953	Pale/Green weathered mafif saprolite
	**Surface Description**			
	BIF and quartz rubble with sands, gravels and colluvium. No erosion			
	Vegetation Description			
	Sparse mulga coverage			
				

Table 6: Description Maid Marion Soil 3

Image	Description			
	**MAID MARION SOIL 3**	**Coordinates**	658,871E 7,071,728N	
	Depth	**Material**	**Sample ID**	**Description**
	0 – 50 mm	Topsoil colluvium	CGC08935 CGC08954	Red/Orange topsoil partially layered texture. Angular gravels at about 20%. Root abundances classified as 'few' and 'fine', loose, non- binding roots present, 1mm in thickness.
	50 – 110mm	Angular gravelly sand	CGC08936 CGC08955	Red/Orange sub soil. Unconformed anguar gravels (80%) and sands. Moderate root systems, semi binding, 3mm thick.
	110 -210	Sandy gravels (rounded)	CGC08937 CGC08956	Red/Orange subsoil. Unconformed rounded gravels (30%) and sands. Minor roots systems, non-binding.
				Hard base mafic saprock. No sample achieved
	**Surface Description**			
	Quartz and BIF rubble with sands, gravels and colluvium. No erosion			
	Vegetation Description			
	Sparse mulga coverage			
				

Table 7: Description Maid Marion Soil 4

Image	Description			
	**MAID MARION SOIL 4**	**Coordinates**	658,768E 7,071,546N	
	Depth	**Material**	**Sample ID**	**Description**
	0 – 20 mm	Topsoil colluvium	CGC08938 CGC08957	Red/Orange topsoil partially layered texture. Angular gravels at about 20%. Root abundances classified as 'few' and 'fine', loose, non- binding roots present, 1mm in thickness.
	20 – 160mm	Sandy gravels	CGC08939 CGC08958	Red/Orange sub soil. Unconformed angular gravels (30%) and sands. Minor root systems, non-binding, 1mm thick.
	160 -160mm	Mafic saprock		Hard base of pit mafic saprock. No sample achieved.
	**Surface Description**			
	Quartz and ironstone rubble with sands, gravels and colluvium. No erosion			
	Vegetation Description			
	Sparse mulga coverage			
				

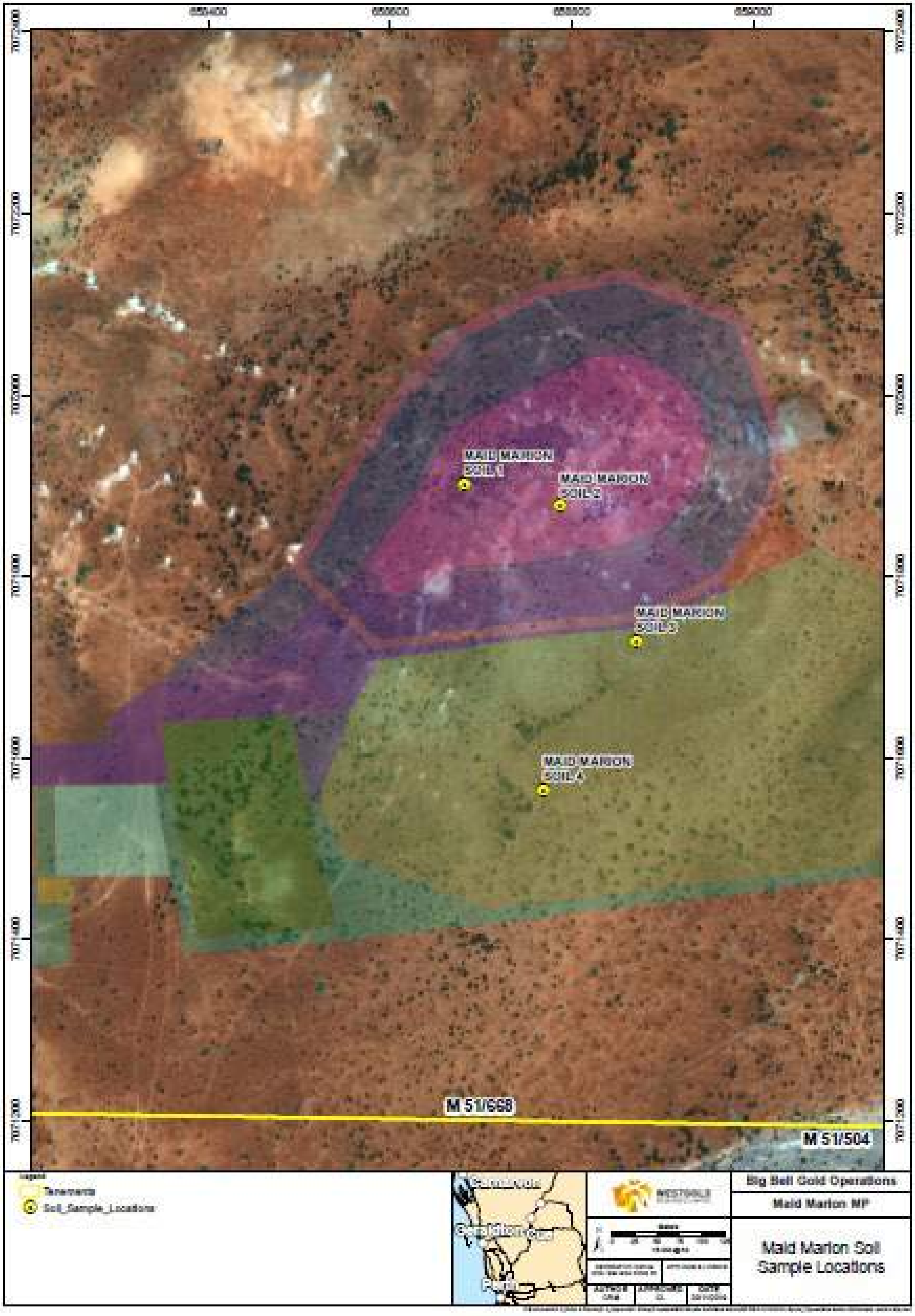

Figure 10: Maid Marion Soil Sample Locations

4.0 WASTE ROCK RESULTS

4.1 Acid Base Accounting

4.1.1 Paste pH

The paste pH gives an indication of the inherent acidity of the waste material when initially exposed in a waste rock emplacement area. pH values <5.0 generally indicates stored acidic oxidation products. The paste pH value for the samples ranged from 5.8 to 8.8 (Table 8).

Table 8: Paste pH Results

Sample ID	Depth (m)	Colour	Weathering	Regolith	Lithology	Paste pH
CMR84961	3 - 4	Brown	Oxidised	Saprolite	Undifferiated mafic	6.9
CMR84963	46 - 47	Purple	Oxidised-transitional	Saprock	Chert	6.9
CMR84965	4 - 5	Dark grey	Transitional	Saprock	BIF	5.8
CMR84967	55 - 56	Olive	Oxidised	Clay	Undifferiated ultra mafic	6.9
CMR84969	39 - 40	Olive	Oxidised-transitional	Saprock	Undifferiated ultra mafic	7.0
CMR84971	16 - 17	Brown yellow	Oxidised	Saprolite	Mafic volcanic	8.0
CMR84973	71 - 72	Green	Transitional	Saprock	Ultra mafic schist	8.8
CMR84975	26 - 27	Brown	Transitional	Saprock	BIF	7.9

4.1.2 Paste EC

The paste EC measurements for the Maid Marion waste samples ranged from 6 (ultramafic schist) to 110 µS/cm (undifferiated ultra mafic) (Table 9). The test work results indicate 100% of samples are classified non saline.

Table 9: Paste EC Results

Sample ID	Depth (m)	Colour	Weathering	Regolith	Lithology	Paste EC
CMR84961	3 - 4	Brown	Oxidised	Saprolite	Undifferiated mafic	26
CMR84963	46 - 47	Purple	Oxidised-transitional	Saprock	Chert	20
CMR84965	4 - 5	Dark grey	Transitional	Saprock	BIF	13
CMR84967	55 - 56	Olive	Oxidised	Clay	Undifferiated ultra mafic	11
CMR84969	39 - 40	Olive	Oxidised-transitional	Saprock	Undifferiated ultra mafic	110
CMR84971	16 - 17	Brown yellow	Oxidised	Saprolite	Mafic volcanic	53
CMR84973	71 - 72	Green	Transitional	Saprock	Ultra mafic schist	6
CMR84975	26 - 27	Brown	Transitional	Saprock	BIF	13

4.1.3 Total S %

Total Sulphur ranges from <0.005 to 0.006 (Table 10).

Table 10: Total Sulphur

Sample ID	Depth (m)	Colour	Weathering	Regolith	Lithology	Total S %
CMR84961	3 - 4	Brown	Oxidised	Saprolite	Undifferiated mafic	<0.005
CMR84963	46 - 47	Purple	Oxidised-transitional	Saprock	Chert	<0.005
CMR84965	4 - 5	Dark grey	Transitional	Saprock	BIF	0.006
CMR84967	55 - 56	Olive	Oxidised	Clay	Undifferiated ultra mafic	<0.005
CMR84969	39 - 40	Olive	Oxidised-transitional	Saprock	Undifferiated ultra mafic	<0.005
CMR84971	16 - 17	Brown yellow	Oxidised	Saprolite	Mafic volcanic	<0.005
CMR84973	71 - 72	Green	Transitional	Saprock	Ultra mafic schist	<0.005
CMR84975	26 - 27	Brown	Transitional	Saprock	BIF	<0.005

4.1.4 Acid Neutralising Capacity

The acid produced by waste through pyrite oxidation will react with other minerals in the material and can be neutralised. The ANC is a measurement of the inherent buffering capacity of the sample. The sample is reacted with a known volume of acid at a pH of <1 for 1 to 2 hours. The amount of acid neutralised is calculated by titration. The ANC of the waste samples ranged from <0.5 to 14 kg H_2SO_4/t (Table 11). The test results indicate 98% of waste samples have ANC values less than 10 kg H_2SO_4/t indicating low buffering capacity.

Table 11: ANC Results

Sample ID	Depth (m)	Colour	Weathering	Regolith	Lithology	ANC
CMR84961	3 - 4	Brown	Oxidised	Saprolite	Undifferiated mafic	2.5
CMR84963	46 - 47	Purple	Oxidised-transitional	Saprock	Chert	0.5
CMR84965	4 - 5	Dark grey	Transitional	Saprock	BIF	0.5
CMR84967	55 - 56	Olive	Oxidised	Clay	Undifferiated ultra mafic	<0.5
CMR84969	39 - 40	Olive	Oxidised-transitional	Saprock	Undifferiated ultra mafic	3.0
CMR84971	16 - 17	Brown yellow	Oxidised	Saprolite	Mafic volcanic	2.5
CMR84973	71 - 72	Green	Transitional	Saprock	Ultra mafic schist	14
CMR84975	26 - 27	Brown	Transitional	Saprock	BIF	1.3

4.1.5 Net Acid Producing Potential

The NAPP is the amount of acid that potentially can be produced by a sample after the ANC is taken into account. The NAPP is calculated by subtracting the ANC value from the MPA. If the NAPP is negative then it is considered that the sample has sufficient buffering capacity to neutralise any acid produced. The waste NAPP values ranged from -0.32 to -13.85 (Table 12).

Table 12: NAPP Results

Sample ID	Depth (m)	Colour	Weathering	Regolith	Lithology	NAPP
CMR84961	3 - 4	Brown	Oxidised	Saprolite	Undifferiated mafic	-2.35
CMR84963	46 - 47	Purple	Oxidised-transitional	Saprock	Chert	-0.35
CMR84965	4 - 5	Dark grey	Transitional	Saprock	BIF	-0.32
CMR84967	55 - 56	Olive	Oxidised	Clay	Undifferiated ultra mafic	-0.35
CMR84969	39 - 40	Olive	Oxidised-transitional	Saprock	Undifferiated ultra mafic	-2.85
CMR84971	16 - 17	Brown yellow	Oxidised	Saprolite	Mafic volcanic	-2.35
CMR84973	71 - 72	Green	Transitional	Saprock	Ultra mafic schist	-13.85
CMR84975	26 - 27	Brown	Transitional	Saprock	BIF	-1.15

4.1.6 NAG pH

This is a method of estimating the potential for the sample to form acid. The sample is reacted with hydrogen peroxide to oxidise any sulphide minerals. Acid is generated and neutralised at the same time within the sample. The pH of the sample (NAG pH) can be used to predict the likelihood of the sample to produce acid with a sample having a NAG pH ≤ 4.5 considered to be acid forming. Waste material NAG pH ranged from 5.2 to 8.0 (Table 13). The test work results indicate that under the strongly-oxidising conditions of the NAG-test work, the Maid Marion samples did not acidify.

Table 13: NAG pH Results

Sample ID	Depth (m)	Colour	Weathering	Regolith	Lithology	NAG pH
CMR84961	3 - 4	Brown	Oxidised	Saprolite	Undifferiated mafic	6.0
CMR84963	46 - 47	Purple	Oxidised-transitional	Saprock	Chert	6.0
CMR84965	4 - 5	Dark grey	Transitional	Saprock	BIF	5.2
CMR84967	55 - 56	Olive	Oxidised	Clay	Undifferiated ultra mafic	6.1
CMR84969	39 - 40	Olive	Oxidised-transitional	Saprock	Undifferiated ultra mafic	7.5

Sample ID	Depth (m)	Colour	Weathering	Regolith	Lithology	NAG pH
CMR84971	16 - 17	Brown yellow	Oxidised	Saprolite	Mafic volcanic	6.2
CMR84973	71 - 72	Green	Transitional	Saprock	Ultra mafic schist	8.0
CMR84975	26 - 27	Brown	Transitional	Saprock	BIF	6.4

4.1.7 ABA Classification

Figure 11 is a plot of the NAPP versus the NAG pH. This plot shows that all samples plot into the NAF category. No samples plot into PAF or UC zones.

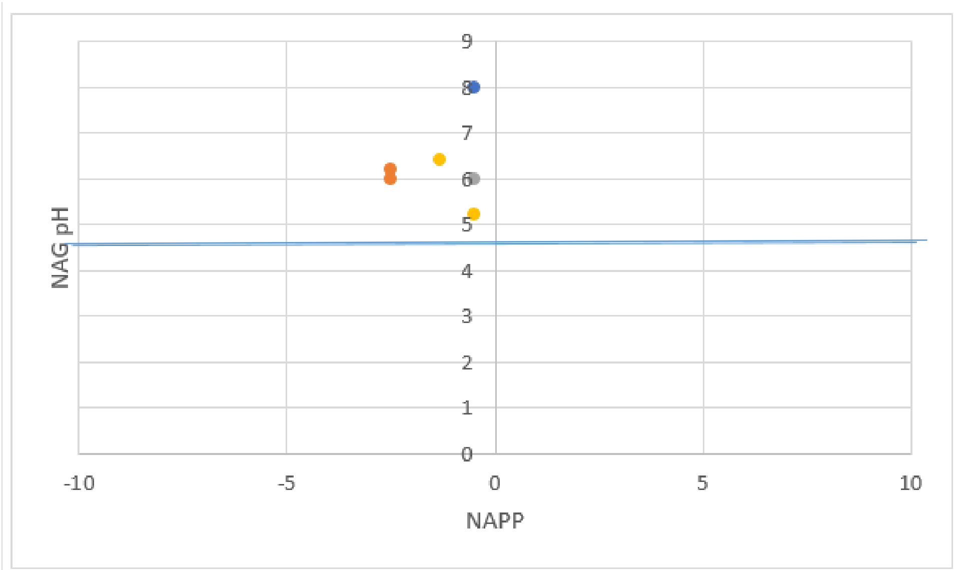

Figure 11: ABA Classification NAPP versus NAG pH

4.2 Total Metals Waste Material

GAI results presented Table 14. One sample (CMR84973) is significantly enriched in chromium. The same sample exceeds chromium EIL (Table 15). Table 16 shows the leachate from this sample is within ANZECC Livestock limits for chromium.

Table 14: GAI Results

	84961	84963	84965	84967	84969	84971	84973	84975
As	0	0	0	0	0	0	0	0
Ni	0	0	0	0	0	0	**1**	0
Pb	0	0	0	0	0	0	0	0
Zn	0	0	0	0	0	0	0	0
Cu	0	0	0	0	0	0	0	0
Cr	0	0	0	0	**2**	0	**4**	0
Fe	0	0	**1**	0	0	0	0	0

Table 15: Metals and EIL Limits

Sample ID	As	As EIL	Pb	Pb EIL	Cu	Cu EIL	Ni	Ni EIL	Cr	Cr EIL	Zn	Zn EIL
CMR84961	10	160	1	1800	20	55	35	90	170	920	6	310
CMR84963	12	160	3	1800	33	70	19	75	77	890	10	190
CMR84965	<1	160	<1	1800	12	110	12	200	36	1300	8	140
CMR84967	5	160	<1	1800	16	85	9.2	120	43	860	6	150
CMR84969	5	160	<1	1800	8.9	95	110	240	470	1300	45	550
CMR84971	1	160	2	1800	14	60	22	240	110	1200	6	600
CMR84973	<1	160	<1	1800	19	95	270	420	2300	720	48	850
CMR84975	<1	160	1	1800	57	160	39	230	16	1500	18	220

Table 16: Metal Leachate Results

Sample ID	As	Pb	Cu	Ni	Cr	Zn	pH	EC
CMR84961	<0.02	<0.02	<0.005	<0.005	<0.005	<0.01	8.0	6
CMR84963	<0.02	<0.02	<0.005	<0.005	0.005	<0.01	7.5	4
CMR84965	<0.02	<0.02	<0.005	<0.005	<0.005	<0.01	6.6	4
CMR84967	<0.02	<0.02	<0.005	<0.005	<0.005	<0.01	7.1	3
CMR84969	<0.02	<0.02	<0.005	<0.005	0.024	<0.01	7.8	35
CMR84971	<0.02	<0.02	<0.005	<0.005	0.022	<0.01	9.3	28
CMR84973	<0.02	<0.02	<0.005	0.005	0.084	<0.01	9.6	24
CMR84975	<0.02	<0.02	0.01	0.012	0.007	<0.01	8.8	5

4.3 Texture

The particle size distributions of the soil sized fraction of future mine waste materials ranged from silty loam to clay (Figure 12). Coarse material content was variable, ranging between 6 and 39 %.

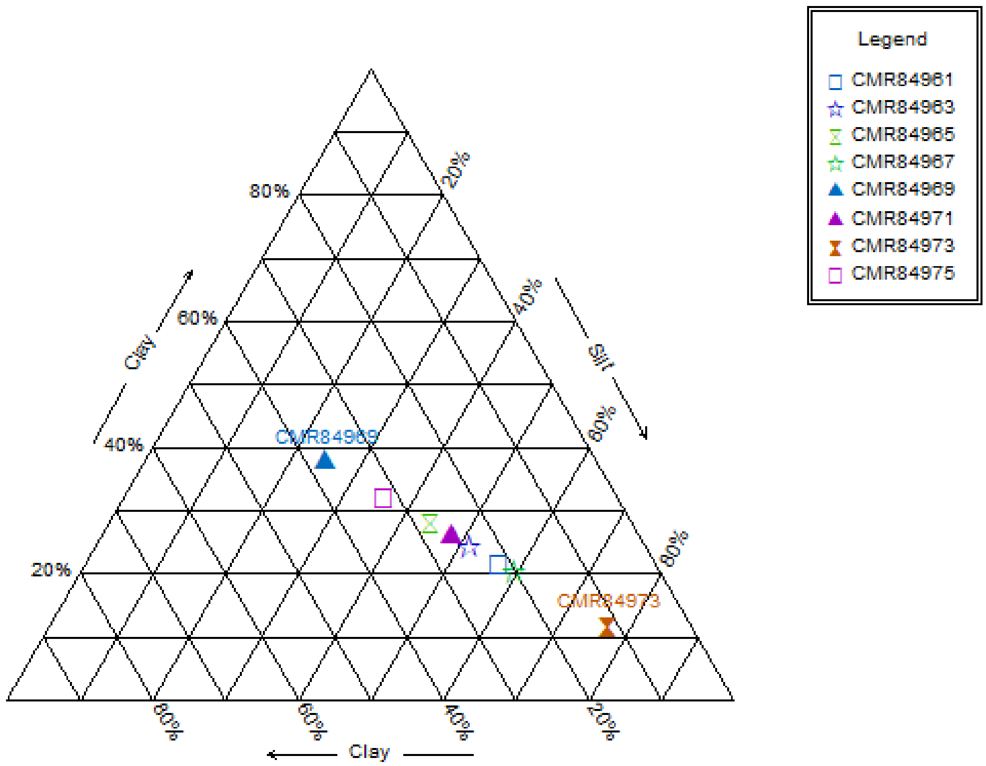

Figure 12: Textural Triangle

4.4 Structural Stability

The structural stability of a soil or mine waste material and its susceptibility to structural decline is complex and depends on the net effect of a number of properties, including the amount and type of clay present, organic matter content, soil chemistry and the nature of disturbance. Soil aggregates that slake and disperse indicate a weak soil structure that is easily degraded. These soils should be seen as potentially unstable (from an erodibility perspective) and problematic when used for the reconstruction of soil profiles for rehabilitation, particularly if left exposed at the surface.

The Emerson Aggregate Test identifies the potential slaking and dispersive properties of soil aggregates. The dispersion test identifies the properties of the soil materials under a worst case scenario, where severe stress is applied to the material. 50 % samples class 2(1), 40% samples class 3(1) and 10% class 6.

4.5 Exchangeable Cations and ESP% Waste Material

Exchangeable cations, held on clay surfaces and within organic matter are an important source of soil fertility and can influence the physical properties of soil. Generally, if cations such as Ca^{2+}, Mg^{2+} and K^{+} are dominant on the clay exchange surfaces, the soil will typically display increased physical structure and stability, leading to increased aeration, drainage and root growth (Moore, 1998). If sodium cations (Na^{+}) are dominant on exchange surfaces and exceed more than 6 % of the total exchangeable cations, then the soil is considered to be sodic, which can lead to poor physical properties (i.e. dispersion, hard setting and erosion in clay-rich soils).

If the ESP exceeds more than 15 %, then the soil is considered to be highly sodic (Moore 1998). Sodic soils have an increased tendency to disperse upon wetting and are therefore more prone to hard setting at the soil surface and erosion when placed on the slopes of constructed landforms. Dispersion is also dependent on the interaction between sodicity and salinity. Relationships have been derived by Rengasamy *et al*., (1984) and can be used as a guide for the dispersive behaviour of soils (Figure 13) (Hazelton and Murphy, 2016). Dispersion is also dependent on the interaction between sodicity and salinity. Results provided Table 17.

Hydraulic conductivity ranges from slow to extremely slow. 50% samples have emerson class 2(2), 40% class 3(1) and 10% class 6. All samples are non-saline but have sodicity ranging from non-sodic to moderately sodic. 30% samples have dispersion class 1 (dispersive) and 70% class 2A (potentially dispersive). Calcium and potassium levels (meq/100g) range from very low to moderate. Magnesium levels range from very low to high. The CEC ranged from very low to moderate.

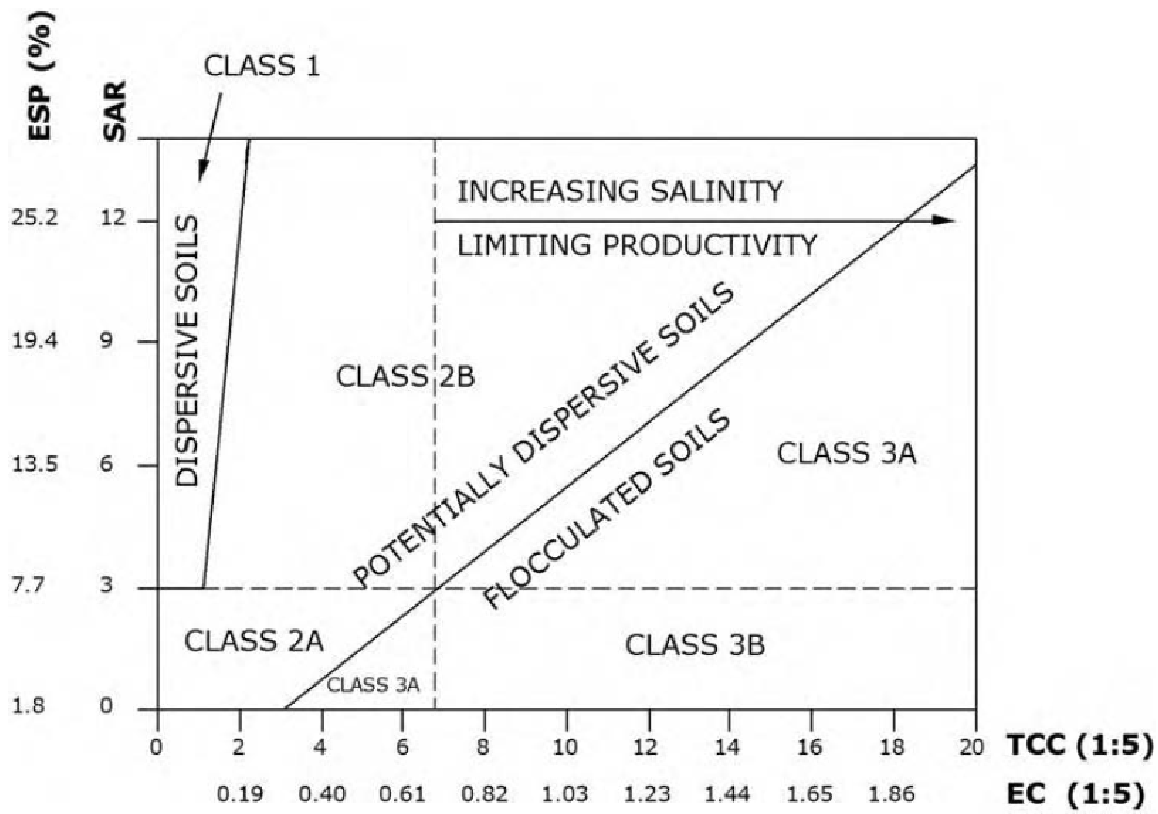

Figure 13: Predicting Dispersion based on ESP and EC

Table 17: Emerson Class and Exchangeable Cations

Sample ID	Saturated Hydraulic Conductivity mm/hr	Emerson Class	EC	Dispersion class	Ca	Mg	Na	K	CEC	ESP %	Salinity, Sodicity
CMR84961	2 (slow)	2(1)	0.015	Class 1	1.0	0.70	0.51	0.67	2.9	17.7	Moderately sodic non-saline
CMR84963	1(very slow)	2(1)	0.012	Class 2A	0.54	0.47	0.07	0.06	1.1	6.4	Slightly sodic non-saline
CMR84965	2 (slow)	6	0.008	Class 1	0.26	0.18	0.09	0.07	0.60	15.3	Moderately sodic non-saline
CMR84967	<1 (extremely slow)	2(1)	0.007	Class 2A	0.34	0.29	0.05	0.04	0.71	6.4	Slightly sodic non-saline
CMR84969	1 (very slow)	2(1)	0.13	Class 2A	2.4	4.1	0.36	0.11	7.0	5.2	Non-sodic non-saline
CMR84971	1(very slow)	3(1)	0.042	Class 2A	2.5	4.4	0.48	0.57	7.9	6.0	Non-sodic non-saline
CMR84973	3 (slow)	3(1)	0.015	Class 2A	5.9	6.8	0.53	0.12	13	4.0	Non-sodic non-saline
CMR84975	5 (moderately slow)	3(1)	0.01	Class 1	0.57	0.73	0.15	0.06	1.5	10.1	Slightly sodic non-saline

5.0 SOIL RESULTS

5.1 Texture

Soil texture describes the proportions of sand, silt and clay (the particle size distribution) within a soil. The particle size distribution and resulting textural class of soils is an important factor influencing most physical and many chemical and biological properties. Soil structure, water holding capacity, hydraulic conductivity, soil strength, fertility, erodibility and susceptibility to compaction are some of the factors closely linked to soil texture. The particle size distributions of the soil materials ranged from silty loam to sandy loam (Figure 14). The majority of the mine waste materials is classified as sandy loams. Coarse material content was variable, ranging between 7.7 (topsoil site CGCO8935) and 97% (topsoil CGCO8929) (Figure 15).

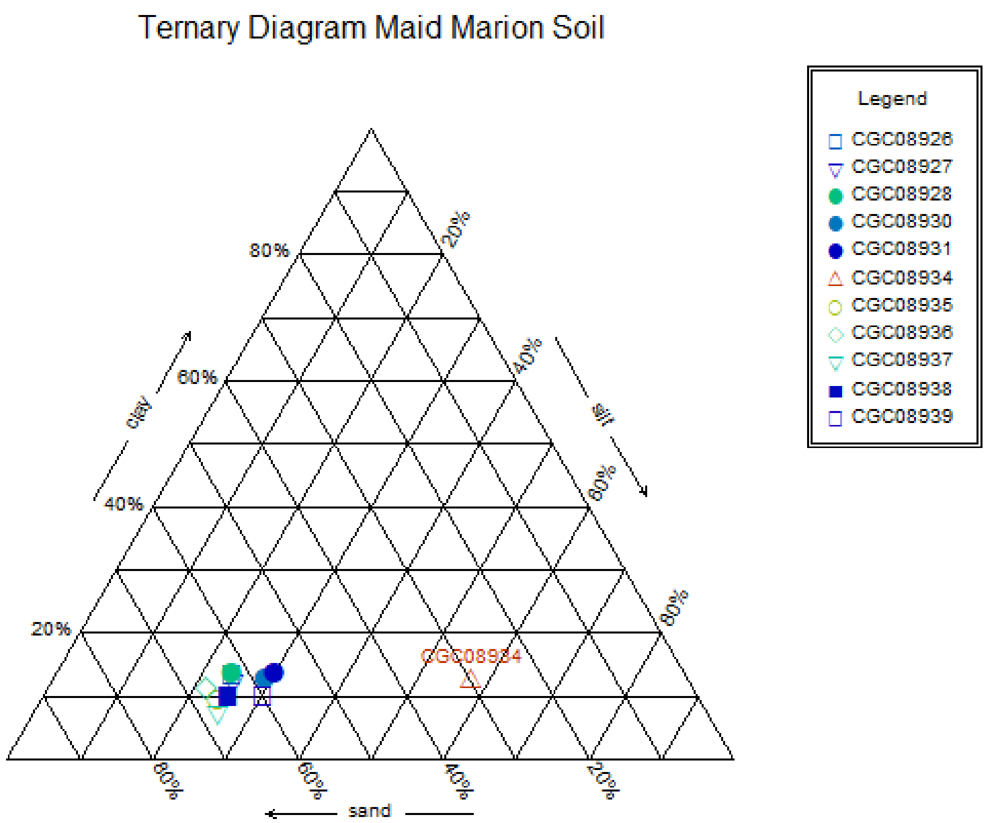

Figure 14: Textural Triangle

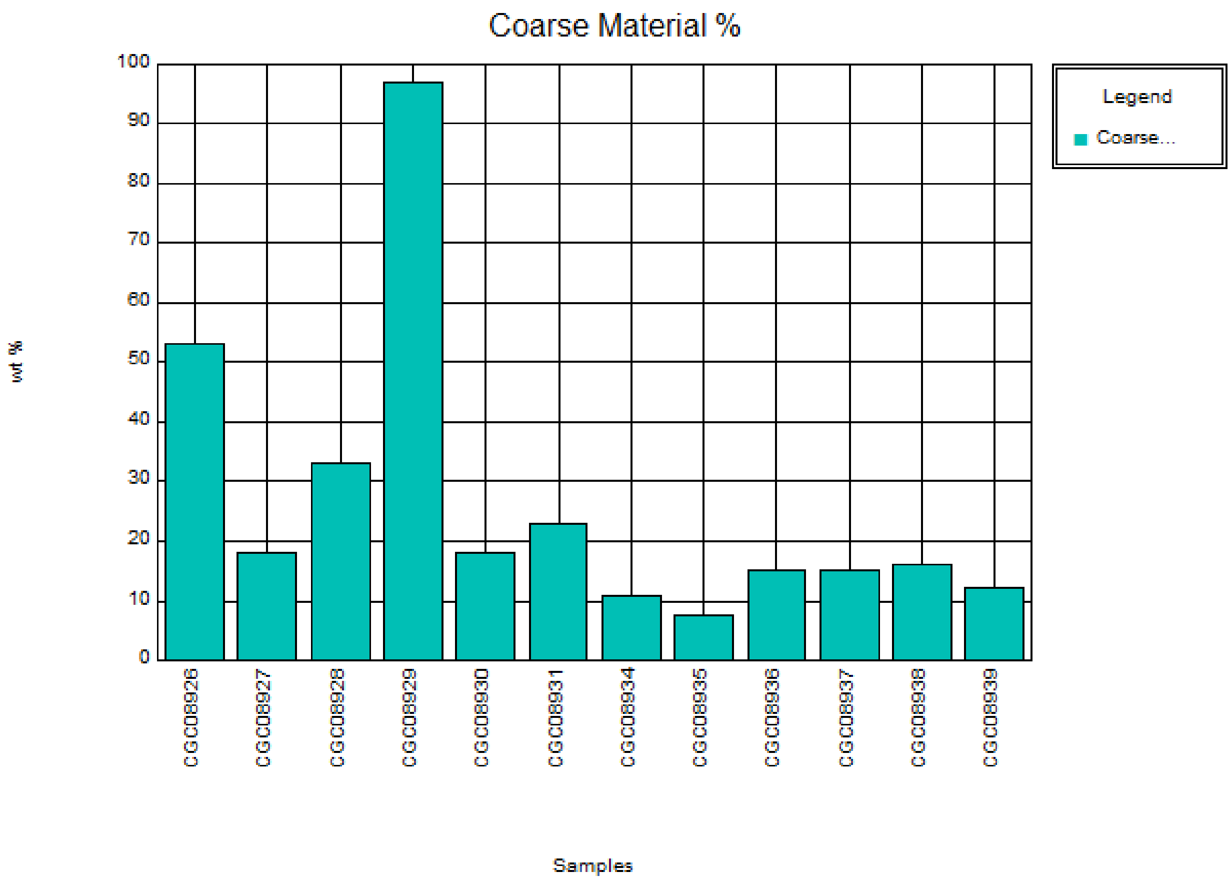

Figure 15: Coarse Material Maid Marion Soil

5.2 Soil Structure

Soil structure describes the arrangement of solid particles and void space in a soil. It is an important factor influencing the ability of soil to support plant growth, store and transmit water and resist erosional processes. A well-structured soil is one with a range of different sized aggregates, with component particles bound together to give a range of pore sizes facilitating root growth and the transfer of air and water.

Soil structure can be influenced by the particle size distribution, chemical composition and organic matter content of a soil and is often affected by root growth, vehicle compaction and in reconstructed soil profiles, the methods of soil handling and construction. When a soil material is disturbed, the breakdown of aggregates into primary particles can lead to structural decline (Needham *et al.,* 1998). This can result in hard-setting and crusting at the soil surface and a 'massive' soil structure at depth, potentially reducing the ability of seeds to germinate, roots to penetrate, and water to infiltrate.

A range of soil structures were identified throughout the sample sites, with the dominant soil structure comprising moderately-structured soils with weak to moderate aggregation. No massive soils or physical restrictions to root penetration (apart from coarse materials) were identified.

5.3 Structural Stability

The structural stability of a soil and its susceptibility to structural decline is complex and depends on the net effect of a number of properties, including the amount and type of clay present, organic matter content, soil chemistry and the nature of disturbance. Soil aggregates that slake and disperse indicate a weak soil structure that is easily degraded. These soils should be seen as potentially problematic when used for the reconstruction of soil profiles for rehabilitation, particularly if left exposed at the surface.

The Emerson Aggregate Test identifies the potential slaking and dispersive properties of soil aggregates. The dispersion test identifies the properties of the soil materials under a worst case scenario, where severe stress is applied to the soil material.

All soil samples had an Emerson Class of 2: Air-dried crumbs of soil show a moderate to slight reaction with the exception of CGC08930 Emerson Class 1 dispersive. .

5.4 Saturated Hydraulic Conductivity

Saturated hydraulic conductivity (Ksat) refers to the permeability of material or the ability of water to infiltrate and drain through the material matrix and is dependent on material properties such as texture and structure (Hunt and Gilkes 1992; Hazelton and Murphy 2007; Moore 1998). Freely draining materials with high Ksat values will generally be less susceptible to surface runoff and erosion. Slow draining materials with low Ksat values, are more likely to experience water logging, increase surface runoff and erosion. Saturated hydraulic conductivity was determined for soil samples which were collected in the field and repacked to their respective bulk densities. Drainage classes were determined for each according to their Ksat (Hunt and Gilkes 1992). The drainage class of the selected soil samples ranged from ‘very slow’ to ‘moderately slow’.

5.5 Soil pH

The soil pH gives a measure of the soil acidity or alkalinity, with ratings determined by pH range and analysis method (Van Gool *et al.*, 2005). The ideal pH range for plant growth of most agricultural species is considered to be between 5.0 and 7.5 (Moore 1998). Outside this range, the plant-availability of some nutrients is affected, while various metal toxicities (e.g. Al and Mn) can become limiting at low pH. For native species, which are known to be tolerant of wider ranges in soil pH, preferred pH ranges are best inferred from the soil in which they are observed to occur.

Soil pH measured in 0.01 M calcium chloride ($CaCl_2$) is considered a more accurate measurement of hydrogen ion concentration ([H^+]), closer to that of the natural soil solution which is taken up by plants (Hunt and Gilkes 1992). As a result, soil pH measured in $CaCl_2$ is lower than pH measured in water. However, both measurements are taken for a complete assessment.

There was significant variation in pH values between the soil samples. Soil pH ($CaCl_2$) values ranged between pH 4.0 (very strongly acid) and pH 6.4 (neutral) (Figure 16). Soil pH (H_2O) values ranged between pH 4.6 (very strongly acid) and pH 7.0 (neutral) (Figure 16). The majority of samples were classed as acidic.

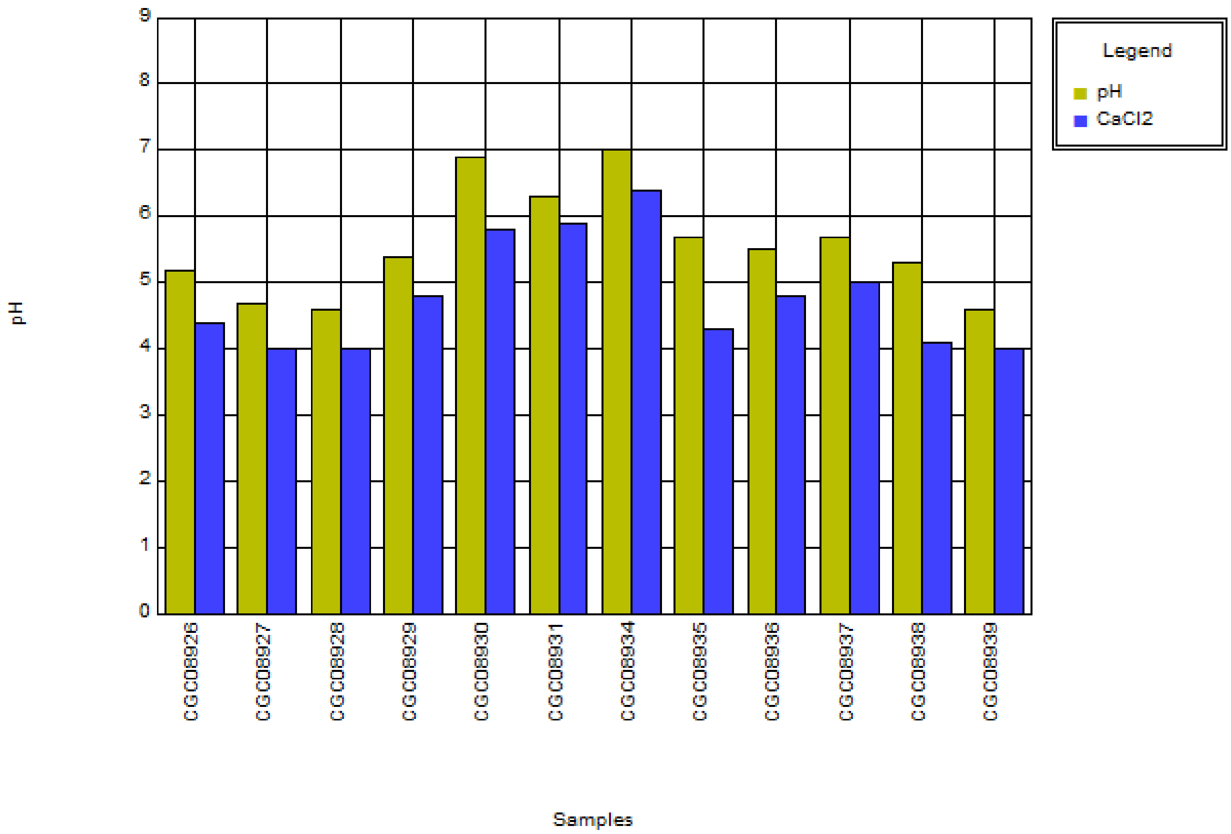

Figure 16: Soil pH

5.6 Soil EC

Electrical conductivity (EC) is a measurement of the soluble salts in soils or water. Soil salinity results from natural processes of landscape evolution, hydrological processes and rainfall (Hunt and Gilkes 1992). The EC of the soil materials sampled from the Maid Marion area were variable, and ranged between 'non-saline' (0 to 0.17 dS / m) and 'moderately saline' (0.34 dS / m), based on the standard USDA and CSIRO categories, with most sites falling into the 'non saline' categories.

5.7 Soil Organic Matter

The organic matter content of soil is an important factor influencing many physical, chemical and biological soil characteristics. Directly derived from plants and animals, its functions in soil include supporting the micro and macro fauna and flora populations in the soil, increasing the water retention capacity, buffering pH and improving soil structure. The organic matter content of the soils within Maid Marion area was determined as a measure of the soil organic carbon percentage (SOC %).

The SOC within all of the soils sampled from the Maid Marion Project area was low (less than 1 % SOC) (Purdie, 1998), ranging from 0.11 % to 0.88 %, as is the case in most natural Western Australian soils.

5.8 Exchangeable Cations and ESP%

Results provided Table 18 and Table 19.

Table 18: CEC Proportions

Sample ID	Ca%	Mg %	K%	ESP%	Base Saturation %	CEC
CGC08926	44.9	27.0	22.6	5.5	96	1.3
CGC08927	42.9	22.9	26.7	7.4	99	0.84
CGC08928	53.8	23.4	19.3	3.6	100	0.88
CGC08929	52.7	23.4	16.2	7.7	100	0.67
CGC08930	36.4	47.3	11.1	5.1	100	4.4
CGC08931	33.8	50.2	7.9	8.1	100	5.6
CGC08934	37.1	55.7	3.5	3.8	99	7.7
CGC08935	27.8	44.0	25.8	2.3	96	1.3
CGC08936	31.5	41.7	17.1	9.6	99	1.9
CGC08937	30.9	41.9	11.8	15.4	98	2.7
CGC08938	38.0	37.5	22.8	1.7	99	0.84
CGC08939	44.9	32.4	20.6	2.1	95	1.1

Sample ID	Ca%	Mg %	K%	ESP%	Base Saturation %	CEC
Desirable Range	65-80	10-15	1-5	0-1		<6 very low
						6-12 low
						12-25 medium
						25-40 high
						>40 very high

Table 19: Emerson, ESP and Dispersion Class

Sample ID	Texture	Emerson	Salinity	ESP	CEC	Sodicity	Dispersion class	Soil erodability
CGC08926	Sandy Loam	2	Non-saline	5.5	1.3	Non-sodic	Class 2A	Moderate
CGC08927	Sandy Loam	2	Non-saline	7.4	0.84	Slightly sodic	Class 2A	Moderate
CGC08928	Sandy Loam	2	Non-saline	3.6	0.88	Non-sodic	Class 2A	Moderate
CGC08929	Sandy Loam	NS	Non-saline	7.7	0.67	Slightly sodic	Class 2A	NS
CGC08930	Sandy Loam	1	Non-saline	5.5	4.4	Slightly sodic	Class 2A	High
CGC08931	Sandy Loam	2	Moderately-saline	8.1	5.6	Slightly sodic	Class 2B	Moderate
CGC08934	Silty loam	2	Slightly -saline	3.8	7.7	Non sodic	Class 2A	Extreme
CGC08935	Sandy Loam	2	Non-saline	2.3	1.3	Non sodic	Class 2A	Moderate
CGC08936	Sandy Loam	2	Non-saline	9.6	1.9	Slightly sodic	Class 1	Moderate
CGC08937	Sandy Loam	2	Non-saline	15.4	2.7	Moderately sodic	Class 1	Moderate
CGC08938	Sandy Loam	2	Non-saline	1.7	0.84	Non sodic	Class 2A	Moderate
CGC08939	Sandy Loam	2	Non-saline	2.1	1.1	Non sodic	Class 2A	Moderate

5.9 Plant Available Nutrients

The most important macronutrients for plant growth are nitrogen (N), phosphorus (P), potassium (K), and sulphur (S). These nutrients are largely derived from the soil mineral component and organic matter. Native plant species have a number of physiological adaptations that enable them to be productive in areas where the supply of macronutrients is limited. There is limited information available which details the specific nutritional requirements for native plant species in the semiarid zone of WA. Therefore, the use of analogue sites is an effective way to baseline the soil nutritional requirements of native plant species within the Project area. Plant available nutrient results provided Table 20.

Table 20: Plant Available Nutrient Results

Sample ID	Nitrogen	Phosphorus	Potassium	Sulphur
CGC08926	7.5	4	150	8
CGC08927	6.6	3	120	13
CGC08928	7.8	2	93	12
CGC08929	6.5	1	57	25
CGC08930	1.3	2	280	4
CGC08931	37	2	260	61
CGC08934	21	1	290	24
CGC08935	0.74	4	190	3
CGC08936	5.7	1	170	17
CGC08937	12	<1	160	22
CGC08938	0.91	7	130	3
CGC08939	3.0	2	130	11

5.9.1 Plant Available Nitrogen

A significant proportion of soil nitrogen is held in organic matter and it is not immediately available for plant uptake (Hazelton and Murphy 2007). The nitrogen that is readily available to plants is generally measured as nitrate. Nitrogen is an integral component of many essential plant compounds. It is a major part of all amino acids, which are the building blocks of all proteins, including the enzymes which effectively control all biological processes (Brady and Weil 2002). A good supply of nitrogen stimulates root growth and development, and enhances the uptake of other nutrients (Brady and Weil 2002).

The results indicate that the amount of plant-available nitrogen between the existing soil material samples was variable. However, predominately low. All sites reported concentrations of plant-available nitrogen considered adequate for native plant growth.

5.9.2 Plant Available Phosphorus

Phosphorus is essential for the growth of plants and animals as it plays a key role in the formulation of energy producing organic compounds. Adequate phosphorus nutrition enhances many aspects of plant physiology, including the fundamental processes of photosynthesis, nitrogen fixation, flowering, fruiting (including seed production), and maturation (Brady and Weil 2002).

All of the samples reported concentrations of plant-available phosphorus considered 'low' (Moore, 1998). All samples reported plant-available phosphorus concentrations considered adequate for native plant growth.

5.9.3 Plant Available Potassium

Potassium plays a critical role in a number of plant physiological processes. Adequate amounts of potassium have been linked to improved drought tolerance, improved winter hardiness, better resistance to certain fungal diseases and greater tolerance to insect pests. Potassium can also improve the structural stability of plants (Brady and Weil 2002).

5.9.4 Plant Available Sulphur

Potassium plays a critical role in a number of plant physiological processes. Adequate amounts of potassium have been linked to improved drought tolerance, improved winter hardiness, better resistance to certain fungal diseases, and greater tolerance to insect pests. Potassium can also improve the structural stability of plants (Brady and Weil 2002). All sites had concentrations of plant-available sulphur considered adequate for soil biological processes and native plant growth within the Maid Marion Project area.

5.10 Total Metals Soil

Metal results provided Table 21 to Table 27. Two soil samples exceeded the NEPM Ecological Investigation Limit (EIL) (National parks and areas of high conservation value) for chromium but were within the EIL for urban residential and open public spaces and commercial and industrial limits. One soil sample exceeded the National parks and areas of high conservation value EIL for nickel but was within urban residential and open public spaces and commercial and industrial limits. Some soil soils were slightly enriched in arsenic.

Table 21: Arsenic Results

Sample ID	Arsenic (mg/kg)	EIL			GAI
CGC08926	3.7	40[1]	100[2]	160[3]	0
CGC08927	4.2	40	100	160	0
CGC08928	3.8	40	100	160	0
CGC08929	4.4	40	100	160	0
CGC08930	5.0	40	100	160	1
CGC08931	4.8	40	100	160	1
CGC08934	15	40	100	160	2
CGC08935	5.4	40	100	160	1
CGC08936	4.3	40	100	160	0
CGC08937	5.1	40	100	160	1
CGC08938	4.2	40	100	160	0
CGC08939	5.6	40	100	160	1

1 National parks and areas of high conservation value
2 Urban residential and open public spaces
3 Commercial and industrial

Table 22: Lead Results

Sample ID	Lead (mg/kg)	EIL			GAI
CGC08926	7	470[1]	1100[2]	1800[3]	0
CGC08927	6.7	470	1100	1800	0
CGC08928	7.1	470	1100	1800	0
CGC08929	23	470	1100	1800	0
CGC08930	7.4	470	1100	1800	0
CGC08931	6.6	470	1100	1800	0
CGC08934	5.2	470	1100	1800	0
CGC08935	7.6	470	1100	1800	0
CGC08936	13	470	1100	1800	0
CGC08937	12	470	1100	1800	0
CGC08938	8.3	470	1100	1800	0
CGC08939	8.3	470	1100	1800	0

1 National parks and areas of high conservation value
2 Urban residential and open public spaces
3 Commercial and industrial

Table 23: Chromium Results

Sample ID	Chromium (mg/kg)	EIL			GAI
CGC08926	180	380[1]	610[2]	830[3]	0
CGC08927	180	400	670	940	0
CGC08928	170	400	660	920	0
CGC08929	320	630	630	630	1
CGC08930	250	400	670	940	0

Sample ID	Chromium (mg/kg)	EIL			GAI
CGC08931	230	400	670	940	0
CGC08934	410	590	860	1100	1
CGC08935	230	390	640	890	0
CGC08936	220	400	660	920	0
CGC08937	270	380	610	830	0
CGC08938	410	390	640	890	1
CGC08939	410	390	640	890	1

1 National parks and areas of high conservation value
2 Urban residential and open public spaces
3 Commercial and industrial

Table 24: Copper Results

Sample ID	Copper (mg/kg)	EIL			GAI
CGC08926	16	50[1]	65[2]	75[3]	0
CGC08927	15	50	60	65	0
CGC08928	16	50	60	65	0
CGC08929	55	95	100	110	0
CGC08930	23	55	75	90	0
CGC08931	24	60	85	100	0
CGC08934	57	90	120	150	0
CGC08935	17	50	55	65	0
CGC08936	18	45	50	50	0
CGC08937	28	50	55	60	0
CGC08938	17	50	60	65	0
CGC08939	17	50	55	60	0

1 National parks and areas of high conservation value
2 Urban residential and open public spaces
3 Commercial and industrial

Table 25: Iron Results

Sample ID	Iron %	GAI
CGC08926	4.7	0
CGC08927	4.2	0
CGC08928	4.2	0
CGC08929	15	1
CGC08930	4.5	0
CGC08931	4.2	0
CGC08934	6.0	0
CGC08935	4.0	0
CGC08936	4.0	0
CGC08937	4.4	0
CGC08938	4.6	0
CGC08939	5.3	0

Table 26: Nickel Results

Sample ID	Nickel (mg/kg)	EIL			GAI
CGC08926	17	75[1]	75[2]	75[3]	0
CGC08927	18	75	75	75	0
CGC08928	13	75	75	75	0
CGC08929	79	160	160	160	0
CGC08930	30	80	100	120	0
CGC08931	37	80	120	150	0
CGC08934	190	140	210	270	0
CGC08935	20	75	75	75	0
CGC08936	18	75	80	80	0
CGC08937	28	75	85	90	0
CGC08938	17	75	75	75	0
CGC08939	17	75	75	75	0

1 National parks and areas of high conservation value
2 Urban residential and open public spaces
3 Commercial and industrial

Table 27: Zinc Results

Sample ID	Zinc (mg/kg)	EIL			GAI
CGC08926	13	95[1]	120[2]	140[3]	0
CGC08927	12	90	110	120	0
CGC08928	11	90	110	120	0
CGC08929	63	170	190	210	0
CGC08930	21	130	280	400	0
CGC08931	20	140	340	480	0
CGC08934	53	200	460	640	0
CGC08935	16	90	120	140	0
CGC08936	14	100	140	180	0
CGC08937	16	100	170	220	0
CGC08938	16	90	110	120	0
CGC08939	15	90	110	120	0

1 National parks and areas of high conservation value
2 Urban residential and open public spaces
3 Commercial and industrial

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Soils

Soils at the Maid Marion project area are dominated by shallow red-brown surface soils of aeolian origin overlying either an indurated siliceous hardpan, compacted gravel or, BIF. . Assessment of the physical and chemical properties of these soils by field assessment of profiles and laboratory analysis of samples indicate the following characteristics:

- Surface soils are generally unconsolidated red-brown sandy loams with low concentrations of soil organic matter and nutrients;
- Surface soils rely mainly on stony surface lag materials, rather than vegetative cover, for stability against wind and water erosion;
- Surface soils and subsoils range from very strongly acidic to circum-neutral as indicated by pH values ranging from 4.0 to 6.4 and very high BS% values ranging from 96 to 100%. The inherent natural soil acidity is predicted to play an important role in determining suitability of native plant species to grow on Maid Marion soils;
- Very low to low CEC values, indicating dominance of "unreactive" clay minerals over "reactive" clay minerals, low nutrient retention capacity and a history of extensive weathering and leaching;
- Low salinity and low to moderate sodicity;
- A propensity for dispersion of the clay fraction (for the majority of samples). Despite this, clays present were not associated with high elevated sodicity. Factors contributing to the dispersive behaviour of clays (and silts) are likely to include low salinity, low soil organic matter contents and "unreactive" clay minerals; and
- Generally low concentrations of heavy metals and metalloids. There is evidence for slight enrichment by arsenic and chromium. Exceeds

All surface soils are suitable for rehabilitation of disturbed areas at mine closure. There is no need to segregate different soil types in terms of their "usability" characteristics, as differences in chemical and physical properties of surface soils are not significant.

The depth of potentially recoverable soil from project locations to be disturbed by mining operations is expected to be variable. A minimum depth of 50 to 100 mm of surface soil is likely from locations with very shallow indurated siliceous hardpan or outcropping sedimentary or ironstone low hills and ridges.

It is recommended that soil harvesting focuses on landforms with higher vegetation densities and should include surface soils and plant-bearing gravels. It is also recommended that additional subsoil materials are collected. Increasing the coarse material content is particularly favourable for rehabilitation of sloping surfaces of mine waste landforms.

As pre-mining stripping of soil at Maid Marion is expected to provide sufficient material for rehabilitation of disturbed areas at Maid Marion, there is no requirement to transport any soil stripped from the proposed haul road corridor. It is recommended that soil disturbed by construction of the haul road be pushed aside as low windrows for subsequent on site rehabilitation at mine closure.

6.2 Waste Rock Material

Non-mineralised waste rock samples:

- Contained low total sulfur concentrations and low ANC;
- Were all classified as NAF;
- Apart from chromium there was no evidence for significant geochemical enrichment (GAI of three or more) with environmentally significant metals and metalloids in waste rock samples.
- Analysis for water leachable metals identified no concentrations of metals or metalloids of concern for the local environment;
- Seepage is predicted to be circum-neutral to alkaline, non-saline to brackish and below Livestock Drinking Water (ANZECC 2000) Guidelines for soluble metals and metalloids;

All competent NAF waste rock is considered benign and suitable for use as construction material for road base and hardstand material. Seepage and runoff from these materials has very low risk of adversely affecting existing groundwater quality.

7.0 Reference List

AMIRA 2002. ARD Test Handbook: Project 387A Prediction and Kinetic Control of Acid Mine Drainage. Australian Minerals Industry Research Association, Ian Wark Research Institute and Environmental Geochemistry International Pty Ltd, May 2002.

ANZECC 2000. National Water Quality Management Strategy, Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Australasian Institute of Mining and Metallurgy (AIMM). 1991. Field Geologists' Manual. Monograph 9. 4th ed. Carlton: AIMM.

Beard, J.S. 1990. Plant life of Western Australia. Kenthurst: Kangaroo Press.

BOM 2019. Climate statistics for Australian locations. Summary statistics Meekatharra Bureau of Meteorology

Bowen, H.J.M. 1979. Environmental Chemistry of the Elements. Academic Press, London; New York.

Brady, N. and Weil, R. 2002, The Nature and Properties of Soils - Thirteenth Edition, Prentice Hall, Upper Saddle River, New Jersey.

DITR 2007. Managing Acid and Metalliferous Drainage (Department of Industry, Tourism and Resources, 2007.

Hazelton, P. and Murphy, B. 2007. Interpreting Soil Test Results, What Do All the Numbers Mean? Collingwood: CSIRO Publishing.

Hazelton, P. and Murphy, B. Third edition. 2016. Interrpreting soil test results : what do all the numbers mean? Published by CSIRO Publishing Locked Bag 10 Clayton South VIC 3169 Australia

Hunt and Gikes, 1992 Farm Monitoring handbook: A Practical Down-to-Earth Manual for Farmers and Other Land Users University of Western Australia/Land Management Society, Perth.

INAP 2009. Global Acid Rock Drainage (GARD) Guide. International Network for Acid Prevention, http://www.gardguide.com

McKenzie, N., Coughlan, K. and Cresswell, H. (2002) Soil physical measurement and interpretation for land evaluation. CSIRO Publishing, Canberra.

Moore, G. (1998) Soilguide. A handbook for understanding and managing agricultural soils, Agriculture Western Australia. Bulletin No. 4343.

National Environment Protection Council (NEPC). 2013. National Environment Protection (Assessment of Site Contamination) Measure. Guideline on Laboratory Analysis of Potentially Contaminated Soil. Schedule B3. Canberra: NEPC.

NEPM 2013. Guideline on Investigation Levels for Soil and Groundwater. Schedule B1. National Environment Protection (Assessment of Site Contamination) Measure 1999. Prepared by the Office of Parliamentary Counsel Canberra.

Needham, P., Moore, G. and Scholz., G. (1998) Soil structure decline. In: G. Moore (ed) Soil guide - a handbook for understanding and managing agricultural soils, vol Bulletin No. 4343. Agriculture Western Australia, Perth, Western Australia, pp 64 – 79

Pidgeon, R. T., & Hallberg, J. A. (2000). Age relationships in supracrustal sequences of the northernpart of the Murchison Terrane, Archaean Yilgarn Craton, Western Australia: a combined field and zircon U-Pb study. Australian Journal of Earth Sciences, 47, 153-165.

Purdie, B. R. (1998) Understanding and interpreting soil chemical and physical data. In, vol Bulletin 4343.

Agriculture Western Australia, p 315.

Rayment, G. E. and Higginson, F. R. (1992) Australian Laboratory Handbook of Soil and Chemical Methods. Inkata Press,

Rengasamy, P., Greene, R.S B., Ford, G. W., and Mehanni, A. H. 1984. Identification of dispersive behavior and the management of red brown earths. Australian Journal of Soil Research 22, 413-431.

Timms, N. R. (2007). Structural controls and U-Pb constrains for gold mineralisation in the Murchinson Province WA, Deformation in the desert: Alice Springs, Northern Territory: Geological Society of Australia.

Timms, N., Hollingsworth, D., Culpan, N, Penkethman, A.,Vearncombe, S., and Gates, K. 2011. Geological Mapping Report, Yaloginda Area, Murchison Region, Western Australia.

van Gool, D, Tille, P J, and Moore, G A. (2005), Land evaluation standards for land resource mapping : assessing land qualities and determining land capability in south-western Australia. Department of Agriculture and Food, Western Australia, Perth. Report 298.

Van Kranendonk, M., & Ivanic, T. (2009). A new lithostratigraphic scheme for the northeastern Yilgarn Craton in Geological Survey of Western Australia, Annual Review 2008-2009.

Watkins, K & Hickman, A (1990). Geological evolution and mineralization of the Murchison Province, Western Australia. Perth: Geological Survey of Western Australia.

Wingate, M. T., & Pirajno, F. &. (2004). Wingate, M. T. D., Pirajno, F. & Morris, P. A. 2004, Warakurna large igneous province: A new Mesoproterozoic large igneous province in west-central Australia. Geology 32, 105 - 108.

Appendix 1 – Maid Marion Waste Rock Lab Report

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Administration for Subcontracting
Client	SGS EHS PERTH
Address	5256 601 EHS PERTH 28 REID ROAD PERTH AIRPORT WA 6105
Telephone	08 9373 3500
Facsimile	08 9373 3556
Email	au.environmental.subcon@sgs.com
Project	**PE138827 - Maid Marion MP Soil**
Order Number	**PE138827**
Samples	12

LABORATORY DETAILS

Manager	Anthony Nilsson
Laboratory	SGS Cairns Environmental
Address	Unit 2, 58 Comport St Portsmith QLD 4870
Telephone	+61 07 4035 5111
Facsimile	+61 07 4035 5122
Email	AU.Environmental.Cairns@sgs.com
SGS Reference	**CE142678 R0**
Date Received	28 Oct 2019
Date Reported	13 Nov 2019

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(3146).

SIGNATORIES

Anthony NILSSON
Operations Manager

Jon Dicker
Manager Northern QLD

Leanne ORSMOND
Quality & Microbiology Coordinator

Maristela GANZAN
Metals Team Leader

Parameter	Units	LOR	CE142678.001 Soil 18 Oct 2019 PE138827.001 CGC08926	CE142678.002 Soil 18 Oct 2019 PE138827.002 CGC08927	CE142678.003 Soil 18 Oct 2019 PE138827.003 CGC08928	CE142678.004 Soil 18 Oct 2019 PE138827.004 CGC08929

Sample Number / Sample Matrix / Sample Date / Sample Name

Moisture Content Method: AN002 Tested: 28/10/2019

% Moisture	%w/w	0.5	<0.5	1.1	0.6	<0.5

Particle sizing of soils <75µm by hydrometer Method: AN005 Tested: 4/11/2019

Clay (<0.002mm)	%w/w	0.1	6	10	9	-
Silt and Clay (<0.005mm)*	%w/w	0.1	8	12	11	-
Silt (0.002mm to 0.06mm)*	%w/w	0.1	11	20	16	-
Fine Sand (0.06mm to 0.20mm)*	%w/w	0.1	22	40	33	3
Medium and Coarse Sand (0.20mm to 2.0mm)*	%w/w	0.1	6.2	10	8.0	-
Gravels (>2.0mm)*	%w/w	0.1	53	18	33	97

pH in soil (1:5) Method: AN101 Tested: 4/11/2019

pH	pH Units	-	5.2	4.7	4.6	5.4
pH (CaCl2)*	pH Units	0.1	4.4	4.0	4.0	4.8

Conductivity and TDS by Calculation - Soil Method: AN106 Tested: 4/11/2019

Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	40	50	40	40

Colwell Phosphorus Method: AN015 Tested: 8/11/2019

Colwell Phosphorus	mg/kg	1	4	3	2	1

Bicarbonate Extractable (Colwell) Potassium, K Method: AN015/AN320 Tested: 7/11/2019

Bicarbonate Extractable (Colwell) Potassium, K*	mg/kg	10	150	120	93	57

Parameter	Units	LOR	CE142678.001	CE142678.002	CE142678.003	CE142678.004
Sample Matrix			Soil	Soil	Soil	Soil
Sample Date			18 Oct 2019	18 Oct 2019	18 Oct 2019	18 Oct 2019
Sample Name			PE138827.001 CGC08926	PE138827.002 CGC08927	PE138827.003 CGC08928	PE138827.004 CGC08929

Potassium Chloride Extractable Sulphur   Method: RL 10D1/AN320   Tested: 7/11/2019

KCl-40-extractable Sulphur, S*	mg/kg	1	8	13	12	25

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by Auto Analyser in Soil   Method: AN248   Tested: 8/11/2019

Nitrate/Nitrite Nitrogen, NOx as N	mg/kg	0.05	7.5	6.6	7.8	6.5

Ammonia Nitrogen (soluble) in Soil   Method: AN280   Tested: 11/11/2019

Soluble Ammonia Nitrogen, NH_3 as N	mg/kg	0.1	5.6	5.7	3.1	3.8

Total Organic Carbon by Heanes Oxidation   Method: AN273   Tested: 6/11/2019

Total Organic Carbon	%w/w	0.05	0.33	0.33	0.51	0.18
Organic Matter	%w/w	0.1	0.57	0.56	0.88	0.30

Emerson Class Number   Method: AN009   Tested: 5/11/2019

Emerson Class Number	No unit	1	2	2	2	IS

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR)   Method: AN122   Tested: 4/11/2019

Exchangeable Sodium, Na	mg/kg	2	16	14	7	12
Exchangeable Potassium, K	mg/kg	2	110	88	67	43
Exchangeable Calcium, Ca	mg/kg	2	110	72	95	71
Exchangeable Magnesium, Mg	mg/kg	2	41	24	25	19
Exchangeable Sodium, Na	meq/100g	0.01	0.07	0.06	0.03	0.05
Exchangeable Potassium, K	meq/100g	0.01	0.28	0.22	0.17	0.11
Exchangeable Calcium, Ca	meq/100g	0.01	0.56	0.36	0.48	0.36
Exchangeable Magnesium, Mg	meq/100g	0.02	0.34	0.19	0.21	0.16
Exchangeable Sodium Percentage*	%	0.1	5.5	7.4	3.6	7.7
Exchangeable Potassium Percentage*	%	0.1	22.6	26.7	19.3	16.2
Exchangeable Calcium Percentage*	%	0.1	44.9	42.9	53.8	52.7
Exchangeable Magnesium Percentage*	%	0.1	27.0	22.9	23.4	23.4
Cation Exchange Capacity	meq/100g	0.02	1.3	0.84	0.88	0.67

Parameter	Units	LOR	CE142678.001	CE142678.002	CE142678.003	CE142678.004
Sample Matrix			Soil	Soil	Soil	Soil
Sample Date			18 Oct 2019	18 Oct 2019	18 Oct 2019	18 Oct 2019
Sample Name			PE138827.001 CGC08926	PE138827.002 CGC08927	PE138827.003 CGC08928	PE138827.004 CGC08929

Total Recoverable Elements in Soil/Waste Solids/Materials by ICPOES Method: AN040/AN320 Tested: 4/11/2019

Parameter	Units	LOR	CE142678.001	CE142678.002	CE142678.003	CE142678.004
Arsenic, As	mg/kg	0.5	3.7	4.2	3.8	4.4
Chromium, Cr	mg/kg	0.5	180	180	170	320
Copper, Cu	mg/kg	0.5	16	15	16	55
Iron, Fe	mg/kg	50	47000	42000	42000	150000
Nickel, Ni	mg/kg	0.5	17	18	13	79
Lead, Pb	mg/kg	0.5	7.0	6.7	7.1	23
Zinc, Zn	mg/kg	0.5	13	12	11	63

Parameter	Units	LOR	CE142678.005	CE142678.006	CE142678.007	CE142678.008
Sample Matrix			Soil	Soil	Soil	Soil
Sample Date			18 Oct 2019	18 Oct 2019	18 Oct 2019	18 Oct 2019
Sample Name			PE138827.005 CGC08930	PE138827.006 CGC08931	PE138827.007 CGC08934	PE138827.008 CGC08935

Moisture Content Method: AN002 Tested: 28/10/2019

% Moisture	%w/w	0.5	0.9	0.6	0.5	<0.5

Particle sizing of soils <75µm by hydrometer Method: AN005 Tested: 4/11/2019

Clay (<0.002mm)	%w/w	0.1	10	10	10	8
Silt and Clay (<0.005mm)*	%w/w	0.1	14	14	16	14
Silt (0.002mm to 0.06mm)*	%w/w	0.1	23	22	48	21
Fine Sand (0.06mm to 0.20mm)*	%w/w	0.1	23	22	14	22
Medium and Coarse Sand (0.20mm to 2.0mm)*	%w/w	0.1	23	19	11	35
Gravels (>2.0mm)*	%w/w	0.1	18	23	11	7.7

pH in soil (1:5) Method: AN101 Tested: 4/11/2019

pH	pH Units	-	6.9	6.3	7.0	5.7
pH (CaCl2)*	pH Units	0.1	5.8	5.9	6.4	4.3

Conductivity and TDS by Calculation - Soil Method: AN106 Tested: 4/11/2019

Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	30	340	180	10

Colwell Phosphorus Method: AN015 Tested: 8/11/2019

Colwell Phosphorus	mg/kg	1	2	2	1	4

Bicarbonate Extractable (Colwell) Potassium, K Method: AN015/AN320 Tested: 7/11/2019

Bicarbonate Extractable (Colwell) Potassium, K*	mg/kg	10	280	260	290	190

Parameter	Units	LOR	CE142678.005	CE142678.006	CE142678.007	CE142678.008
Sample Matrix			Soil	Soil	Soil	Soil
Sample Date			18 Oct 2019	18 Oct 2019	18 Oct 2019	18 Oct 2019
Sample Name			PE138827.005 CGC08930	PE138827.006 CGC08931	PE138827.007 CGC08934	PE138827.008 CGC08935

Potassium Chloride Extractable Sulphur Method: RL 10D1/AN320 Tested: 7/11/2019

Parameter	Units	LOR	CE142678.005	CE142678.006	CE142678.007	CE142678.008
KCl-40-extractable Sulphur, S*	mg/kg	1	4	61	24	3

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by Auto Analyser in Soil Method: AN248 Tested: 8/11/2019

Parameter	Units	LOR	CE142678.005	CE142678.006	CE142678.007	CE142678.008
Nitrate/Nitrite Nitrogen, NOx as N	mg/kg	0.05	1.3	37	21	0.74

Ammonia Nitrogen (soluble) in Soil Method: AN280 Tested: 11/11/2019

Parameter	Units	LOR	CE142678.005	CE142678.006	CE142678.007	CE142678.008
Soluble Ammonia Nitrogen, NH_3 as N	mg/kg	0.1	6.1	7.9	3.6	2.5

Total Organic Carbon by Heanes Oxidation Method: AN273 Tested: 6/11/2019

Parameter	Units	LOR	CE142678.005	CE142678.006	CE142678.007	CE142678.008
Total Organic Carbon	%w/w	0.05	0.19	0.23	0.23	0.23
Organic Matter	%w/w	0.1	0.33	0.39	0.40	0.40

Emerson Class Number Method: AN009 Tested: 5/11/2019

Parameter	Units	LOR	CE142678.005	CE142678.006	CE142678.007	CE142678.008
Emerson Class Number	No unit	1	1	2	2	2

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) Method: AN122 Tested: 4/11/2019

Parameter	Units	LOR	CE142678.005	CE142678.006	CE142678.007	CE142678.008
Exchangeable Sodium, Na	mg/kg	2	52	100	67	7
Exchangeable Potassium, K	mg/kg	2	190	170	100	130
Exchangeable Calcium, Ca	mg/kg	2	320	380	570	70
Exchangeable Magnesium, Mg	mg/kg	2	250	340	520	67
Exchangeable Sodium, Na	meq/100g	0.01	0.22	0.45	0.29	0.03
Exchangeable Potassium, K	meq/100g	0.01	0.49	0.44	0.27	0.32
Exchangeable Calcium, Ca	meq/100g	0.01	1.6	1.9	2.8	0.35
Exchangeable Magnesium, Mg	meq/100g	0.02	2.1	2.8	4.3	0.55
Exchangeable Sodium Percentage*	%	0.1	5.1	8.1	3.8	2.3
Exchangeable Potassium Percentage*	%	0.1	11.1	7.9	3.5	25.8
Exchangeable Calcium Percentage*	%	0.1	36.4	33.8	37.1	27.8
Exchangeable Magnesium Percentage*	%	0.1	47.3	50.2	55.7	44.0
Cation Exchange Capacity	meq/100g	0.02	4.4	5.6	7.7	1.3

Parameter	Units	LOR	CE142678.005	CE142678.006	CE142678.007	CE142678.008
Sample Matrix			Soil	Soil	Soil	Soil
Sample Date			18 Oct 2019	18 Oct 2019	18 Oct 2019	18 Oct 2019
Sample Name			PE138827.005 CGC08930	PE138827.006 CGC08931	PE138827.007 CGC08934	PE138827.008 CGC08935

Total Recoverable Elements in Soil/Waste Solids/Materials by ICPOES   Method: AN040/AN320   Tested: 4/11/2019

Parameter	Units	LOR	CE142678.005	CE142678.006	CE142678.007	CE142678.008
Arsenic, As	mg/kg	0.5	5.0	4.8	15	5.4
Chromium, Cr	mg/kg	0.5	250	230	410	230
Copper, Cu	mg/kg	0.5	23	24	57	17
Iron, Fe	mg/kg	50	45000	42000	60000	40000
Nickel, Ni	mg/kg	0.5	30	37	190	20
Lead, Pb	mg/kg	0.5	7.4	6.6	5.2	7.6
Zinc, Zn	mg/kg	0.5	21	20	53	16

Parameter	Units	LOR	CE142678.009	CE142678.010	CE142678.011	CE142678.012
Sample Matrix			Soil	Soil	Soil	Soil
Sample Date			18 Oct 2019	18 Oct 2019	18 Oct 2019	18 Oct 2019
Sample Name			PE138827.009 CGC08936	PE138827.010 CGC08937	PE138827.011 CGC08938	PE138827.012 CGC08939

Moisture Content Method: AN002 Tested: 28/10/2019

Parameter	Units	LOR	CE142678.009	CE142678.010	CE142678.011	CE142678.012
% Moisture	%w/w	0.5	<0.5	<0.5	<0.5	0.6

Particle sizing of soils <75µm by hydrometer Method: AN005 Tested: 4/11/2019

Parameter	Units	LOR	CE142678.009	CE142678.010	CE142678.011	CE142678.012
Clay (<0.002mm)	%w/w	0.1	9	6	8	8
Silt and Clay (<0.005mm)*	%w/w	0.1	12	10	10	14
Silt (0.002mm to 0.06mm)*	%w/w	0.1	18	21	21	25
Fine Sand (0.06mm to 0.20mm)*	%w/w	0.1	22	24	17	17
Medium and Coarse Sand (0.20mm to 2.0mm)*	%w/w	0.1	33	31	36	32
Gravels (>2.0mm)*	%w/w	0.1	15	15	16	12

pH in soil (1:5) Method: AN101 Tested: 4/11/2019

Parameter	Units	LOR	CE142678.009	CE142678.010	CE142678.011	CE142678.012
pH	pH Units	-	5.5	5.7	5.3	4.6
pH (CaCl2)*	pH Units	0.1	4.8	5.0	4.1	4.0

Conductivity and TDS by Calculation - Soil Method: AN106 Tested: 4/11/2019

Parameter	Units	LOR	CE142678.009	CE142678.010	CE142678.011	CE142678.012
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	50	90	10	30

Colwell Phosphorus Method: AN015 Tested: 8/11/2019

Parameter	Units	LOR	CE142678.009	CE142678.010	CE142678.011	CE142678.012
Colwell Phosphorus	mg/kg	1	1	<1	7	2

Bicarbonate Extractable (Colwell) Potassium, K Method: AN015/AN320 Tested: 7/11/2019

Parameter	Units	LOR	CE142678.009	CE142678.010	CE142678.011	CE142678.012
Bicarbonate Extractable (Colwell) Potassium, K*	mg/kg	10	170	160	130	130

Parameter	Units	LOR	Sample Number: CE142678.009 Sample Matrix: Soil Sample Date: 18 Oct 2019 Sample Name: PE138827.009 CGC08936	CE142678.010 Soil 18 Oct 2019 PE138827.010 CGC08937	CE142678.011 Soil 18 Oct 2019 PE138827.011 CGC08938	CE142678.012 Soil 18 Oct 2019 PE138827.012 CGC08939

Potassium Chloride Extractable Sulphur Method: RL 10D1/AN320 Tested: 7/11/2019

KCl-40-extractable Sulphur, S*	mg/kg	1	17	22	3	11

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by Auto Analyser in Soil Method: AN248 Tested: 8/11/2019

Nitrate/Nitrite Nitrogen, NOx as N	mg/kg	0.05	5.7	12	0.91	3.0

Ammonia Nitrogen (soluble) in Soil Method: AN280 Tested: 11/11/2019

Soluble Ammonia Nitrogen, NH_3 as N	mg/kg	0.1	1.1	1.1	3.9	1.1

Total Organic Carbon by Heanes Oxidation Method: AN273 Tested: 6/11/2019

Total Organic Carbon	%w/w	0.05	0.06	0.11	0.33	0.20
Organic Matter	%w/w	0.1	0.11	0.18	0.57	0.35

Emerson Class Number Method: AN009 Tested: 5/11/2019

Emerson Class Number	No unit	1	2	2	2	2

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) Method: AN122 Tested: 4/11/2019

Exchangeable Sodium, Na	mg/kg	2	42	94	3	5
Exchangeable Potassium, K	mg/kg	2	130	120	75	85
Exchangeable Calcium, Ca	mg/kg	2	120	160	64	95
Exchangeable Magnesium, Mg	mg/kg	2	97	140	38	42
Exchangeable Sodium, Na	meq/100g	0.01	0.18	0.41	0.01	0.02
Exchangeable Potassium, K	meq/100g	0.01	0.32	0.32	0.19	0.22
Exchangeable Calcium, Ca	meq/100g	0.01	0.60	0.82	0.32	0.47
Exchangeable Magnesium, Mg	meq/100g	0.02	0.79	1.1	0.31	0.34
Exchangeable Sodium Percentage*	%	0.1	9.6	15.4	1.7	2.1
Exchangeable Potassium Percentage*	%	0.1	17.1	11.8	22.8	20.6
Exchangeable Calcium Percentage*	%	0.1	31.5	30.9	38.0	44.9
Exchangeable Magnesium Percentage*	%	0.1	41.7	41.9	37.5	32.4
Cation Exchange Capacity	meq/100g	0.02	1.9	2.7	0.84	1.1

Parameter	Units	LOR	CE142678.009	CE142678.010	CE142678.011	CE142678.012
Sample Matrix			Soil	Soil	Soil	Soil
Sample Date			18 Oct 2019	18 Oct 2019	18 Oct 2019	18 Oct 2019
Sample Name			PE138827.009 CGC08936	PE138827.010 CGC08937	PE138827.011 CGC08938	PE138827.012 CGC08939

Total Recoverable Elements in Soil/Waste Solids/Materials by ICPOES Method: AN040/AN320 Tested: 4/11/2019

Parameter	Units	LOR	CE142678.009	CE142678.010	CE142678.011	CE142678.012
Arsenic, As	mg/kg	0.5	4.3	5.1	4.2	5.6
Chromium, Cr	mg/kg	0.5	220	270	410	410
Copper, Cu	mg/kg	0.5	18	21	17	20
Iron, Fe	mg/kg	50	40000	44000	46000	53000
Nickel, Ni	mg/kg	0.5	18	28	17	17
Lead, Pb	mg/kg	0.5	13	12	8.3	8.3
Zinc, Zn	mg/kg	0.5	14	16	16	15

QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Ammonia Nitrogen (soluble) in Soil   Method: ME-(AU)-[ENV]AN280

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Soluble Ammonia Nitrogen, NH_3 as N	LB073201	mg/kg	0.1	<0.1	3 - 5%	105%

Bicarbonate Extractable (Colwell) Potassium, K   Method: ME-(AU)-[ENV]AN015/AN320

Parameter	QC Reference	Units	LOR	MB	DUP %RPD
Bicarbonate Extractable (Colwell) Potassium, K*	LB073108	mg/kg	10	<10	1 - 5%

Colwell Phosphorus   Method: ME-(AU)-[ENV]AN015

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Colwell Phosphorus	LB073140	mg/kg	1	<1	0 - 7%	93 - 96%

Conductivity and TDS by Calculation - Soil   Method: ME-(AU)-[ENV]AN106

Parameter	QC Reference	Units	LOR	DUP %RPD
Conductivity of Extract (1:5 dry sample basis)	LB072977	µS/cm	1	0%

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR)   Method: ME-(AU)-[ENV]AN122

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Exchangeable Sodium, Na	LB072953	mg/kg	2		12 - 18%	96%
Exchangeable Potassium, K	LB072953	mg/kg	2		2 - 3%	97%
Exchangeable Calcium, Ca	LB072953	mg/kg	2		0 - 4%	97%
Exchangeable Magnesium, Mg	LB072953	mg/kg	2		0 - 5%	99%
Exchangeable Sodium, Na	LB072953	meq/100g	0.01	<0.01		
Exchangeable Potassium, K	LB072953	meq/100g	0.01	<0.01		
Exchangeable Calcium, Ca	LB072953	meq/100g	0.01	<0.01		
Exchangeable Magnesium, Mg	LB072953	meq/100g	0.02	<0.02		
Exchangeable Sodium Percentage*	LB072953	%	0.1	<0.1		
Exchangeable Potassium Percentage*	LB072953	%	0.1	72.2		
Exchangeable Calcium Percentage*	LB072953	%	0.1	23.7		
Exchangeable Magnesium Percentage*	LB072953	%	0.1	6.5		
Cation Exchange Capacity	LB072953	meq/100g	0.02	<0.02		

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by Auto Analyser in Soil Method: ME-(AU)-[ENV]AN248

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Nitrate/Nitrite Nitrogen, NOx as N	LB073096	mg/kg	0.05	<0.05	8 - 18%	109 - 110%
	LB073136	mg/kg	0.05	<0.05	2%	110%

pH in soil (1:5) Method: ME-(AU)-[ENV]AN101

Parameter	QC Reference	Units	LOR	DUP %RPD
pH	LB072974	pH Units	-	0%
pH (CaCl2)*	LB072974	pH Units	0.1	0%

Potassium Chloride Extractable Sulphur Method: RL 10D1/AN320

Parameter	QC Reference	Units	LOR	DUP %RPD
KCl-40-extractable Sulphur, S*	LB073084	mg/kg	1	0 - 5%

Total Organic Carbon by Heanes Oxidation Method: ME-(AU)-[ENV]AN273

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Total Organic Carbon	LB072991	%w/w	0.05	<0.05	2 - 3%	96%	105%
Organic Matter	LB072991	%w/w	0.1	<0.10	2 - 3%	NA	NA

Total Recoverable Elements in Soil/Waste Solids/Materials by ICPOES Method: ME-(AU)-[ENV]AN040/AN320

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Arsenic, As	LB072959	mg/kg	0.5	<0.5	2 - 17%	NA
Chromium, Cr	LB072959	mg/kg	0.5	<0.5	3 - 6%	NA
Copper, Cu	LB072959	mg/kg	0.5	<0.5	1 - 3%	NA
Iron, Fe	LB072959	mg/kg	50	<50	3%	NA
Nickel, Ni	LB072959	mg/kg	0.5	<0.5	0 - 9%	NA
Lead, Pb	LB072959	mg/kg	0.5	<0.5	5 - 13%	NA
Zinc, Zn	LB072959	mg/kg	0.5	<0.5	0 - 5%	NA

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN005	Following wet sieving of the sample,(particles smaller than 75 µm) a dispersing solution is added and a hydrometer is used to measure sedimentation. Soil density is determined and the percentage of each size fraction calculated. Referenced to AS1289.3.6.3.
AN009	The method follows AS1289 3.8.1 - 2006. Soils are divided into seven classes on the basis of their coherence in water, with one further class being distinguished by the presence of calcium-rich minerals. Class 1: Air-dried crumbs of soil show a strong dispersion reaction, i.e., a colloidal cloud covers nearly the whole of the bottom of the beaker, usually in a very thin layer. The reaction should be evident within 10min. In extreme cases all the water in the beaker becomes cloudy, leaving only a coarse residue in a cloud of clay.
AN009	Class 2: Air-dried crumbs of soil show a moderate to slight reaction. A moderate reaction consists of an easily recognisable cloud of colloids in suspension, usually spreading in thin streaks on the bottom of the beaker. A slight reaction consists of the bare hint of cloud in water at the surface of the crumbs. Class 3: The soil remoulded at the plastic limit disperses in water. Class 4: The remoulded soil does not disperse in water. Calcium carbonate (calcite) or calcium sulfate (gypsum) is present. Class 5: The remoulded soil does not disperse in water and the 1:5 soil/water suspension remains dispersed after 5 min.
AN009	Class 6: The remoulded soil does not disperse in water and the 1:5 soil/water suspension begins to flocculate within 5 min. Class 7: The air-dried crumbs of soil remain coherent in water and swells. Class 8: The air-dried crumbs of soil remain coherent in water and do not swell.
AN015	Soil sample is extracted in an end over end roller in 0.5 N sodium bicarbonate at pH 8.5 with the supernatant liquor analysed for Phosphorous. Orthophosphate anion (PO43-) is reacted with ammonium molybdate and potassium antimony tartrate in sulfuric acid solution. The resulting phospho-molybdate complex is reduced, using ascorbic acid, to an intense blue coloured complex Molybdenum Blue. The absorbance of this complex is measured at 880 nm by Discrete Analyser, and compared with calibration standards to obtain the concentration of orthophosphate in the sample. Based on Rayment & Higginson 9B1.
AN015/AN320	Soil sample is extracted in an end over end roller in 0.5 N sodium bicarbonate at pH 8.5 with the supernatant liquor analysed for Potassium by ICP OES. Based on Rayment & Higginson 18A1.
AN040/AN320	A portion of sample is digested with nitric acid to decompose organic matter and hydrochloric acid to complete the digestion of metals. The digest is then analysed by ICP OES with metals results reported on the dried sample basis. Based on USEPA method 200.8 and 6010C.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode and is calibrated against 3 buffers purchased commercially. For soils, sediments and sludges, an extract with water (or 0.01M CaCl2) is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos/cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Salinity can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. Reference APHA 2510 B.
AN122	Exchangeable Cations, CEC and ESP: Soil sample is extracted in 1 M Ammonium Acetate at pH=7 (or 1M Ammonium Chloride at pH=7) with cations (Na, K, Ca & Mg) then determined by ICP OES/ICP MS and reported as Exchangeable Cations. For saline soils, these results can be corrected for water soluble cations and reported as Exchangeable cations in meq/100g or soil can be pre-treated (aqueous ethanol/aqueous glycerol) prior to extraction. Cation Exchange Capacity (CEC) is the sum of the exchangeable cations in meq/100g.

METHOD	METHODOLOGY SUMMARY
AN122	The Exchangeable Sodium Percentage (ESP) is calculated as the exchangeable sodium divided by the CEC (all in meq/100g) times 100. ESP can be used to categorise the sodicity of the soil as below: ESP < 6% non-sodic ESP 6-15% sodic ESP >15% strongly sodic Method is referenced to Rayment and Lyons, 2011, sections 15D3 and 15N1.-
AN248	Nitrate / Nitrite in extract by Auto Analyser: In an acidic medium, nitrate is reduced quantitatively to nitrite by cadmium metal. This nitrite plus any original nitrite is determined as an intense red-pink azo dye at 540 nm following diazotisation with sulphanilamide and subsequent coupling with N-(1-naphthyl) ethylenediamine dihydrochloride. Reference APHA 4500-NO3- F.
AN273	The sample is digested in Dichromate / Sulfuric Acid to oxidise the organic carbon. The determination is completed colourimetrically by Aquakem Discrete Analyser at 600 nm. Based on Rayment & Higginson 6B1.
AN280	Filtered soil water extract containing ammonia (NH3) or ammonium cations (NH4+) is reacted with alkaline phenol and hypochlorite in a buffered solution to form the blue indophenol colour. The absorbance is measured at 630nm and compared with calibration standards to obtain the concentration of ammonia in the sample.
RL 10D1/AN320	Air dried <2mm soil is extractedin 0.25M KCl at 40 deg C followed by analysis of filtrate for S by ICP OES. Referenced to Rayment and Lyons method 10D1.

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	NATA accreditation does not cover the performance of this service.	QFH	QC result is above the upper tolerance
**	Indicative data, theoretical holding time exceeded.	QFL	QC result is below the lower tolerance
		-	The sample was not analysed for this analyte
		NVL	Not Validated

Unless it is reported that sampling has been performed by SGS, the samples have been analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calcuated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au.pv.sgsvr/en-gb/environment.

ANALYTICAL REPORT

CLIENT DETAILS		LABORATORY DETAILS	
Contact	Administration for Subcontracting	Manager	Anthony Nilsson
Client	SGS EHS PERTH	Laboratory	SGS Cairns Environmental
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Project	**PE138827 - Maid Marion MP Soil Additiona**	SGS Reference	**CE142678A R0**
Order Number	**PE138827**	Date Received	07 Nov 2019
Samples	12	Date Reported	12 Nov 2019

COMMENTS

Whilst SGS laboratories conform to ISO:17025 standards, results of analysis in this report fall outside of the current scope of NATA accreditation .

SIGNATORIES

Anthony NILSSON
Operations Manager

Jon Dicker
Manager Northern QLD

Parameter	Units	LOR	CE142678A.001	CE142678A.002	CE142678A.003	CE142678A.004
Sample Matrix			Soil	Soil	Soil	Soil
Sample Date			30 Oct 2019	30 Oct 2019	30 Oct 2019	30 Oct 2019
Sample Name			PE138827.001 CGC08947	PE138827.002 CGC08948	PE138827.003 CGC08949	PE138827.004 CGC08950
Constant Head Permeability (Saturated Conductivity) Method: AN036 Tested: 8/11/2019						
Saturated Hydraulic Conductivity (K)	mm/hour	0.01	2.5	0.37	3.9	0.65

		Sample Number	CE142678A.005	CE142678A.006	CE142678A.007	CE142678A.008
		Sample Matrix	Soil	Soil	Soil	Soil
		Sample Date	30 Oct 2019	30 Oct 2019	30 Oct 2019	30 Oct 2019
		Sample Name	PE138827.005 CGC08951	PE138827.006 CGC08952	PE138827.007 CGC08953	PE138827.008 CGC08954
Parameter	Units	LOR				
Constant Head Permeability (Saturated Conductivity) Method: AN036 Tested: 8/11/2019						
Saturated Hydraulic Conductivity (K)	mm/hour	0.01	2.2	2.4	0.97	5.4

Parameter	Units	LOR	Sample Number / Sample Matrix / Sample Date / Sample Name	CE142678A.009 / Soil / 30 Oct 2019 / PE138827.009 CGC08955	CE142678A.010 / Soil / 30 Oct 2019 / PE138827.010 CGC08956	CE142678A.011 / Soil / 30 Oct 2019 / PE138827.011 CGC08957	CE142678A.012 / Soil / 30 Oct 2019 / PE138827.012 CGC08958
Constant Head Permeability (Saturated Conductivity) Method: AN036 Tested: 8/11/2019							
Saturated Hydraulic Conductivity (K)	mm/hour	0.01		12	9.8	4.3	16

QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage*. Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

No QC samples were reported for this job.

METHOD SUMMARY

METHOD	METHODOLOGY SUMMARY
AN036	Soil should be in a moist condition ("as received") as dry samples can be water repellent. The <10mm sieved soil is lightly compacted in a plastic cylinder which has a drainage mesh at the bottom. The soil is saturated overnight and then the permeability (cm/hr) is measured under a constant head of 6 cm of water. The permeability is calculated using Darcy's law for saturated vertical flow.

FOOTNOTES

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Some totals may not appear to add up because the total is rounded after adding up the raw values.

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The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au.pv.sgsvr/en-gb/environment.

APPENDIX D - HYDROLOGICAL STUDIES TO SUPPORT MINING PROPOSAL – MAID MARION PROJECT

HYDROLOGICAL STUDIES TO SUPPORT MINING PROPOSAL

Maid Marion Project

EWP19056.002
Hydrological Studies to support Mining Proposal
3
19 November 2019

rpsgroup.com

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
0	Issued to Client for Review	NT, RW, ER	RC	RC	10/10/2019
1	Updated with Production Bore design	NT, RW, ER	RC	RC	18/10/2019
2	Updated with Client Review Comments	NT, RW, ER	RC	RC	8/11/2019
3	Updated with Pit Shell Changes	NT, RW, ER	RC	RC	19/11/2019

Approval for issue

Ron Colman	Ron Colman	19 November 2019

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EXECUTIVE SUMMARY

Westgold Resources (**Westgold**) are seeking to develop the new Maid Marion gold project (the **Project**), located 16km north of Meekatharra (660km north of Perth) in the in the Murchison Goldfields of Western Australia. As part of enabling works for this Project, Westgold has commissioned RPS to conduct a desktop surface water and groundwater assessment that will be used as inputs to the Mining Proposal document. The assessment was completed to assist in understanding the hydrological and hydrogeological environment associated with the project and is used as a risk management tool to ensure there are sufficient controls, systems and processes in place to develop the project in a safe manner that also lowers potential environmental risks.

The proposed development is a simple operation that will include an open pit mine; waste rock storage facility; Run of Mine (ROM) pads; topsoil storage areas; and also small-scale support infrastructure such as a site office, ablutions building, workshop, temporary self-bunded fuel storage, and laydown / parking areas. All infrastructure areas will be bunded to control surface-water flows where appropriate. Ore will be hauled to Bluebird via road train along the Great Northern Highway and no chemical processing or tailings will be involved. The current Project preliminary design (November 2019) has a total disturbance area of 54 ha and is planned to operate over a 7-month period.

The Project lies adjacent to the Garden Gully Creek, at the very top of the Murchison River catchment. It has a hot and dry climate, with unreliable rainfall. This area is part of the Meekatharra–Wydgee Greenstone Belt that features high-Mg basalts, BIF, talc schist, and various metasedimentary rocks. Weathering in the area is commonly deep, except around cherty banded iron-formation and quartz veins that outcrop in the western part of the Project area.

The surface water assessment shows that the Project infrastructure lies on flat undulating ground. It is likely to be minimally impacted by surface water flooding, and only minor bunding is required to protect the infrastructure. While there is a minimal risk of erosion and sedimentation on disturbed ground it will still be managed and monitored during the mine life to minimise adverse impacts. Storage areas will be located away from, or bunded off from, external surface water flows.

Potential pit flood volumes are typically low with the calculated 100-year ARI 72-hour rainfall event accumulating just over 9,000kL in the pit. This could be pumped out of the within 1 day with a pumping capacity of 100L/s.

The groundwater assessment indicates that the Project is within a local fractured-rock aquifer, with the water table about 10m below ground and water quality expected to be brackish. This type of aquifer is typically not high-yielding, and the Project is not expected to have a large dewatering volume. However, a sensitivity analysis using three likely hydraulic conductivity values gave wide range of values; a lower estimate of 454 kL/d (a total volume of ~95,000 kL), a mid-case estimate of 980 kL/d (a total volume of ~190,000kL) and an upper estimate of 2,770 kL/d (a total volume of ~580,000 kL). Most likely the Project will produce less than 300,000 kL from dewatering, which will be used for dust suppression around the Project in the first instance. Remaining water could either be used for other purposes at the Meekatharra Gold Operations, reticulated on waste dumps and evaporated, or discharged to the Garden Gully Creek. The uncertainty around the total dewatering volume indicates that further test work on the BIF may be required to better constrain the inflows, as some of the water management options will require additional infrastructure.

An amendment to the existing 5C licence (GWL 156252) will be required, to include dewatering at Maid Marion. Following submission of the amendment DWER will advise of any additional reporting or investigation work.

At completion it is anticipated that the pit void will become a local groundwater sink, with final water levels lower than the regional water table at ~500 mAHD. The rehabilitated Project areas will be free draining, non-polluting and visually compatible with the surrounding landscape, and suitable for alternative land use. The final waste dump slopes will be in equilibrium with local conditions of rainfall, soil type, and vegetation cover and form long term stable landforms.

An abandonment bund will be constructed at closure to fulfil minimum requirements of 2m high, 5m wide at base, and wherever possible, constructed from unweathered, freely draining rockfill.

1 INTRODUCTION

Westgold Resources (**Westgold**) are seeking to develop the Maid Marion gold project (the **Project**), located 16km north of Meekatharra (660km north of Perth) in the in the Murchison Goldfields of Western Australia (Figure 1). The Project represents an expansion of Westgold's existing Meekatharra Gold Operations (**MGO**).

Maid Marion project is located on Mining tenement M51/504, with haulage to be undertaken on M51/668. The current Project preliminary design (November 2019) is anticipated to have a disturbance area of 54 ha. The project involves the excavation of a new open pit mine that will be about 400m long by 200m wide by 70m deep. The pit will be active for about 7 months.

The proposed development is a simple operation that will include topsoil storage; open-pit mine; waste rock storage facility; Run of Mill (ROM) pads; and bunds. Facilities also include offices, ablutions, workshop, temporary self-bunded fuel storage, and laydown / parking areas. Ore will be transported off site and no chemical processing or tailings will be involved in the operation at Maid Marion Project.

Westgold requires a hydrological and hydrogeological desktop study to support their Mining Proposal. The aim of the study is to improve the understanding of the hydrological and hydrogeological environment associated with the project and will be used as a risk management tool to ensure there are sufficient controls, systems and processes in place to develop the project in a safe manner that also lowers potential environmental risks. The hydrological and hydrogeological assessments focus on the key requirements of the Mining Proposal, to a level of detail warranted by the site hydrology and hydrogeology, and the operational footprint.

1.1 Document Organisation

This document is divided into two sections; a surface water assessment and a groundwater assessment.

The surface water assessment is a high-level desk-top study of potential environmental and engineering hydrological impacts associated with the proposed mine, and includes:

- A description of the catchment areas;
- A description of the surface hydrology of the project area, and downstream environment;
- A description of the environmental values and beneficial uses of surface water;
- Details of any nearby surface water management areas;
- A summary of surface water quality characteristics; and
- A description of the flooding characteristics of the area.

The groundwater assessment is a high-level desk-top study of potential hydrogeological impacts and requirements of the proposed mine, and includes:

- An overview of the regional and local hydrogeology;
- A description of the environmental values and beneficial use of groundwater in the area;
- Details of any nearby groundwater management areas;
- A hydrogeological conceptualisation of the mine area
- An analytical dewatering / drawdown assessment
- A sensitivity / range analysis; and
- A summary of groundwater quality characteristics.

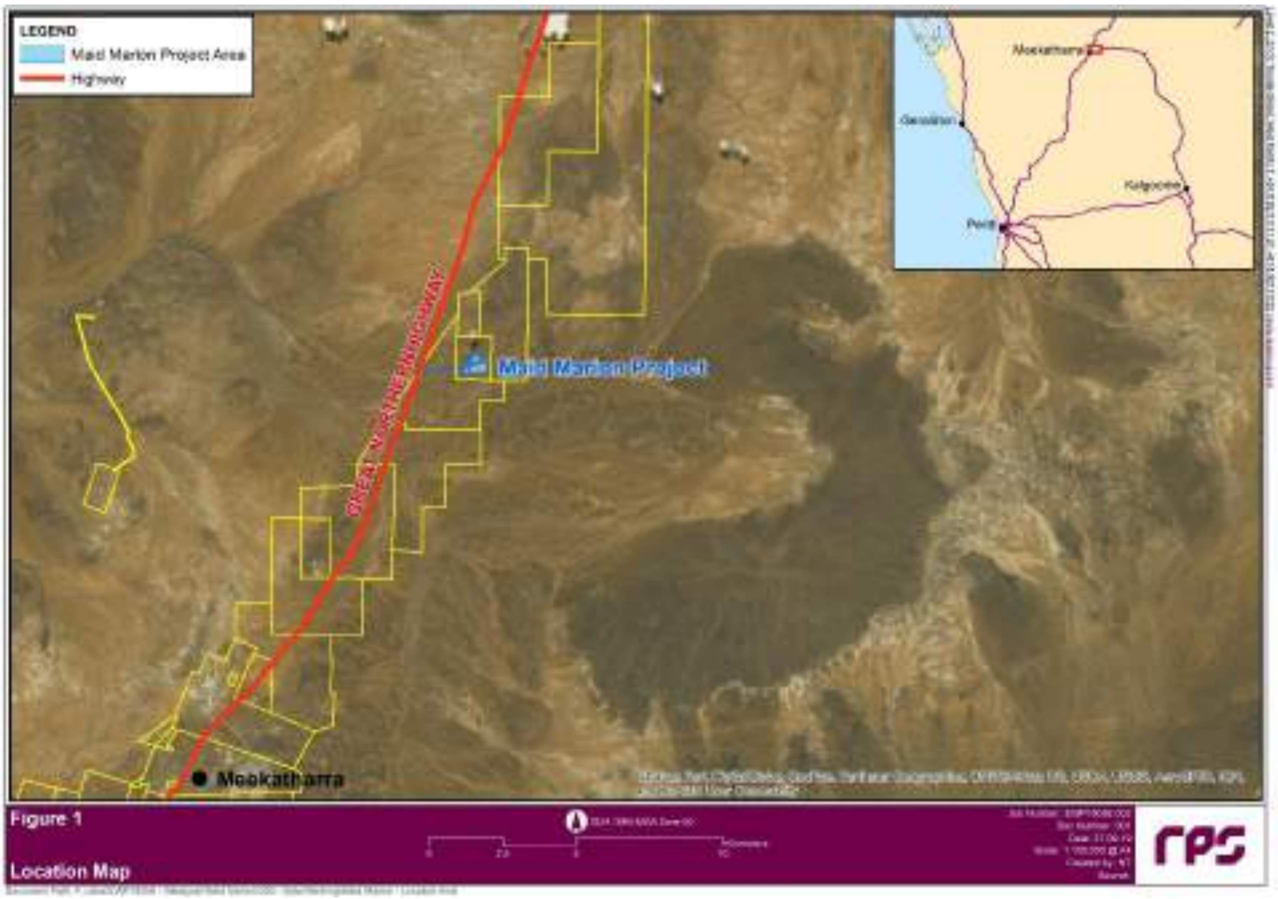

Figure 1 Location map of the Maid Marion Project

2 EXISTING ENVIRONMENT

2.1 Hydrology

2.1.1 Climate

The Project area has a hot arid climate. Figure 2 and Figure 3 show the seasonal cycle for temperature, rainfall and evaporation for the Meekatharra Bureau of Meteorology Station (16km south of the Project).

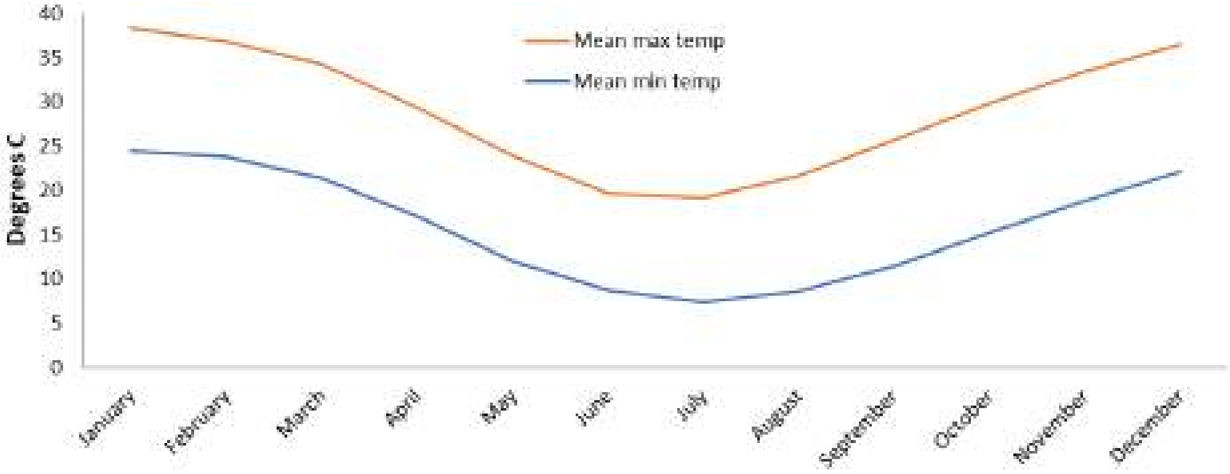

Figure 2 Seasonal temperature at Meekatharra

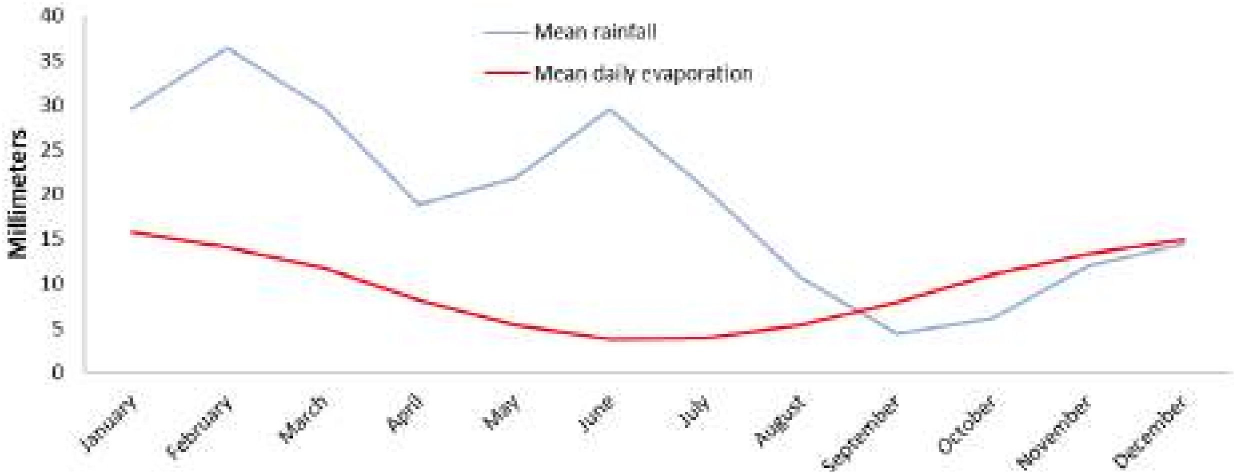

Figure 3 Mean monthly rainfall and evaporation at Meekatharra

Rainfall is unreliable and inconsistent; summer rainfall events originate from the north-west often from decaying tropical cyclones, most likely between January and March, whereas in the winter months rainfall originates from stronger cold fronts that extend well north of their typical range. Annual average rainfall for Meekatharra (BoM site no. 007045) is 238mm, with rain falling on an average of 46 days per year. The annual potential pan evaporation rate is 3,500mm, with mean maximum temperatures ranging from 19.2°C in winter to 38.3°C in summer

The principle features of rainfall patterns and the associated dryland creek systems in arid regions are unreliability and inconsistency, with variable hydrological regimes (erratic extremes of drought and flood). The infrequent and irregular heavy thunderstorms create higher intensity short duration rainfall events with the possibility of inundation and local flooding.

2.2 Geology & Hydrogeology

2.2.1 Geology

The Project lies in the Meekatharra–Wydgee greenstone belt of the Youanmi Terrane in the northwest Yilgarn Craton.

2.2.1.1 Geological Setting

Structure

The Project area lies on the western limb of a regional north-plunging synform; the Pollele Syncline (Timms, 2011), and rocks typically dip steeply to the east. The large NNE–SSW Meekatharra Shear Zone runs along the western side of the Project area and bounds the greenstone belt from granitoid rocks to the west.

Regional Geology

The Meekatharra–Wydgee greenstone belt has recently been defined as the Norie Group of the Murchison Supergroup (Romano, 2018), with both the Singleton Formation (metamorphosed basalt and komatiitic basalt) and Yaloginda Formation (metamorphosed felsic volcaniclastic rock and banded-iron formation (BIF), local metasiliclastic rocks) present in the Project area. The greenstone belt is bounded to the west by the Chunderloo Monzogranite.

Local Geology

The local geology has been deformed in the nose of a smaller antiform within the larger Pollele Syncline. The antiform swings from a NE orientation to a distinctly E–W orientation where the inferred antiform is heavily faulted. The Project area features high-Mg basalts, BIF, talc schist, various metasedimentary rocks and is bounded to the west by granitic rocks. Quartz veining is common throughout the area.

Weathering

Weathering in the area is commonly deep, except around cherty banded iron-formation and quartz veins that outcrop in the western part of the Project. Exploration drilling shows that the base of oxidation extends to more than 100m depth in some areas. The deep weathering appears most intense south of a jog in the Meekatharra Shear Zone through the centre of the Project area. The immediate pit area features weathered BIF and Mafic schist.

Base of complete oxidation (BOCO) data supplied by Westgold was used to create an interpreted weathering surface for the project area (Figure 4). The weathering in the Project is focused in mafic schist to the west of the pit area. Weathering in the pit varies from around 10mbgl to 60mbgl (near the base of the pit). This weathering profile will have significant bearing on the dewatering of the pit. Weathered BIF is likely to allow free flow of water. However, the clays associated with the weathered mafic rocks are likely to require more time to dewater.

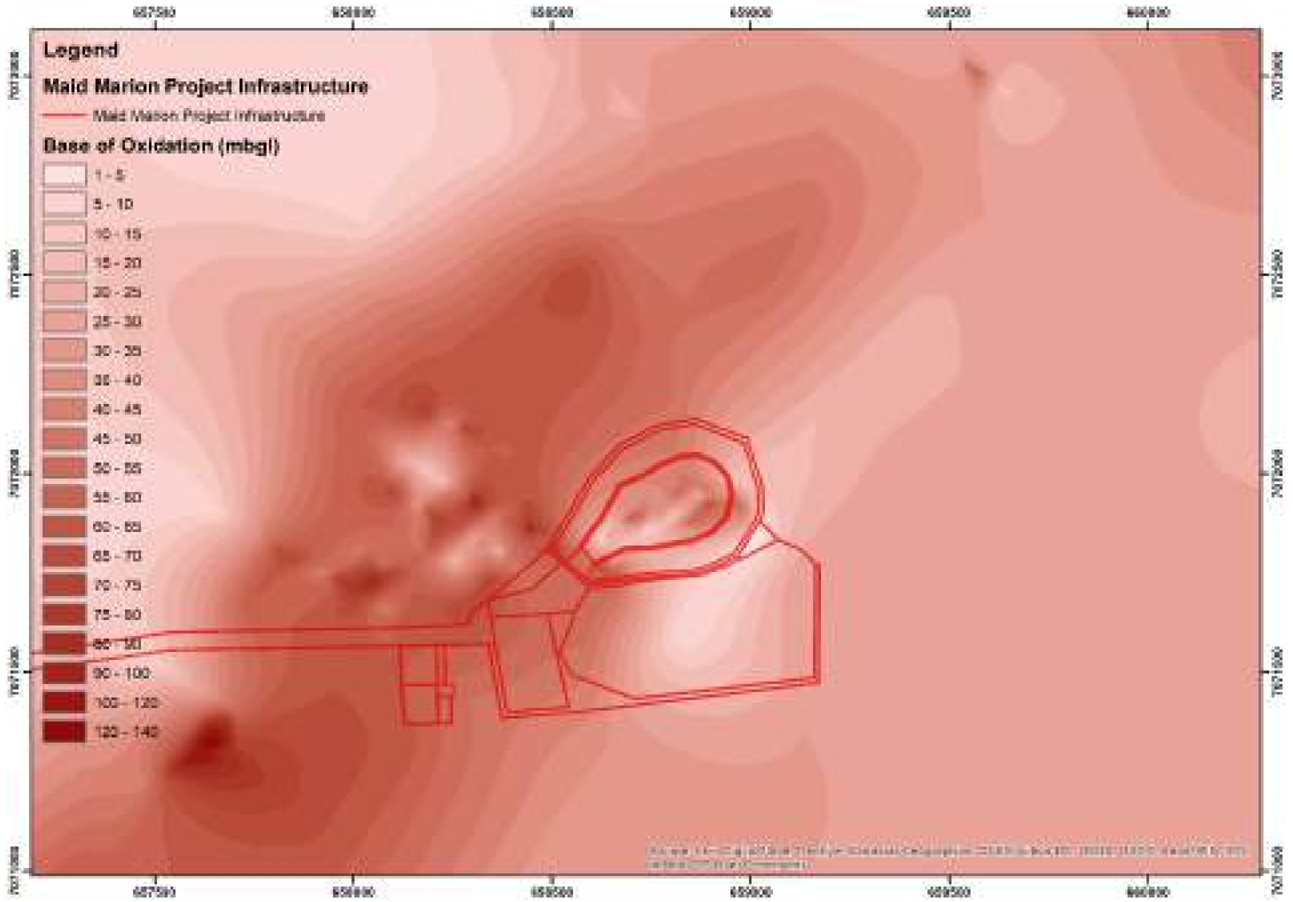

Figure 4 Interpreted Weathering Depth around Maid Marion

2.2.2 Hydrogeology

Regional Hydrogeology

The Project lies in the Youanmi Terrane of the Yilgarn Craton that comprises Archaean granite-greenstone rocks that have been deeply weathered and overlain by duricrusts or Cenozoic valley-fill deposits. Duricrusts (lateritic and siliceous) developed following humid weathering in the Mesozoic that also cut wide valley systems with active drainage. The onset of drier conditions in the Cenozoic and lower stream gradients (associated with slight uplift) reduced river flow, which in turn led to the deposition of sediments in the river valleys. Calcrete formation in the valleys occurred throughout these periods as water tables rose and fell.

Aquifers developed in the region include fractured-rock aquifers in the deeply weathered granite-greenstone rock, the alluvial aquifers developed in low-gradient drainage lines, and the productive palaeochannel aquifers in Cenozoic sediments in the old river valleys.

Fractured-rock Aquifer

The fractured-rock aquifer is developed in secondary porosity formed in otherwise impermeable rock. In the Goldfields the aquifer includes the weathering profile and faults and fractures in Archean rocks. Highest yields from the aquifer are found towards the base of the weathering profile in the lower saprolite and saprock. Within this profile, weathering of fresh rock is focussed along small fractures that expand as weathering continues. These expanded fracture zones form conduits for water flow and underdrain the upper saprolite.

Deeper in the fresh rock, the fracture zones tend to stay open to between 200 and 300m depth (after which ground pressures tend to close them off). Thus, yield declines rapidly with depth. The geology also tends to influence yield, with fractures tending to stay clean and open in granitic rocks. In mafic/ultramafic areas the fractures tend to fill with clay and are less productive.

Alluvial Aquifer

The alluvial aquifer is found in and around drainage lines where basement has been overlain by colluvial and alluvial deposits of sand and clay up to 20 metres thick. Groundwater storage within these thin deposits of alluvial and colluvial material is typically low, and water quality is fresh to brackish. The aquifer is recharge by direct infiltration during rainfall events.

Palaeochannel Aquifer

Palaeochannel aquifers are formed within Eocene and Miocene sediments from a more humid climate in Western Australia. Sand and gravel beds at the base of these aquifers are typically high-yielding and tend to have high salinity water ranging from 30,000 mg/L to over 150,000 mg/L. There are no palaeochannel aquifers near the Project.

Other Water Users

The Meekatharra Town Water Supply Borefield lies about 5km southwest of the pit and the surrounding Meekatharra Groundwater Protection Zone (p1) lies about 2.5km to the southwest (Figure 5).

The area has low potential for groundwater dependent ecosystems (GDEs) according to the Bureau of Meteorology GDE Atlas, and there are no listed Threatened or Priority Ecological Communities in the region.

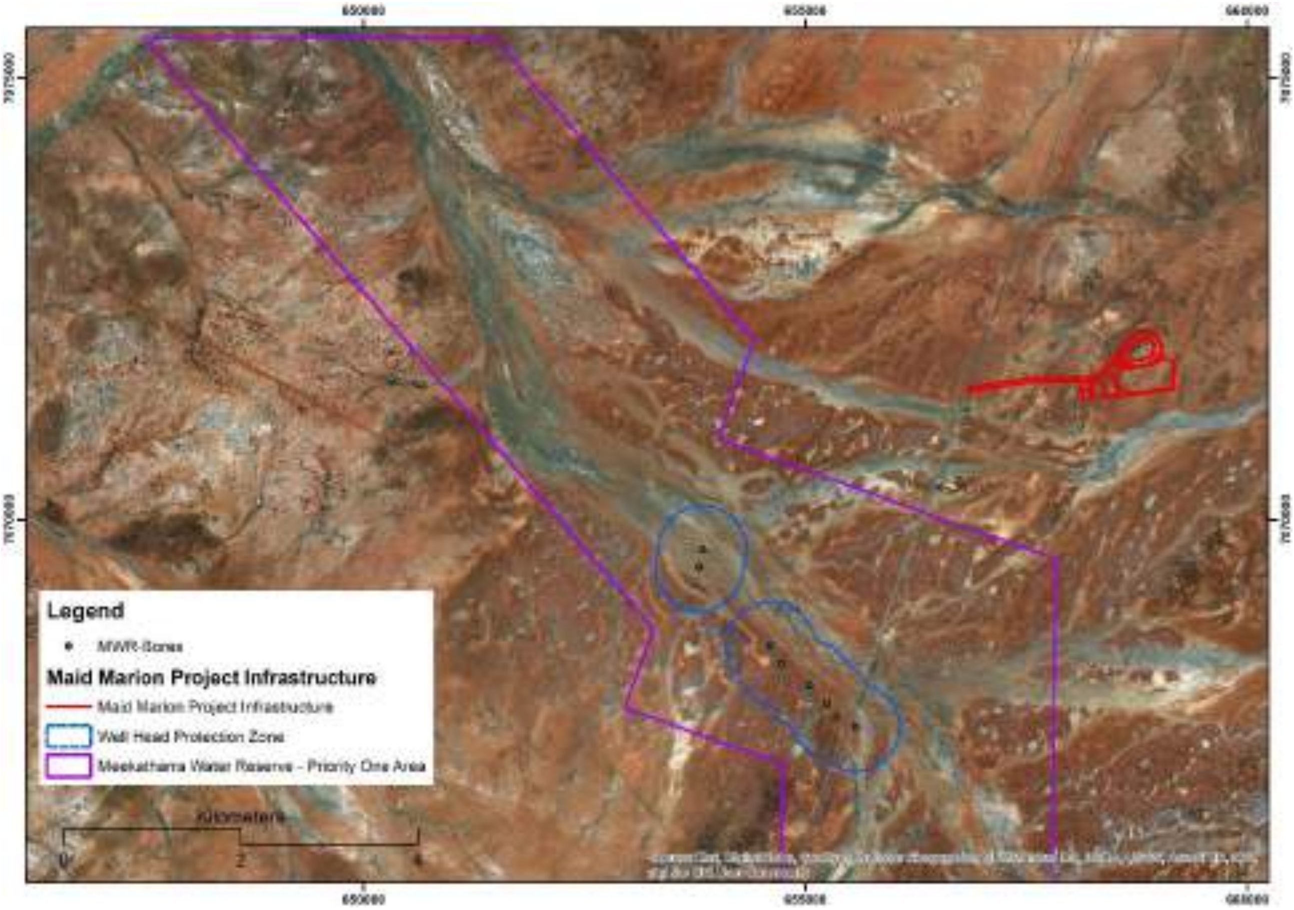

Figure 5 Meekatharra Water Reserve Location

Local Hydrogeology

The Project lies at the upper reaches of the Garden Gully Creek, a tributary of the Hope River at the very top of the Murchison River Catchment. The aquifer in the area is a fractured-rock aquifer, although it lies adjacent to an alluvial aquifer.

Weathering

The properties of the fractured rock aquifer at Maid Marion are largely contingent on both the degree of weathering and the parent rock type. In the pit area, the mafic schist will weather to low hydraulic conductivity clays and whereas the BIF will include hematite-goethite rich weathering products that increase the hydraulic conductivity.

The clay-rich material has the capacity to store relatively large volumes of water and the low conductivity suggests it will take time to dewater. The higher hydraulic conductivity in the weathered BIF will provide a conduit to draw water from the clay, but without a good estimate for hydraulic conductivity in the pit area it is difficult to estimate the time required for dewatering or the total volume.

Water Levels

The water table in the area is typically between 10 and 25m below surface and fluctuates seasonally with rainfall.

Water Quality

The Project area lies north of the Menzies Line, so water salinity is typically lower than areas further south. Although groundwater quality within the Meekatharra area varies from brackish or saline, around the project area bores feature potable or marginal quality water.

One water sample was collected from the nearby Five Mile Well (about 1km south of the Project, on Sherwood Station) in October 2019. The sample was fresh water, with a TDS of 820mg/L. The water also contained 63mg/L nitrate (as NO_3; 15.4 mg/L NO_3 as N). Full water quality data is presented in Appendix B.

Salinity in the Meekatharra Town Water Supply (in an alluvial aquifer) varies between 800 and 1,000 mg/L and the State Groundwater Atlas places regional water salinity at 1,000 mg/L to 3,000 mg/L. As the Maid Marion area is within a fractured-rock aquifer, the TDS is probably slightly higher than the alluvium so is estimated to range from 1,500mg/L to 3,000 mg/L.

Water encountered during gold exploration drilling

During the gold exploration programme, water was intersected between 20 and 45m. More permeable zones were typically found in fractured rock BIF units and some holes noted bogged rods or high water-flow. The most recent results near the put typically put the water table at about 15mbgl.

Overall, the drilling did not record excessive water-flow and appeared typical of a fractured rock aquifer.

3 PROPOSED DEVELOPMENT

3.1 Project Location

The Project area is 16 km north of Meekatharra on the eastern side of the Great Northern Highway at the top of the Garden Gully Creek catchment.

3.2 Mining

The Project involves the excavation of gold-bearing ore from the host rocks in an open-pit mine. The layout out of the Project is described below and outlined in Figure 6 and according to the current preliminary design (November 2019) has a planned disturbance area of about 54 ha. No chemical processing or tailings will be involved at the Project, with all ore hauled to Bluebird via road train along the Great Northern Highway.

The Project is a small satellite mining operation that will include:

- Topsoil storage areas;
- Open pit mine;
- Waste rock storage facility;
- Run of mine (ROM) pad;
- Office/workshop/crib-room/ablutions area;
- Self-bunded transportable fuel storage facility;
- Laydown and parking areas; and
- Bunding around all infrastructure.

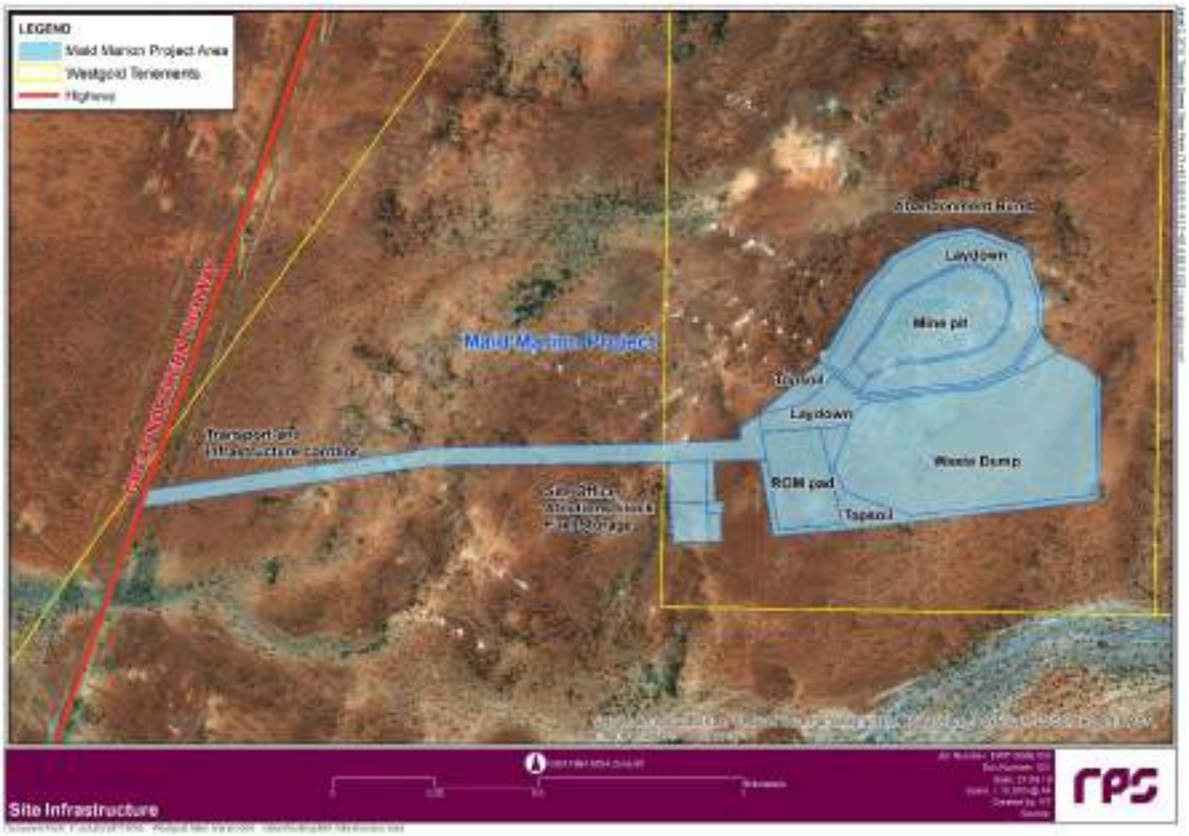

Figure 6 Maid Marion Site Infrastructure

3.2.1 Mine Pit

The Project will develop the Maid Marion pit, proposed to be about 400m long, 200m wide and 70m deep.

3.2.2 Dewatering

Local dewatering is required as the pit will operate below the local water table. The abstracted water would be used for dust suppression, with excess water managed according to salinity. Dewatering would be achieved using in-pit sumps or external dewatering bore. A detailed assessment of the dewatering is presented in 5.3.

3.2.3 Process Water

No process water is required for the Project.

3.2.4 Final Landform

Following the completion of mining the final landform will comprise:

- The waste rock storage facility;
- The pit void itself; and
- The abandonment bunds around the pit area.

All other areas will be rehabilitated.

4 SURFACE WATER MANAGEMENT

4.1 Potential Surface Water Impacts from Development

Potential surface water impacts associated with mining developments include:

- Interruption to minor local surface water sheet flow patterns
- Runoff loss to downstream environment (minor due to the “top of catchment” mine location)
- Increased risk of erosion and sedimentation due to land disturbance on the mine site
- Contamination of surface water by chemicals or hydrocarbons
- It is noted that there is a nearby P1 groundwater protection zone 2.75km from the pit.

4.2 General Surface Water Management

4.2.1 General Principles

The landscape can be subject to heavy rainfall / storms, and there is a risk of erosion and sedimentation on disturbed or degraded lands, that can adversely affect water quality and ecological systems downstream. This potentially includes interruption of surface water flow patterns and reduction of runoff volumes, or water quality in the environment downstream, and resultant impact on dependent vegetation communities downstream.

The potential for erosion generating sediment offsite increases with vegetation and topsoil removal, mining activities, spoil stockpiling and general construction activities. Sediment laden run-off from waste dumps and stockpiles is a key issue.

The storage and spillage of chemicals and hydrocarbons can also adversely impact water quality downstream. The pooling of water in low-lying areas should also be eliminated.

Generally environmental approvals for projects that involve land disturbance require adherence to surface water protection principles, with the objective to maintain surface water hydrological processes so that the ecosystem and existing and potential uses are protected.

4.2.2 Surface Water Management

General mine site infrastructure is shown in Figure 7 and key surface water features are listed below:

- The terrain is generally a flat undulating area, and drainage within the infrastructure areas can be characterised as sheet flow towards the west. A creek 400m south of the infrastructure areas flows west across Great Northern Highway;
- The site occupies about 54 ha (~900m x 600m);
- The pit lies at the top of a low rise and the other infrastructure (waste dump, ROM pad, laydown and topsoil stockpiles) is located around the pit, to the west and south;
- A bund will be provided around the pit. Other infrastructure will be bunded at the perimeter, to divert capture internal dirty run-off. Bunds may be compacted topsoil. The surface water management plan is shown in Figure 8; and
- The mine access road is about 1.6km long, running east from the Great Northern Highway on flat grades.

4.2.3 Mitigation of Impacts

Surface water management requires engineering surface water controls in each drainage area to limit sediment (and other contaminants) from escaping from site. Potential mitigation measures include:

- Construct away from natural flow paths (or in the dry season if required)
- Limit clearing and provide adequate buffer zones between disturbed areas and natural drainage lines. Divert upstream surface water around structures, and into downstream water courses. Prevent clean water mixing with internal (disturbed) dirty runoff
- Minimise disturbance and vehicle movements, use existing tracks where possible
- Waste landforms – surfaces are centrally draining to dissipate runoff by evaporation / seepage and reduce runoff and erosion down the batters. Use appropriate batter slopes, contour drains, etc. to provide effective water management
- Build access roads with a camber, and side table drains with regular “turnouts” to discharge runoff into the road surrounds
- Locate storage areas (chemicals, hydrocarbons, etc.) away from, or bunded off from, surface water flows
- Capture sediment laden surface runoff from disturbed (operational) areas for evaporation / seepage; or settling prior to release downstream
- On completion of mining, commence decommissioning of the mine, and rehabilitation of disturbed areas. Retain sediment retention in place until revegetation of surfaces and surface stability has been achieved.

4.2.4 Bunds and Channels

As and when required, diversion of surface flow consists of earth bunds and excavated channels, with an appropriate freeboard. They are constructed if possible, using cut-to-fill (by excavating the channel on the upstream side as fill for the bund on the downstream side).

Earth bunds are typically trapezoidal shaped and constructed of watertight materials using the most suitable available material (sourced from diversion excavations or selected mine waste). Excavated open (trapezoidal) diversion channels typically have side batters of 1V:2H (depending on materials).

Sediment traps are constructed by forming earth bunds at low points downstream of the site to capture run-off from disturbed areas. A formal basin has a settling zone above, and a sediment storage zone below. Water quality capture and treatment devices are not expected to treat all the flow, but rather focus on smaller more frequent run-off events.

4.3 Local Surface Hydrology

Due to the ephemeral nature of the local drainage, no baseline surface water quality data is available.

However, flows will occur periodically following significant rainfall events, particularly during the summer and autumn months from January to July when the potential exposure to high intensity rainfall is greatest. Subsequent run-off will occur and, on occasion, may be sufficient to cause flooding.

Although significant rainfall-runoff events do not occur regularly in a variable climatic region, their probability of occurrence within any given period can be estimated. The reciprocal of this probability is typically expressed as a return period (years) or ARI (average recurrence interval) and is the average time that elapses between two events that equal or exceed the flow magnitude in question.

It is understood that the operational LOM (life of mine) is < 1 year. Table 1 shows the probability for a range of different ARI flood events that could occur during an assumed 1-year LOM.

Table 1 Percentage Probability of N-Year ARI Flood Event Occurring in a 1 Year Operational Life

Average Recurrence Interval (ARI)	5 yr.	10 yr.	20 yr.	50 yr.	100 yr.	200 yr.
Probability of Occurrence	18%	10%	5%	2%	1%	0.5%

Typically, a 20% chance of occurrence in the LOM is considered reasonable i.e. a 5-year ARI flood criterion is reasonable. For Maid Marion, the impact of external catchments on the mine site is minimal, and catchments internal to the mine infrastructure are small.

There is one significant creek system to the south of the proposed mine, with a catchment area of $51km^2$. Hydrological calculations were carried out to estimate peak flows using the RFFE method (Table 2).

Table 2 Peak Flow Estimates

Catchment	5 yr.	10 yr.	20 yr.	50 yr.	100 yr.
$51km^2$	$7m^3/s$	$10m^3/s$	$14m^3/s$	$21m^3/s$	$26m^3/s$

4.4 Project Interaction with Surface Water Flows

4.4.1 Mine Site

There is one creek to the south of the mine site which has a large catchment, but in very flat terrain has relatively minor flood flows ($Q5 = 7m^3/s$), is 400m minimum from the bunded mine infrastructure and as such is very unlikely to impact the mine site.

The mine site is in a generally flat area and is not subject to impact from significant external runoff. The project area lies at the top of the catchments (Figure 7), and as such surface flows will be localised and small, and only minor surface sheet flow patterns will be interrupted (and readily diverted).

The pit will be provided with a normal pit bund around. Other infrastructure will be bunded around the perimeter, to divert external flows and capture internal dirty run-off. Topsoil stockpiles / bunds are proposed and suitable provided they are compacted. The surface water management plan is shown in Figure 8.

4.4.2 Road Crossings

The mine access road is about 1.6km long through flat to slightly undulating terrain. A floodway is a depressed or lowered section of roadway to direct flows that may run across the road. Given the short mine life and limited period of exposure, the road can grade through water course crossings. A more formal floodway structure can be created to enhance trafficability during flow conditions across the road (such as a stabilised pavement, rock armour protection).

It is anticipated that side table drains and regular road grading after flow events would be sufficient to maintain trafficability along the road.

Figure 7 Maid Marion Surface Water Catchment Boundaries

Figure 8 Surface Water Management Plan

4.5 Open Pit Surface Water Management

4.5.1 Pit Flood Protection Design Philosophy

Pit flood risk can be ameliorated, and flood protection provided, by a combination of the following measures:

- Pit crest / safety bunds placed close to the pit crest to prevent any external runoff, and minimise water reporting to the pit
- 'Roll-over' crest at the top of the pit ramps
- Internal roadside drains to direct runoff away from infrastructure / development areas.

4.5.2 In-Pit Runoff Volume Estimate

Runoff will report in-pit from direct precipitation within the pit bund. The excavated pit will store any surface inflows, but the impact that flood water has on mining operations largely depends on the provisions made for flood storage. Flooded plant and equipment or production loss due to a flooded mining face would be undesirable and may be critical.

Mine stormwater management includes ascertaining flood storage requirements at any stage of pit development and setting aside areas and prior workings in the lower parts of the pit as flood storage, to minimise disruption / risk to operations (leaving some upper mine areas available for work in the event of flooding, etc.).

Rainfall-runoff will report to in-pit sump pumps before being pumped back to surface.

The proposed pit has dimensions of about 400m long x 200m wide (Figure 6). The volume of water that accumulates in the pit, and needs to be removed, will increase as the pit gets bigger. The direct rain catchment is the final pit outline and is a about 6ha (the area inside the abandonment bund location is ~14ha).

The pit stormwater management system and flood storage capacity should ideally be able to accommodate the 72-hour rainfall event (a common industry practice). Durations <72-hours result in lower total inflow volumes, and durations >72-hours reduce rainfall intensity and rate of inflow, and there is typically adequate time to mount a dewatering response. The 72-hour rainfall depths are estimated in Table 3.

Table 3 72-hour Rainfall Depths

ARI / Duration	1-yr	2-yr	5-yr	10-yr	20-yr	50-yr	100-yr
72-hour rainfall	47mm	67mm	94mm	115mm	135mm	165mm	187mm

The rainfall runoff will collect on mine benches or to evaporate before reaching the pit bottom. In high rainfall, the runoff overflows the benches and flows into the pit, and a greater proportion of runoff reaches the bottom as rainfall increases. Antecedent rainfall / ponding may be present on mine benches and add to runoff in the pit. The runoff coefficient was therefore estimated to increase with rainfall e.g. 65% for the 5-year event and 80% for the 100-year event, by way of example.

Applying these rainfall depths to the final pit outline results in the total in-pit runoff volumes shown in Table 4.

Table 4 In-Pit Runoff Volume Estimate – Project Pit

ARI / Duration	1-yr	2-yr	5-yr	10-yr	20-yr	50-yr	100-yr
Flood Vol (m^3)	1,250	2,250	3,700	4,800	6,000	7,700	9,000

For a 20% risk of flooding during the mine life (<12 months for this project), the 5-year ARI design flood volume would therefore be in the order of 3700m³. Pump out in 1-day (for example) would require a (small) storm water pump out rate of 40L/s. The 100-year flood volume would be about 9000m³, with a 100L/s pump out rate to remove in 1 day (for example).

4.6 Maintenance of Water Management Structures

Effective erosion, sedimentation, water quality and fuel / chemical storage and handling control is required in accordance with relevant regulatory and legislative requirements. Soil and water controls should be identified, planned, properly implemented, and regularly monitored and audited to assess their effectiveness; with changes made to the stipulated controls if they are not achieving their objectives.

Site inspections or informal visual checks should take place regularly to ensure appropriate mitigation measures and controls are implemented, and that they are operational and effective.

4.7 Post-Closure Surface Water Management

General mine closure principles include:

- Surface and groundwater hydrological patterns / flow not adversely affected
- Surface and groundwater levels, and water quality reflect original levels and water chemistry
- No long-term reduction in the availability of water to meet local environmental values

Post-mining landforms consist of unconsolidated materials, dispersive, and erodible materials, which combined with steep and / or long slopes can give rise to high erosion risks and reduction in water quality. Mining is a temporary land use and therefore rehabilitation objectives should be consistent with projected future land use, designed to contribute to maintenance free closure over the long term.

Closure plans are integrated with mine development planning and operations. Decommissioning involves minimising sterilisation of ore, rehandling waste materials, removal of infrastructure and rehabilitated / revegetation of surfaces to approximate pre-development conditions. Final areas should be free draining, non-polluting and visually compatible with the surrounding landscape, and suitable for alternative land use (such as pastoralism and heritage conservation).

Waste dumps are usually the landforms most prone to erosion. The final slopes should be flat with natural vegetation regeneration. Geomorphic principles (drainage density and catchments, and the incorporation of natural slope features that emulate slopes in equilibrium with local conditions of rainfall, soil type, and vegetation cover) should be applied for stable landforms over the long term.

An abandonment bund is provided at closure with minimum requirements of 2m high, 5m wide at base, and wherever possible, constructed from unweathered, freely draining rockfill. The pit bund may be upgraded onto its final alignment as an abandonment bund (outside the area designated as the potentially unstable pit edge zone).

4.8 Surface Water Management Summary

The disturbance footprint will incorporate a pit, waste dump, ROM pad, laydown, topsoil stockpile and crib / office building. These areas lie in flat undulating ground and are minimally impacted by surface water flooding. Minor bunding only is required to protect infrastructure.

There is a risk of erosion and sedimentation on disturbed ground. The general objective is to maintain surface water regimes so that existing and potential uses are protected. While minimal, the potential for erosion and sedimentation offsite will be considered, and soil and water issues identified, planned, managed and monitored during the mine life to minimise adverse impacts (sedimentation, interruption to existing surface water flow patterns, reduction of surface water runoff volumes / quality, discharge of chemicals, including hydrocarbons, etc). Storage areas (chemicals, hydrocarbons, etc.) will be located away from, or bunded off from, external surface water flows.

Potential pit flood volumes are low. The 5-year ARI 72-hour rainfall event could be pumped out of the pit in 1 day with a dewatering pumping capacity of 30L/s, as one example.

Mine closure requires an effective planning process throughout the life of mine, so closure is achieved in an environmentally sustainable manner.

5 GROUNDWATER MANAGEMENT

5.1 Potential Groundwater Impacts from Development

Potential groundwater impacts associated with the planned development include:

- Groundwater drawdown associated with below water table mining;
- Impacts upon the water quality of the groundwater resource;
- Impacts to the nearby Meekatharra groundwater Reserve, a P1 groundwater protection zone;
- Impacts to nearby pastoral station bores.

The sections below explore these potential impacts in detail.

5.2 Groundwater Management Objectives

The Maid Marion groundwater management objectives are to:

- Supply sufficient water to facilitate site operations (including dust suppression);
- Prioritise the use of dewatering where practicable before using supplementary sources;
- Limit potential impacts to the nearby P1 groundwater protection zone;
- Ensure that groundwater quality is not adversely affected by groundwater abstraction or discharge;
- Ensure that pastoral station bores are not adversely affected by groundwater abstraction or discharge.

5.3 Pit Dewatering

5.3.1 Dewatering Requirements

Based on the pit dimensions below the water table (400m long by 200m wide by 55m deep), local groundwater and geology data, estimated local aquifer parameters (based on regional analogues and textbook values), and a pit excavation time frame of seven months, a sensitivity analysis was undertaken using the Thiem-Dupuit equation for groundwater inflow to a pit. Hydraulic conductivity values of 0.005, 0.01, and 0.05 m/day (representing possible bulk hydraulic conductivity values in the weathered to fresh BIF) were used to explore the range of potential outcomes and are listed below:

- A lower estimate of 454 kL/d (with a peak rate of 642 kL/d) — for a total volume of ~95,000 kL over 7 months;
- A mid-case estimate of 980 kL/d (with a peak rate of 1,280 kL/d) — for a total volume of ~190,000 kL over 7 months; and
- An upper estimate of 2,770 kL/d (with a peak rate of 4,250 kL/d) — for a total volume of ~580,000 kL over 7 months.

The lower and mid-case estimate show water inflows would be easily controlled with in-pit sumps, with the upper estimate possibly requiring out-of-pit dewatering bores. Although the upper estimate from the sensitivity analysis is 580,000 kL, experience in the Goldfields suggest that the total dewatering volume is unlikely to exceed 300,000 kL for this size of pit.

5.3.2 Water use recommendations

The large range in dewatering volumes makes planning complicated. The water use on site for dust suppression is unlikely to exceed 60 kL per day, so the mine will have a water surplus, which will require formulation of a management approach to deal with the excess water.

Thick clay beds from weathering of the mafic schist will not release water quickly and may lead to trafficability issues in the pit, slowing pit development.

There are several options for water management include transporting using excess water to the Meekatharra Gold Operations for other mining purposes or storage in abandoned pits, reticulating the waste dump to encourage evaporation, or a final option of discharging water to the nearby Garden Gully Creek. Discharging water to the creek will require Westgold obtain required approvals from DWER. This is likely to attract an impact assessment and additional scrutiny from regulators. However, water quality from dewatering is expected to range from 1,500 mg/L to 3,000 mg/L, so is not expected to impact the local environment given the total timeframe for discharge is about 210 days.

To gain confidence in the dewatering volume and reduce the associated risks, ideally Westgold would install a production bore for testing. The bore would provide important data and improve understanding of the hydraulic properties of the rock (especially the BIF), which would better constrain the dewatering volume. The production bore would also allow Westgold to advance dewater the pit.

5.3.3 Water Levels

Locally, given the known geology and water levels of the area, along with some assumed fractured rock aquifer parameters, dewatering of the Maid Marion pit will see drawdown expanding to a few hundred metres. Within the pit, the east-northeast–west-southwest oriented BIF may provide a preferred pathway for drawdown to propagate – with drawdown possibly reaching up to 1200 m away from the pit.

There are no known groundwater dependant ecosystems or groundwater users in the area which may be affected by this influence, which is expected to be localised.

5.3.4 Water Quality

Groundwater quality is expected to be brackish (1,500 – 3,000 mg/L TDS), consistent with the region, and is not expected to change throughout the dewatering phase. There is no high-salinity groundwater nearby, and all recharge to the aquifer is through precipitation.

5.3.5 Groundwater Licencing Requirements

An amendment to the existing 5C licence (GWL 156252) will be required, to include dewatering at Maid Marion. Following submission of the amendment DWER will advise of any additional reporting or investigation work.

5.4 Post Closure

On completion of mining, the pit will be left open to full depth (i.e. no backfill) and depending on pit inflow rates encountered will become a relatively shallow pit lake - which will equilibrate between groundwater inflow volumes and long-term evaporation rates. It is anticipated that the pit void will become a local groundwater sink, with final water levels being lower than the regional water table at ~500 mAHD.

Pit water is anticipated to increase in salinity over time due to the influence of evaporation. Given the landscape, land use, and current hydrogeological setting, this is considered to pose no risk or adverse effects to the current and future environment and/or groundwater users.

REFERENCES

Department of Water 2009 Operational policy no. 5.12- *Hydrogeological reporting associated with a groundwater well licence*, Department of Water, Perth, November 2009.

Romano, SS 2018, Gabanintha, WA Sheet 2644: Geological Survey of Western Australia, 1:100 000 Geological Series.

Timms, N 2011, Geological Mapping Report, Yaloginda Area, Murchison Region, Western Australia: Geological Survey of Western Australia, Record 2011/21, 108p.

Waters and Rivers Commission, 2000, Water Quality Protection Guidelines No. 11. Mining and Mineral Processing —Mine Dewatering.

Appendix A

Production Bore Design

Maid Marion Production Bore

The production bore will be constructed using both the mandatory requirements and good practice outlined in the *Minimum Construction Requirements for water bores in Australia* (3rd Ed., NUDLC). *All dimensions and quantities listed below are nominal, and both the bore-design and drill pad dimensions would need to be confirmed with a suitably qualified and licenced water well driller.*

The production bore target will require an approximately 25m x 25m drill pad to accommodate the drill rig and provide a safe workspace. A drilling sump (5m x 2m x 1.5m) will be dug downslope of the work area to capture discharge during drilling. Water quality from the bore is likely to be fresh to brackish so there will be no environmental impacts from discharging water. The drilling site would be accessed by a minimum 3-m wide track. Topsoil will be stored on the opposite side of the pad.

The production bore has a nominal constructed depth of 65m. At least 3m (or as required) of steel surface casing (260mm nominal dimension (**ND**)) should be cement grouted in place, before the production bore is drilled. If suitable flow is encountered during drilling (>1L/s) the bore will be constructed using 200mm ND Class 12 uPVC casing. Thirty (30) metres of machine slotted casing (1mm slots) will be positioned either at the bottom of the hole or against the main water-bearing interval(s) with an endcap fixed to the bottom of the casing. The hole annulus will be backfilled to within 5m of the surface with graded gravel pack larger than the slot size. The final 5m of the annulus will be backfilled with cement grout, with a layer of bentonite pellets placed above the gravel pack to ensure the cement does not enter the gravel pack.

The bore will be developed use airlifting and surging until the water runs clear and there is less than 5g of sediment per 1000L. A cap will be placed on the bore once development is finished and concrete plinth installed to accommodate the future bore headworks.

Following completion, the site would be rehabilitated with sumps filled and topsoil respread over the site. However, 3-m wide access way and turnaround at the bore would be retained as well as space for future infrastructure (such as generator, headworks, and pipes).

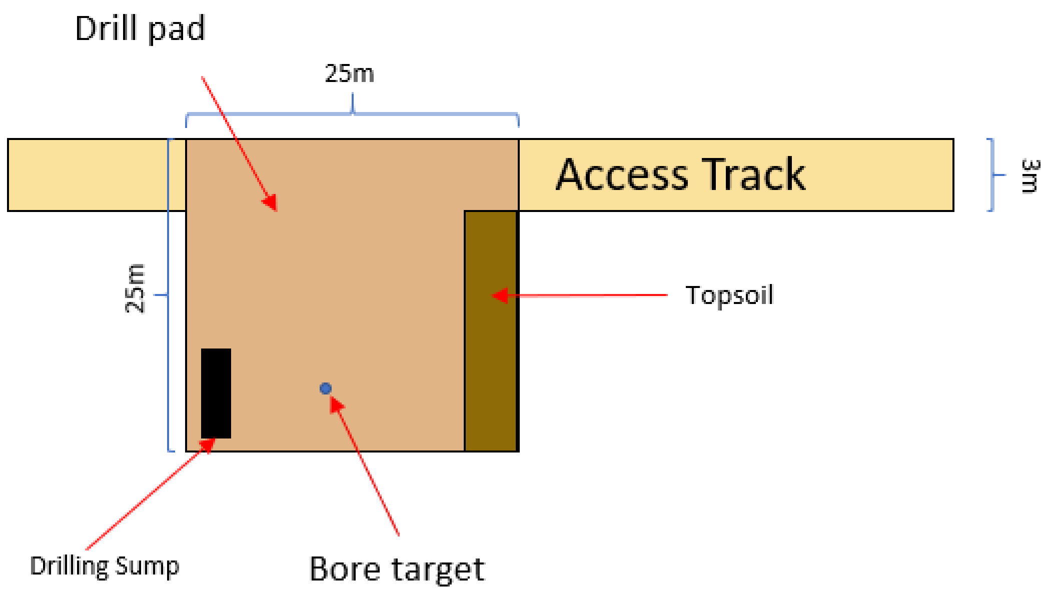

Figure 9 Nominal drill pad design

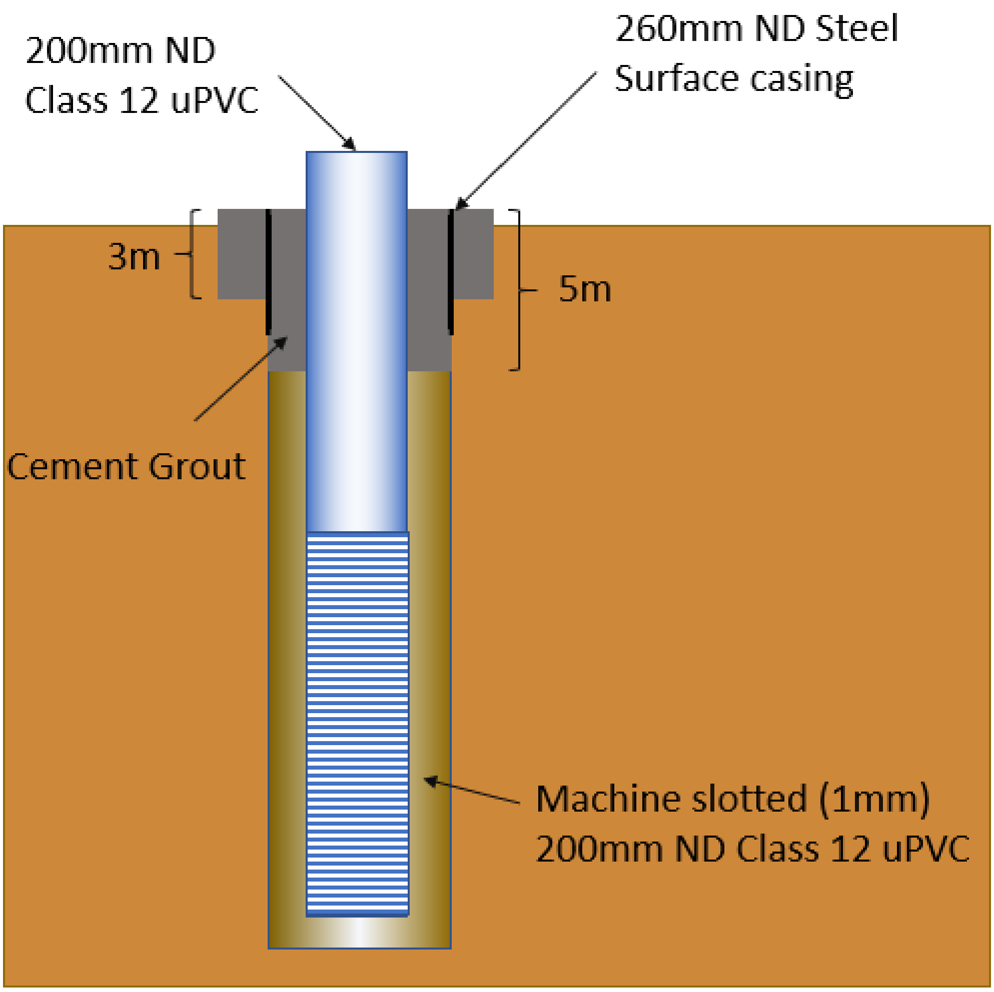

Figure 10 Nominal bore design

Appendix B

Water Quality Data

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS		LABORATORY DETAILS	
Contact	AUSWACMGP Environment	Manager	Marjana Siljanoska
Client	BIG BELL GOLD OPERATIONS PTY LTD	Laboratory	SGS Perth Environmental
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Project	**Maid Marion**	SGS Reference	**PE138684A R0**
Order Number	**121977**	Date Received	28 Oct 2019
Samples	1	Date Reported	30 Oct 2019

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(898/20210).

SIGNATORIES

Louise HOPE
Laboratory Technician

Parameter	Units	LOR	Sample Number: PE138684A.001 Sample Matrix: Water Sample Date: 16/10/19 11:45 Sample Name: Five Mile Well - Sherwood

pH in water Method: AN101 Tested: 17/10/2019

pH**	pH Units	0.1	8.5

Conductivity and TDS by Calculation - Water Method: AN106 Tested: 17/10/2019

Conductivity @ 25 C	µS/cm	2	1300

Total Dissolved Solids (TDS) in water Method: AN113 Tested: 28/10/2019

Total Dissolved Solids Dried at 175-185°C	mg/L	10	820

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Conductivity and TDS by Calculation - Water Method: ME-(AU)-[ENV]AN106

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
Conductivity @ 25 C	LB165379	µS/cm	2	<2	99%

pH in water Method: ME-(AU)-[ENV]AN101

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
pH**	LB165379	pH Units	0.1	5.6	101%

Total Dissolved Solids (TDS) in water Method: ME-(AU)-[ENV]AN113

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery	MSD %RPD
Total Dissolved Solids Dried at 175-185°C	LB165380	mg/L	10	<10	0%	100%	101%	8%

METHOD SUMMARY

METHOD	METHODOLOGY SUMMARY
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode (glass plus reference electrode) and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos/cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Total Dissolved Salts can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. SGS use 0.6. Reference APHA 2510 B.
AN106	Salinity may be calculated in terms of NaCl from the sample conductivity. This assumes all soluble salts present, measured by the conductivity, are present as NaCl.
AN113	Total Dissolved Solids: A well-mixed filtered sample of known volume is evaporated to dryness at 180°C and the residue weighed. Approximate methods for correlating chemical analysis with dissolved solids are available. Reference APHA 2540 C.
AN113	The Total Dissolved Solids residue may also be ignited at 550 C and volatile TDS (Organic TDS) and non-volatile TDS (Inorganic) can be determined.

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	NATA accreditation does not cover the performance of this service.	QFH	QC result is above the upper tolerance
**	Indicative data, theoretical holding time exceeded.	QFL	QC result is below the lower tolerance
		-	The sample was not analysed for this analyte
		NVL	Not Validated

Unless it is reported that sampling has been performed by SGS, the samples have been analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calcuated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au.pv.sgsvr/en-gb/environment.

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS		LABORATORY DETAILS	
Contact	AUSWACMGP Environment	Manager	Marjana Siljanoska
Client	BIG BELL GOLD OPERATIONS PTY LTD	Laboratory	SGS Perth Environmental
Address	PO BOX 7068 CLOISTERS SQUARE WA 6850	Address	28 Reid Rd Perth Airport WA 6105
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Facsimile	08 94818419	Facsimile	(08) 9373 3556
Email	auswacmgp.environment@westgold.com.au	Email	au.environmental.perth@sgs.com
Project	**Maid Marion**	SGS Reference	**PE138684 R0**
Order Number	**121977**	Date Received	17 Oct 2019
Samples	1	Date Reported	26 Oct 2019

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(898/20210).

SIGNATORIES

Hue Thanh LY
Metals Team Leader

Louise HOPE
Laboratory Technician

Mary Ann OLA-A
Inorganics Team Leader

Murray O'NEILL
Lab Technician-Nutrients Signatory

Ohmar DAVID
Metals Chemist

Parameter	Units	LOR	Sample Number: PE138684.001 Sample Matrix: Water Sample Date: 16/10/19 11:45 Sample Name: Five Mile Well - Sherwood

Alkalinity Method: AN135 Tested: 17/10/2019

Carbonate Alkalinity as CO3	mg/L	1	1
Bicarbonate Alkalinity as HCO3	mg/L	5	200
Total Alkalinity as CaCO3	mg/L	5	160

Chloride by Discrete Analyser in Water Method: AN274 Tested: 24/10/2019

Chloride, Cl	mg/L	1	230

Sulfate in water Method: AN275 Tested: 24/10/2019

Sulfate, SO4	mg/L	1	120

Fluoride by Ion Selective Electrode in Water Method: AN141 Tested: 24/10/2019

Fluoride by ISE	mg/L	0.1	0.4

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA Method: AN258 Tested: 22/10/2019

Nitrite, NO_2 as NO_2	mg/L	0.2	<0.2
Nitrate, NO_3 as NO_3	mg/L	0.2	68

Metals in Water (Dissolved) by ICPOES Method: AN320 Tested: 21/10/2019

Calcium, Ca	mg/L	0.2	39
Magnesium, Mg	mg/L	0.1	37
Potassium, K	mg/L	0.1	14
Silicon, Si	mg/L	0.02	35
Sodium, Na	mg/L	0.5	160
Total Hardness by Calculation	mg CaCO3/L	1	250

Parameter	Units	LOR	Sample Number: PE138684.001 Sample Matrix: Water Sample Date: 16/10/19 11:45 Sample Name: Five Mile Well - Sherwood
Trace Metals (Dissolved) in Water by ICPMS in mg/L Method: AN318 Tested: 21/10/2019			
Aluminium, Al	mg/L	0.005	<0.005
Arsenic, As	mg/L	0.001	0.007
Cadmium, Cd	mg/L	0.0001	<0.0001
Chromium, Cr	mg/L	0.001	0.010
Cobalt, Co	mg/L	0.001	0.003
Copper, Cu	mg/L	0.001	0.006
Iron, Fe	mg/L	0.005	<0.005
Lead, Pb	mg/L	0.001	<0.001
Manganese, Mn	mg/L	0.001	<0.001
Nickel, Ni	mg/L	0.001	0.020
Selenium, Se	mg/L	0.001	0.003
Zinc, Zn	mg/L	0.005	<0.005
Mercury (dissolved) in Water Method: AN311(Perth)/AN312 Tested: 22/10/2019			
Mercury	mg/L	0.00005	<0.00005
Total and Volatile Suspended Solids (TSS / VSS) Method: AN114 Tested: 22/10/2019			
Total Suspended Solids Dried at 103-105°C	mg/L	5	<5
Calculation of Anion-Cation Balance (SAR Calc) Method: AN121 Tested: 24/10/2019			
Anion-Cation Balance	%	-100	-4.1

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Alkalinity Method: ME-(AU)-[ENV]AN135

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Carbonate Alkalinity as CO3	LB165123	mg/L	1	<1		
Bicarbonate Alkalinity as HCO3	LB165123	mg/L	5	<5		
Total Alkalinity as CaCO3	LB165123	mg/L	5	<5	1%	105%

Chloride by Discrete Analyser in Water Method: ME-(AU)-[ENV]AN274

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Chloride, Cl	LB165275	mg/L	1	<1	0 - 1%	106%	94 - 106%

Fluoride by Ion Selective Electrode in Water Method: ME-(AU)-[ENV]AN141

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Fluoride by ISE	LB165277	mg/L	0.1	<0.1	0 - 3%	99%	76 - 92%

Mercury (dissolved) in Water Method: ME-(AU)-[ENV]AN311(Perth)/AN312

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Mercury	LB165164	mg/L	0.00005	<5e-005	8 - 198%	107 - 111%	99 - 111%

Metals in Water (Dissolved) by ICPOES Method: ME-(AU)-[ENV]AN320

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Calcium, Ca	LB165102	mg/L	0.2	<0.2	1%	97%	93%
Magnesium, Mg	LB165102	mg/L	0.1	<0.1	0%	96%	97%
Potassium, K	LB165102	mg/L	0.1	<0.1	1%	96%	83%
Silicon, Si	LB165102	mg/L	0.02	<0.02	0%	102%	
Sodium, Na	LB165102	mg/L	0.5	<0.5	0 - 1%	101%	102%
Total Hardness by Calculation	LB165102	mg CaCO3/L	1	<1			

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Sulfate in water   Method: ME-(AU)-[ENV]AN275

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Sulfate, SO4	LB165275	mg/L	1	<1	0 - 3%	105 - 106%	96 - 110%

Total and Volatile Suspended Solids (TSS / VSS)   Method: ME-(AU)-[ENV]AN114

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Total Suspended Solids Dried at 103-105°C	LB165143	mg/L	5	<5	43%	98%

Trace Metals (Dissolved) in Water by ICPMS in mg/L   Method: ME-(AU)-[ENV]AN318

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Aluminium, Al	LB165098	mg/L	0.005	<0.005	4 - 26%	120%	102%
Arsenic, As	LB165098	mg/L	0.001	<0.001	0%	117%	
Cadmium, Cd	LB165098	mg/L	0.0001	<0.0001	16%	117%	108%
Chromium, Cr	LB165098	mg/L	0.001	<0.001	7%	107%	
Cobalt, Co	LB165098	mg/L	0.001	<0.001	1%	105%	
Copper, Cu	LB165098	mg/L	0.001	<0.001	11%	113%	100%
Iron, Fe	LB165098	mg/L	0.005	<0.005	1 - 35%	110%	96%
Lead, Pb	LB165098	mg/L	0.001	<0.001	0%	111%	106%
Manganese, Mn	LB165098	mg/L	0.001	<0.001	2 - 4%	107%	
Nickel, Ni	LB165098	mg/L	0.001	<0.001	7%	111%	
Selenium, Se	LB165098	mg/L	0.001	<0.001	5%	115%	
Zinc, Zn	LB165098	mg/L	0.005	<0.005	5 - 18%	113%	85%

METHOD	METHODOLOGY SUMMARY
	Nitrate and Nitrite by FIA: In an acidic medium, nitrate is reduced quantitatively to nitrite by cadmium metal. This nitrite plus any original nitrite is determined as an intense red-pink azo dye at 540 nm following diazotisation with sulphanilamide and subsequent coupling with N-(1-naphthyl) ethylenediamine dihydrochloride. Without the cadmium reduction only the original nitrite is determined. Reference APHA 4500-NO3- F.
AN114	Total Suspended and Volatile Suspended Solids: The sample is homogenised by shaking and a known volume is filtered through a pre-weighed GF/C filter paper and washed well with deionised water. The filter paper is dried and reweighed. The TSS is the residue retained by the filter per unit volume of sample. Reference APHA 2540 D. Internal Reference AN114
AN121	This method is used to calculation the balance of major Anions and Cations in water samples and converts major ion concentration to milliequivalents and then summed. Anions sum and Cation sum is calculated as a difference and expressed as a percentage.
AN121	The sum of cations and anions in mg/L may also be reported. This sums Na, K, Ca, Mg, NH3, Fe, Cl, Total Alkalinity, SO4 and NO3.
AN135	Alkalinity (and forms of) by Titration: The sample is titrated with standard acid to pH 8.3 (P titre) and pH 4.5 (T titre) and permanent and/or total alkalinity calculated. The results are expressed as equivalents of calcium carbonate or recalculated as bicarbonate, carbonate and hydroxide. Reference APHA 2320. Internal Reference AN135
AN141	Determination of Fluoride by ISE: A fluoride ion selective electrode and reference electrode combination, in the presence of a pH/complexation buffer, is used to determine the fluoride concentration. The electrode millivolt response is measured logarithmically against fluoride concentration. Reference APHA F- C.
AN274	Chloride by Aquakem DA: Chloride reacts with mercuric thiocyanate forming a mercuric chloride complex. In the presence of ferric iron, highly coloured ferric thiocyanate is formed which is proportional to the chloride concentration. Reference APHA 4500Cl-
AN275	sulfate by Aquakem DA: sulfate is precipitated in an acidic medium with barium chloride. The resulting turbidity is measured photometrically at 405nm and compared with standard calibration solutions to determine the sulfate concentration in the sample. Reference APHA 4500-SO42-. Internal reference AN275.
AN311(Perth)/AN312	Mercury by Cold Vapour AAS in Waters: Mercury ions are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500.
AN318	Determination of elements at trace level in waters by ICP-MS technique, in accordance with USEPA 6020A.
AN320	Metals by ICP-OES: Samples are preserved with 10% nitric acid for a wide range of metals and some non-metals. This solution is measured by Inductively Coupled Plasma. Solutions are aspirated into an argon plasma at 8000-10000K and emit characteristic energy or light as a result of electron transitions through unique energy levels. The emitted light is focused onto a diffraction grating where it is separated into components.
AN320	Photomultipliers or CCDs are used to measure the light intensity at specific wavelengths. This intensity is directly proportional to concentration. Corrections are required to compensate for spectral overlap between elements. Reference APHA 3120 B.
Calculation	Free and Total Carbon Dioxide may be calculated using alkalinity forms only when the samples TDS is <500mg/L. If TDS is >500mg/L free or total carbon dioxide cannot be reported. APHA4500CO2 D.

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	NATA accreditation does not cover the performance of this service.	QFH	QC result is above the upper tolerance
**	Indicative data, theoretical holding time exceeded.	QFL	QC result is below the lower tolerance
		-	The sample was not analysed for this analyte
		NVL	Not Validated

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Solid samples expressed on a dry weight basis.

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Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au.pv.sgsvr/en-gb/environment.

APPENDIX E - MAID MARION LEVEL 1 FLORA AND VEGETATION SURVEY

Reconnaissance Flora and Vegetation Survey of the Maid Marion Mining Project- August 2019

Prepared for

WESTGOLD GROUP

FINAL V2.1
October 2019

Prepared by:
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Figures

Tables

1 INTRODUCTION

Big Bell Gold Operations Pty Ltd (BBGO), a subsidiary of West Gold Resources Ltd (WGX), is planning to develop the Maid Marion Project (Maid Marion) as a component of the Meekatharra Gold Operations (MGO). The MGO is located approximately 15 km southwest of Meekatharra, in the northern goldfields of Western Australia. The Maid Marion deposit is located approximately 16.43km northeast of Meekatharra (Figure 1).

BBGO commissioned Native Vegetation Solutions (NVS) to complete a reconnaissance Flora and Vegetation survey of Maid Marion Project area on the 27th August 2019. A survey area which contains the conceptual disturbance footprint and associated infrastructure was provided by BBGO to NVS, covering an area of approximately 80.77 hectares. The main proposed project area lies within Mining Tenement M51/504 and the proposed haul road from the Great Northern Highway lies within Tenement M51/668.

The survey area is shown in Figures 1 & 2 and Appendix 4.

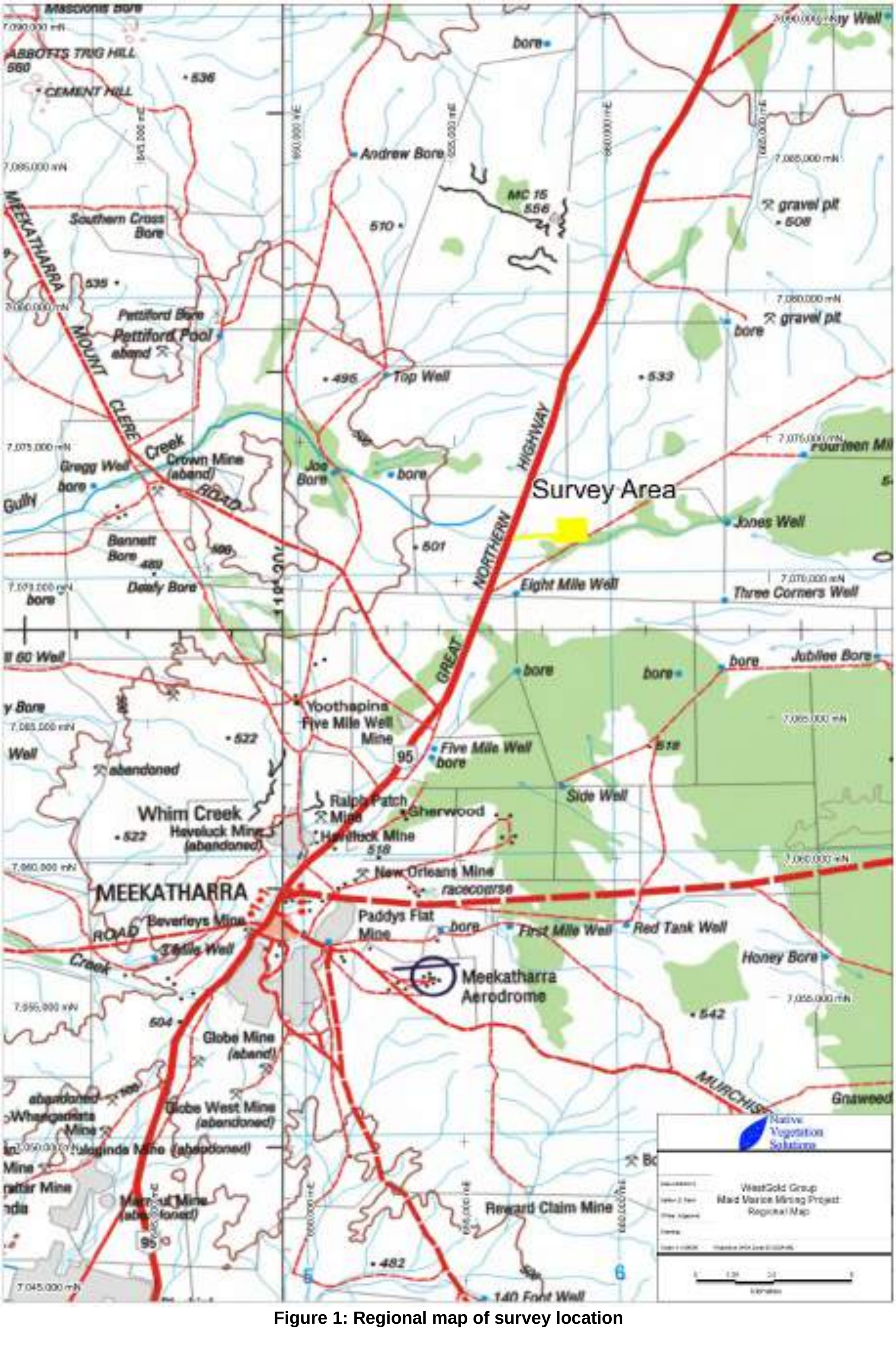

Figure 1: Regional map of survey location

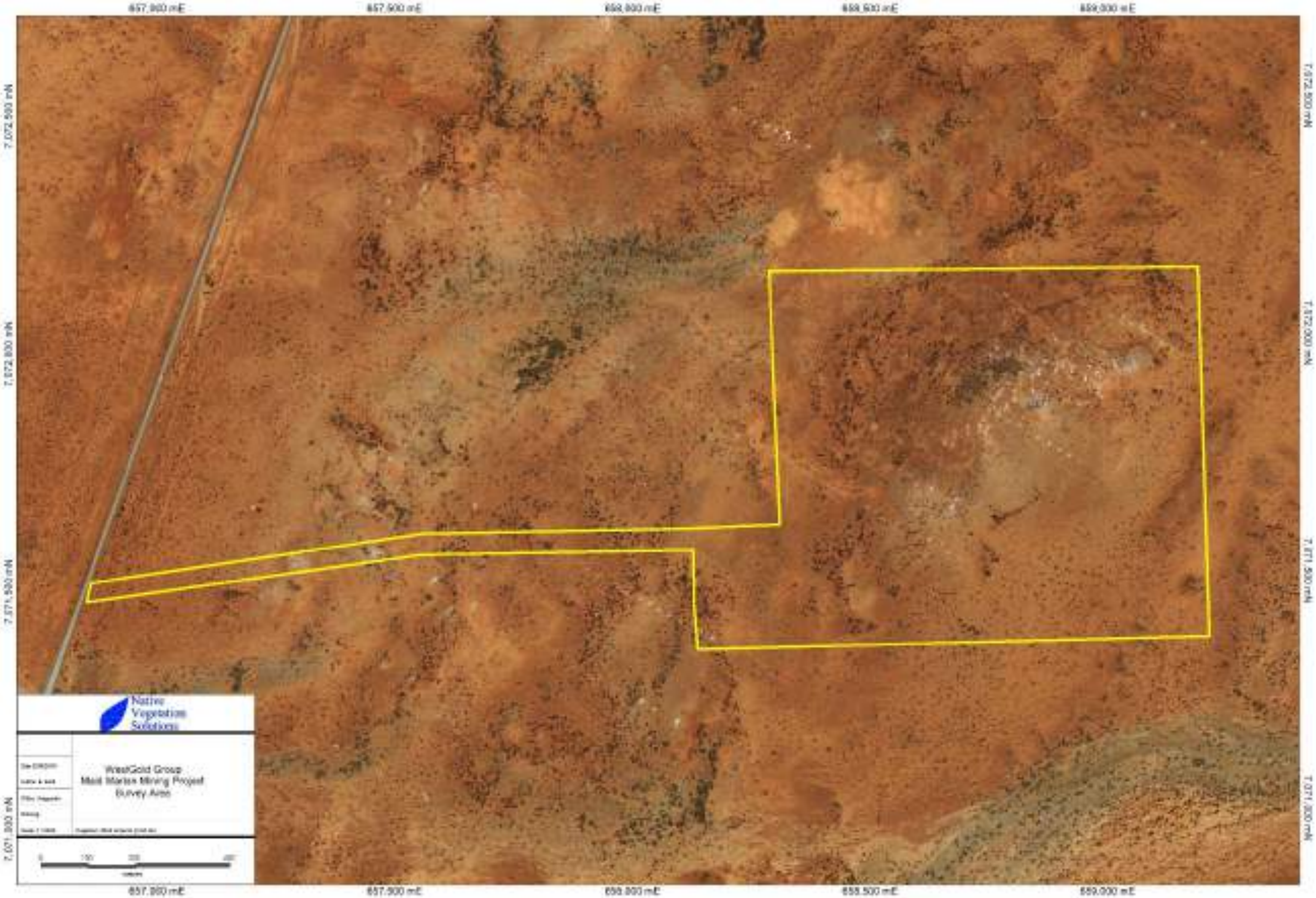

Figure 2: Maid Marion Survey Area

1.1 Objectives

The objective of this report is to document the results of the flora and vegetation component of a reconnaissance assessment conducted in accordance with:

- *Environmental Factor Guideline- Flora and Vegetation* (EPA, 2016); and
- *Technical Guidance- Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA, 2016a).

A reconnaissance assessment has two components:

1). Desktop study which includes a literature review and a search of the relevant databases;

2). Reconnaissance survey of the survey area to verify the desktop survey, to define vegetation groups present in the area, search for species of conservation significance and to determine potential sensitivity to impact.

As part of the reporting for the reconnaissance assessment, NVS has conducted a Flora and Vegetation Survey which includes broad-scale vegetation mapping and vegetation condition mapping of the survey area.

The scope of work for the Reconnaissance flora and vegetation survey was:

- conduct a desktop study that includes a literature review and search of the relevant databases;
- describe the vegetation associations in the survey area;
- prepare an inventory of species occurring in the survey area;
- identify any vegetation communities or flora species of conservation significance;
- Map broad-scale vegetation groups found within the survey area, including vegetation condition; and
- provide recommendations, including the management of perceived impacts to flora and vegetation within the survey area.

1.2 Geology and Vegetation

According to the Interim Biogeographic Regionalisation of Australia (IBRA, 2018), the survey area lies in the Murchison (MUR) bioregion within the Western Murchison (MUR02) subregion which totals over 7.8 million hectares (CALM, 2002). The MUR02 subregion comprises vegetation dominated by Mulga low woodlands, often rich in ephemerals (usually with bunch grasses), on outcrop and fine textured Quaternary alluvial and eluvial surfaces (extensive hardpan wash plains that dominate and characterise the subregion) mantling granitic and greenstone strata of the northern part of the Yilgarn Craton. Surfaces associated with the occluded drainage occur throughout with hummock grasslands on Quaternary sandplains, saltbush shrublands on calcareous soils and *Tecticornia* low shrublands occur on saline alluvia (CALM, 2002).

1.3 Climate

The arid climate of the MUR02 subregion generally relies on winter rainfall (CALM, 2002).

The nearest official meteorological station to the survey area is located at Meekatharra Airport, approximately 15.6 km south of the survey area. Recordings of the local climatic conditions commenced at Meekatharra in 1944 (BOM, 2019) and data collected at this station 007045 was used for this report.

1.3.1 Temperature

Mean annual minimum temperature is 15.9°C and mean annual maximum temperature is 29°C for Meekatharra Airport (BOM, 2019). The coldest month is July (mean minimum temperature 7.4°C), the hottest is January (mean maximum temperature 38.3°C) and diurnal temperature variations are relatively consistent throughout the year (Figure 3).

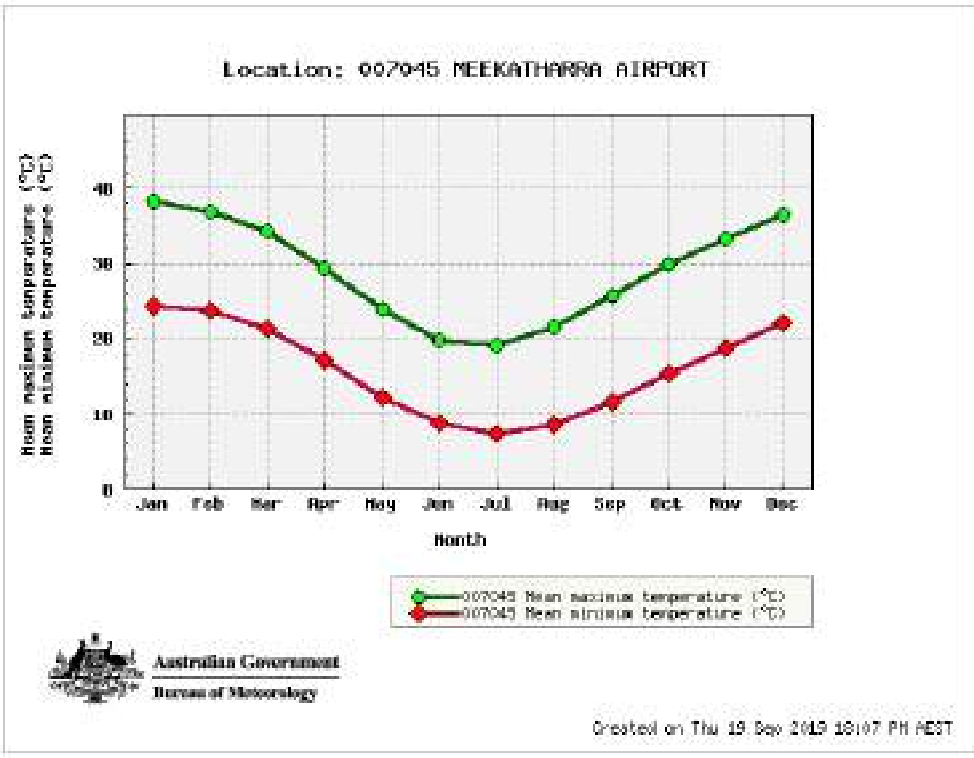

Figure 3: Mean temperature ranges for Meekatharra Airport weather station

1.3.2 Rainfall

The area is arid and the annual average rainfall at Meekatharra is 237.9 mm, which falls (>1 mm) on an average of 28.2 rain-days. Most of the rain usually falls between January and July and this amount varies greatly both seasonally and annually (Figure 4). Rainfall for January, February and March, May, July and August 2019 fell below monthly averages, prior to the survey period (BOM, 2019). Rainfall in April and June were on par with the monthly average (BOM, 2019).

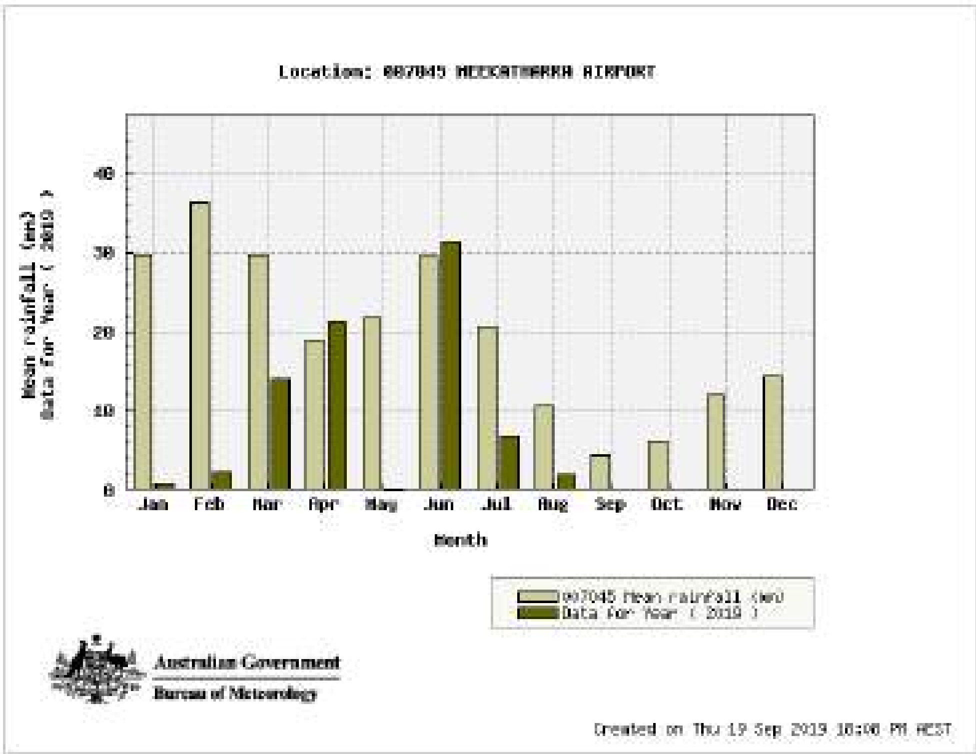

Figure 4: Monthly and mean rainfall for Meekatharra Airport weather station 2019

2. ASSESSMENT METHODOLOGY

2.1 Personnel and Reporting

The following personnel were involved in the reconnaissance flora and vegetation survey:

- Mr Eren Reid (*BSc- Biological Science),* Principal Botanist, Native Vegetation Solutions, undertook the survey, vegetation mapping, data collation, identification of flora, preparation and review of the report;
- Mr Frank Obbens (*BSc*), Consultant Botanist, Bushtech Consultancy, undertook identification of unknown flora samples collected from the field.

2.2 Preliminary Desktop Study

A preliminary assessment of the survey area and its potential constraints was undertaken by reviewing relevant government agency managed databases (Sections 2.2.1 to 2.2.6, and Appendices 1 & 2) and consulting with government agencies where necessary. The following sections provide a summary of desktop searches undertaken for the project.

2.2.1 *Environment Protection and Biodiversity Conservation Act* Protected Matters

The *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* Protected Matters Search tool was utilised to provide results for matters of National Environmental Significance within a 2km buffer of coordinates -26.46604 and 118.5878 (DOTEE, 2019). (http://www.environment.gov.au/arcgis-framework/apps/pmst/pmst-coordinate.jsf)

2.2.2 Threatened Flora and Communities

The Naturemap website of the Department of Biodiversity, Conservation and Attractions (DBCA, 2019) was utilised for a search of their databases containing known populations of threatened flora within a 50km buffer of the shapefile of the survey area. Threatened flora include Declared Rare Flora (DRF- extant, now redefined as 'Threatened') and Priority Flora (Ref: 01-1019FL).

The presence of Threatened and Priority Ecological Communities (TECs & PECs) was determined by examining Geographic Information System (GIS) data supplied by the DBCA upon request within a 15km buffer of the shapefile of the survey area (Reference: 04-01019EC).

2.2.3 Environmentally Sensitive Areas (ESAs) and Conservation Reserves

The Department of Water and Environmental Regulation (DWER, 2019) Clearing Permit System Map Viewer was used to determine the location of any ESAs and Conservation Reserves (https://cps.der.wa.gov.au/main.html).

2.2.4 Vegetation Type, Extent and Status

Vegetation extent and status data was sourced from the Department of Agriculture and Food (DAFWA) report "Land-Use and Vegetation in Western Australia- National Land and Water Resources Audit Report" and its associated GIS file (Shepherd *et al*, 2002). This data comprises Beard's Pre-European vegetation groups.

DBCA's Statewide Vegetation Statistics (DBCA, 2019b) was also referenced for the current extent of Beard's Vegetation Groups.

2.2.5 Wetlands

The potential of wetlands within the project area was determined by examining DWER's Clearing Permit System Map Viewer (DWER, 2019).

2.2.6 Dieback

Dieback is only considered a potential issue for the project if both the mean annual rainfall of the area is >400mm, and if the project area resides south of the 26th parallel.

2.3 Site Investigation

A site visit was carried out by Botanist Eren Reid from Native Vegetation Solutions, on the 27th August 2019 to examine the flora and vegetation groups contained within the survey area. A total of 10 hours was spent on site traversing the survey area, by four-wheel-drive vehicle and on foot.

The survey was conducted in accordance with relevant EPA's Statements and Guidelines (Section 1.1).

The EPA uses the Interim Biogeographic Regionalisation of Australia (IBRA) as the largest unit for Environmental Impact Assessment decision making in relation to the conservation of biodiversity. Given the scale and nature of the proposed disturbance as well as the existing disturbance, and that the survey area is located within the Murchison IBRA region, a reconnaissance flora and vegetation survey was deemed adequate.

2.3.1 Licenses

Field work was conducted under Scientific License SL012445, held by Mr ER Reid with expiry 18/09/2019.

2.3.2 Field Methods

Prior to the field work, the aerial photography was examined and representative sample sites for relevés were chosen to provide coverage over all viable vegetation types.

In the field, these sites were visited and non-permanent 20 x 20m relevé sites were established in appropriate locations, considering representativeness of the site to surrounding vegetation and vegetation boundaries. Relevé sites are represented in Appendix 4.

Each relevé site was captured on a TwoNav Aventura GPS at ±4m accuracy, using Universal Transverse Mercator location on GDA94 datum. Digital photographs were taken of each representative vegetation group present in the survey area.

Data collected at each relevé included:

- Photograph of representative vegetation group;
- GPS Location;
- Species Present;
- Population Count/Estimate of Conservation Significant Flora (if present);
- Disturbance Level; and
- Vegetation Condition

Specimens of taxa not recognised by the Botanists were collected and pressed along with specimens of taxa recognised as, or thought to be, conservation-significant species.

The condition of each relevé was assessed using the method developed by Keighery (1994). Definitions of the condition scale are presented in Appendix 3.

Vegetation groups were mapped (section 2.3.4 below).

Opportunistic sampling of plant taxa and vegetation group mapping was also utilised in the survey area between relevé sampling points, via wandering traverses. Smaller singular relevé sites were also utilised as opportunistic sample sites to collect flora specimens and assist in mapping vegetation groups.

All sample sites, relevés and GPS tracks are included in Appendix 4.

2.3.3 Post-Field Methods

Unknown specimens collected in the field were identified post field work by Frank Obbens with reference to published keys and the reference herbarium at the Western Australian Herbarium (WAHERB) and information published on Florabase (WAHERB, 2019).

Species information was transferred into Microsoft Excel® worksheets representing presence/absence of species per vegetation group.

2.3.4 Mapping

Vegetation mapping was produced via GPS recorded information in the field, cross-referenced with vegetation descriptions made in the field, overlaid on aerial imagery of the survey area. The GPS utilized (TwoNav Aventura GPS) displayed aerial imagery, hence real-time mapping of vegetation groups was available during field work.

Vegetation Health Condition was assessed in the field with reference to Keighery (1994).

GPS tracks and waypoints recorded during field work are presented in Appendix 4.

2.3.5 IBSA Data Package

The Environmental Protection Authority (EPA), Department of Water and Environmental Regulation (DWER) and Department of Mines, Industry Regulation and Safety (DMIRS) require Index of Biodiversity Surveys for Assessments (IBSA) Data Packages to be submitted to support assessment and compliance under the *Environmental Protection Act 1986.*

An IBSA data package is a single file in .zip format, containing:

- one **Metadata and Licensing Statement** in .pdf format;
- one **survey report** in .pdf format;
- one **plain-text survey report** in .txt format; and
- a set of electronic data files, comprising:
    - one **survey details** spatial dataset in shapefile (.shp, etc.) or Mapinfo (.tab, etc.) format; and
    - one or more **survey data** spatial datasets, as required, in shapefile (.shp, etc.) or Mapinfo (.tab, etc.) format.

2.4 Limitations

Table 1 lists potential limitations that may have affected the survey. As shown, this survey may have been limited by drier than average conditions, which affected most of the State of Western Australia in 2019.

Table 1: List of potential survey limitations

Potential Limitations	Constraint (Y/N)	Comment
Competency and experience of the consultants undertaking the survey	N	Mr Eren Reid is an experienced botanist who has conducted many flora and vegetation surveys in the Goldfields, Pilbara and South-west regions of WA.
Proportion of flora identified during survey	N	As the survey was planned to target species of conservation significance and flora within a knwon survey area a complete census of the species present was attempted (Approx. 95%). Sufficient identifications were made to allow vegetation descriptions to be made.
Sources of information	N	Threatened and Priority Flora GIS information was available from DBCA.
Proportion of the task achieved	N	All tasks completed
Timing/Season	Y- Possible	Although many months prior to the field work received below average rainfall, the survey was conducted in August 2019, following above average rainfall in April and June.
Disturbance in survey area	N	Disturbance was present with some minor access tracks present, as well as clearing associated with extensive exploration, in certain areas.
Intensity of survey effort	N	Transects were walked through the survey area with all parts visited
Resources	N	Adequate resources were available
Access problems	N	No problems with access
Availability of contextual information on the region	N	Information on the Murchison Bioregion is readily available.

3. RESULTS

3.1 Preliminary Desktop Assessment

3.1.1 EPBC Protected Matters

The EPBC Protected Matters search tool revealed that the survey area could possibly be suitable habitat for non-native plant species *Cenchrus ciliaris* (Buffel-grass) (DOTEE, 2019)

Buffel-grass is not listed as a declared plant by DPIRD (2019), however according to the EPBC search tool it can impact directly on biodiversity values, for example through competition, and indirectly through increasing the frequency and intensity of fires. Buffel-grass is a high-biomass tussock grass that is generally long-lived, deep-rooted and able to out-compete native vegetation. It can flower and fruit rapidly following rainfall for prolonged periods and produce a large amount of seed which disperses easily. Buffel-grass is tolerant to drought, fire and grazing and can naturalise on a wide range of soil types and landscapes. Hotter fires attributed to buffel-grass can affect groundcover vegetation (including bush foods important to Indigenous communities) and carry into the canopy of keystone arid zone trees such as river red gums (*Eucalyptus camaldulensis*), corkwoods (*Hakea* species) and beefwoods (*Grevillea striata*) with flow-on effects to other plants and animals. They can also increase the risk of damage to infrastructure and cultural sites (DOTEE, 2019).

The EPBC Protected Matters report indicated no TEC's or Commonwealth Reserves within a 2km buffer region of the survey area (DOTEE, 2019).

The results of the EPBC Protected Matters search are included in Appendix 1.

3.1.2 Threatened Flora and Communities

The DBCA databse search revealed a potential for no Threatened and 14 Priority Flora species to occur within a 50km radius of the survey area (DBCA, 2019).

No known locations of these Priority Flora occur within the survey area (WAHERB, 2019). The closest location of Priority Flora occurs 790m west of the proposed Haul Road.

Results of the DBCA database search are included in Appendix 2.

The PEC/TEC search (DBCA, 2019a) revealed that the survey area does not contain any TEC/PECs or lie within any nearby TEC/PEC buffer regions.

3.1.3 Environmentally Sensitive Areas and Conservation Reserves

No ESA's are located within the survey area (DWER, 2019).

No Conservation Reserves were identified within the survey area (DOTEE, 2019).

3.1.4 Vegetation Type, Extent and Status

One vegetation unit defined by Beard (1990) were identified as part of the desktop assessment. These vegetation units identify the Pre-European extent of vegetation, as mapped by Beard (1990).

Information relating to known Beard (1990) vegetation units within the survey area has been summarised in Table 2 below. This information has been compiled through both desktop assessments and the site visit.

Table 2: Summary of information regarding Pre-European and current vegetation extent of Vegetation Association 29 within the survey area

Factor	Value				
Beard Vegetation Association*	29				
Vegetation Association Description*	Sparse low woodland; mulga, discontinuous in scattered groups				
Pre-European Extent (ha)	Scale				
	By Association *(WA)*	***By Association*** *(WA)*	***By IBRA Region*** *(MUR)*	***By IBRA Sub-region*** *(MUR02)*	***By Shire*** *(Shire of Meekatharra)*
	7,015,905*	7,903,991**	2,956,382**	2,160,146**	2,854,683**
% Pre-European Extent Remaining	*100.00%**	*99.94%***	*99.98%***	*99.98%***	*99.89%***
Surrounding Land Use***	Mining, Exploration, Pastoral Lease				
Weed prevalence***	Low				

* Source: Shepherd *et al.* (2002) Appendix 2
**Source: DBCA, (2019b)
***Source: Field Assessment

3.1.5 Wetlands

No wetlands which are recorded on the DWER Clearing Permit System Map Viewer occur within the survey area (DWER, 2019).

3.1.6 Dieback

The survey area lies south of the 26th parallel, however receives average annual rainfall of 237.9 mm, below the 400mm threshold mark. There is no record of *Phytophthora cinnamomi* establishing in natural ecosystems in regions receiving <400mm rainfall per annum (CALM, 2003). Therefore, Dieback is not considered an issue for this survey area, however all measures should be taken to prevent any possible soil contamination (seeds of non-native species *etc*.) which poses a risk in the survey area during seasonally favourable conditions.

3.2 Field Assessment

3.2.1 Threatened Flora

No flora located in the survey area are gazetted as Threatened pursuant to Section 5(1) of the *Biodiversity Conservation Act 2016*. No plant taxa listed as Threatened pursuant to Schedule 1 of the *Environment Protection and Biodiversity Conservation Act 1999* were located within the survey area.

One Priority Flora Species *Calytrix verruculosa* (P3) was recorded at one location within the survey area. Two plants were recorded at this location shown below in Table 3.

Table 3: Priority Flora recorded in the Survey area

Taxon	Conservation Status	Abundance	GDA94 Zone 51 J	
			Easting (m)	Northing (m)
Calytrix verruculosa	P3	2	658790	7071617

Figure 5: *Calytrix verruculosa* (P3)

3.2.2 Vegetation Type, Extent and Status

A total of 11 Families, 17 Genera and 43 Species were recorded within the survey area. Two major vegetation groups were recorded in the survey area, and are in “Good” to “Degraded” condition (using the scale of Keighery 1994, see Appendix 3). Disturbance occurring in the survey area included extensive historic exploration clearing. The summary of Vegetation groups contained within the survey area is summarised in Table 4 below. Maps of the survey area can be seen in Appendix 4.

Table 4: Vegetation Group Summary

Vegeation Group	Family	Genus	Species	Area (ha)	Percentage of Surey Area (%)
Open *Acacia aneura* shrubland	8	9	29	79.63	98.58%
Acacia aneura shrubland over Ironstone outcrop	11	12	19	1.14	1.42%
Total	**11***	**17***	**43***	**80.77#**	**100%#**

Note: * Within total survey area (not sum of column)
Sum of column

The vegetation groups are described in more detail below.

3.2.2.1 Open *Acacia aneura* shrubland

This vegetation group consisted of 8 Families, 9 Genera and 29 Species. The vegetation group was approximately 79.63 ha which makes up 98.58% of the survey area.

Dominant species were *Acacia aneura, Acacia mulganeura, Acacia victoriae* and *Eremophila galeata.*

Figure 6: Open *Acacia aneura* shrubland within the survey area

3.2.2.2 *Acacia aneura* shrubland over Ironstone outcrop

This vegetation group consisted of 11 Families, 12 Genera and 19 Species. The vegetation group was approximately 1.14 ha which makes up 1.42% of the survey area.

Dominant species were *Acacia aneura, Eremophila glutinosa, Acacia pruinocarpa* and *Thryptomene decussata.*

Figure 7: *Acacia aneura* shrubland over Ironstone outcrop within the survey area

3.2.3 Weeds

No weed species were recorded in the survey area.

3.2.4 Vegetation Condition

Overall, the condition of the vegetation was determined to be “Good” to “Degraded”. No areas of vegetation were assessed to be in “Pristine” condition. Degraded areas were affected by extensive disturbance via historical exploration.

A map of the vegetation condition is included in Appendix 4.

3.2.5 Assessment of the Clearing Principles

The Department of Water and Environment Regulation (DWER) assesses clearing permits against ten principles relating to the effect of clearing. NVS submits the following comments regarding the Clearing principles;

(a) Native vegetation should not be cleared if it comprises a high level of biological diversity.

Vegetation communities are predominately Mulga sgrublands on broad loamy plains and low rises. While 43 flora taxa representing 17 families and 11 genera were found during field survey, the vegetation is typical of the region and surrounding regions and not considered to be unusually diverse.

Priority species *Calytrix verruculosa* (P3) was recorded within the survey area. A total of 2 plants were recorded in the survey area.

Clearing of this species within the survey area is not likely to upgrade or increase its Conservation rating, as this species is both widespread and in large numbers throughout the local and regional area and is well documented by other regional surveys. Recorded locations range from 320km northwest of Meekatharra.

Floristically this project is not likely to be at variance to this Principle.

(b) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.

This was not assessed in this report.

(c) Native vegetation should not be cleared if it includes, or is necessary for, the continued existence of rare flora.

No DRF or Threatened Flora were located within the survey area.

Priority species *Calytrix verruculosa* (P3) was recorded within the survey area. A total of 2 plants were recorded in the survey area.

Clearing of this species within the survey area is not likely to upgrade or increase its Conservation rating, as this species is both widespread and in large numbers throughout the local and regional area and is well documented by other regional surveys. Recorded locations range from 320km northwest of Meekatharra.

The Project is not at variance to this Principle.

(d) Native vegetation should not be cleared if it comprises the whole or part of, or is necessary for the maintenance of a threatened ecological community.

There are no known Threatened or Priority Ecological communities recorded in the survey area, and no vegetation groups recorded in the survey area are regarded as such.

The Project is not at variance to this Principle.

(e) Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.

As demonstrated in section 3.1.4, the Beard vegetation associations which occur within the survey area are considered to have between 99-100% of their spatial area remaining post European settlement and are not adversely affected by extensive clearing such as farming.

The Project is not at variance to this Principle.

(f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.

The survey area contains no wetlands or watercourses, as identified by DWER Clearing Permit System Map Viewer (DWER, 2019).

There are no permanent watercourses or wetlands within the area proposed to be cleared.

The Project is not at variance to this Principle.

(g) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.

This was not assessed in this report

(h) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.

No conservation areas will be affected by clearing within the survey area.

The proposed clearing is not at variance to this Principle

(i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.

This was not assessed in this report

(j) Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.

This was not assessed in this report

4. DISCUSSION

A total of 11 Families, 17 Genera and 43 Species were recorded within the survey area. Two major vegetation groups were recorded in the survey area.

The field assessment established that the condition of the vegetation in the proposed disturbance area is overall “Good” to “Degraded”. No areas of vegetation were assessed to be in “Pristine” condition.

No Threatened Flora, TECs or PECs were recorded in the survey area.

One Priority Flora Species *Calytrix verruculosa* (P3) was recorded at one location within the survey area. Two plants were recorded at this location.

No weed species were recorded in the survey area.

Any proposed disturbance/clearing of vegetation will result in a loss of species from the survey area. However, given the size of the area and the extent of the Beard (1990) vegetation associations elsewhere, the impact on the vegetation and its component flora will not affect the conservation values of either, or create fragmentation or patches of remnant vegetation.

The following recommendations arise from the Reconnaissance flora and vegetation survey:

- Where possible, avoid clearing within 10m of the Priority Flora location, if clearing is unavaoidable around this species seek permission to destroy from DBCA;
- Where possible, clearing be aligned to existing roads, tracks and other barriers or follow the boundaries of broad-scale intact native vegetation; and
- Weed control measures to be implemented during and following clearing

5. REFERENCES

Beard, J.S., (1990), *Plant Life of Western Australia*, Kangaroo Press Pty Ltd, NSW

BOM, (2019), *Climate Data Online*, Bureau of Meteorology,
http://www.bom.gov.au/climate/data/
Accessed: 19/09/2019

CALM, (2002), *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002- Murchison (MUR2 – Western Murchison synopsis)*, Department of Conservation and Land Management

CALM, (2003), *Phytophthora cinnamomi and Diseases Caused By It, Volume 1-Management Guidelines,* Department of Conservation and Land Management
http://www.dpaw.wa.gov.au/images/documents/conservation-management/pests-diseases/disease-risk-areas/Phytophthora_cinnamomi_and_disease_caused_by_it-_Vol._1_Management_Guidelines_.pdf
Accessed: 20/09/2019

DBCA, (2019), *Threatened Flora Database Results Ref: 01-1019FL,* Department of Biodiversity Conservation and Attractions

DBCA, (2019a), *TEC/PEC Database Results Ref: 04-01019EC,* Department of Biodiversity Conservation and Attractions

DBCA, (2019b), *2018 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full Report)- Current as of March 2019,* WA Department of Biodiversity, Conservation and Attractions, Perth,
https://catalogue.data.wa.gov.au/dataset/dbca-statewide-vegetation-statistics
Accessed: 20/09/2019

DPIRD, (2019), *Declared Plants Database,* Department of Primary Industries and Regional Development
https://www.agric.wa.gov.au/organisms
Accessed: 20/09/2019

DOTEE (2019), *Protected Matters Search Tool*, Department of the Environment and Energy
http://www.environment.gov.au/webgis-framework/apps/pmst/pmst-coordinate.jsf
Accessed: 20/09/2019

DWER, (2019), Clearing Permit System Map Viewer, Department of Water and Environmental Regulation
https://cps.dwer.wa.gov.au/main.html
Accessed: 20/09/2019

EPA, (2016)*, Environmental Factor Guideline: Flora and Vegetation,* Environmental Protection Authority, Western Australia

EPA (2016a), *Technical Guidance- Flora and Vegetation Surveys for Environmental Impact Assessment,* Environmental Protection Authority, Western Australia

Hussey, B M J, G J, Cousens, R D Dodd, J and Lloyd S G, (2007), *Western Weeds- A guide to the Weeds of Western Australia (Second Edition)*, The Weed Society of Western Australia, Perth WA

Keighery, B.J., (1994), *Bushland Plant Survey; A guide to plant community survey for the Community,* Wildflower Society of Western Australia (Inc.) Nedlands

Lamp, C., and Collet, F., (1999), *Field Guide to Weeds in Australia (Third edition)*, Inkata Press

Shepherd, D.P., Beeston, G.R., and A.J.M. Hopkins, (2002), *Land-Use and Vegetation in Western Australia- National Land and Water Resources Audit Report*, Technical Report 250, Department of Agriculture Western Australia

WAHERB, (2019), *Florabase- the Western Australian Flora*,
https://florabase.dpaw.wa.gov.au/
Accessed 20/09/2019

6. GLOSSARY

Acronyms:

BC Act	*Biodiversity Conservation Act 2016*, Western Australia
BOM	Bureau of Meteorology, Australian Government
BSc	Bachelor of Science
CALM	Department of Conservation and Land Management (now DBCA)
CPS	Clearing Permit System (DWER)
DBCA	Department of Biodiversity, Conservation and Attractions, Western Australia
DMIRS	Department of Mines, Industry Regulation and Safety, Western Australia
DOTEE	Department of the Environment and Energy, Australian Government
DPAW	Department of Parks and Wildlife, Western Australia (now DBCA)
DPIRD	Department of Primary Industries and Regional Development, Western Australia
DRF	Declared Rare Flora
DWER	Department of Water and Environmental Regulation, Western Australia
EPA	Environmental Protection Authority, Western Australia
EP Act	*Environmental Protection Act 1986*, Western Australia
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth Act)
ESA	Environmentally Sensitive Area
GIS	Geographical Information System
ha	Hectare (10,000 square metres)
IBRA	Interim Biogeographic Regionalisation for Australia, DOTEE
IUCN	International Union for the Conservation of Nature and Natural Resources – commonly known as the World Conservation Union
km	Kilometres
m	Metres
MUR	Murchison Bioregion, IBRA
MUR02	Western Murchison Subregion, IBRA
NVS	Native Vegetation Solutions
PEC	Priority Ecological Community, Western Australia
Ramsar	A wetland site designated of international importance under the Ramsar Convention (UNESCO)
TEC	Threatened Ecological Community
UNESCO	United Nations Educational, Scientific and Cultural Organization
WA	Western Australia
WAHERB	Western Australian Herbarium, DBCA

Definitions:

{DBCA (2019) Conservation Codes for Western Australian Flora and Fauna. Department of Biodiversity, Conservation and Attractions, Western Australia, January 2019}: -

T Threatened species:

Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act).

Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for Threatened Fauna.

Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the *Wildlife Conservation (Rare Flora) Notice 2018* for Threatened Flora.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below..

CR Critically endangered species

Threatened species considered to be "*facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for critically endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for critically endangered flora.

EN Endangered species

Threatened species considered to be "*facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for endangered flora.

VU Vulnerable species

Threatened species considered to be "*facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for vulnerable fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for vulnerable flora..

<u>Extinct species:</u>

Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.

EX Extinct species

Species where "*there is no reasonable doubt that the last member of the species has died*", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).

Published as presumed extinct under schedule 4 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for extinct fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.

EW Extinct in the wild species

Species that "is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).

Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.

<u>Specially protected species</u>

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.

MI Migratory species

Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).

Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.

Published as migratory birds protected under an international agreement under schedule 5 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

CD Species of special conservation interest (conservation dependent fauna)

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act).

Published as conservation dependent fauna under schedule 6 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

OS Other specially protected species

Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

Published as other specially protected fauna under schedule 7 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018.*

P <u>Priority Species</u>

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna or flora.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

Priority 1: Poorly-known species

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

Priority 2: Poorly-known species

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

Priority 3: Poorly-known species

Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

Priority 4: Rare, Near Threatened and other species in need of monitoring

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands.
(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent.
(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Appendix 1

Relevant Government Database Search Results

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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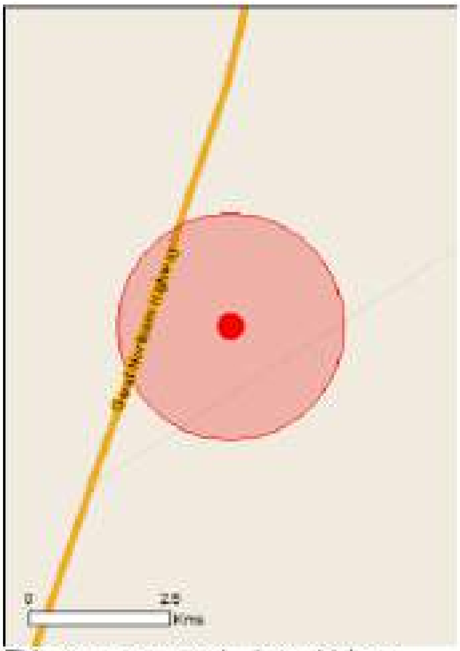

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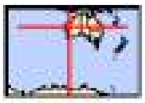
Coordinates
Buffer: 2.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	3
Listed Migratory Species:	7

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	10
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	9
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
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Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area

Extra Information

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Mammals		
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-26.46604 118.5678

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Department of the Environment
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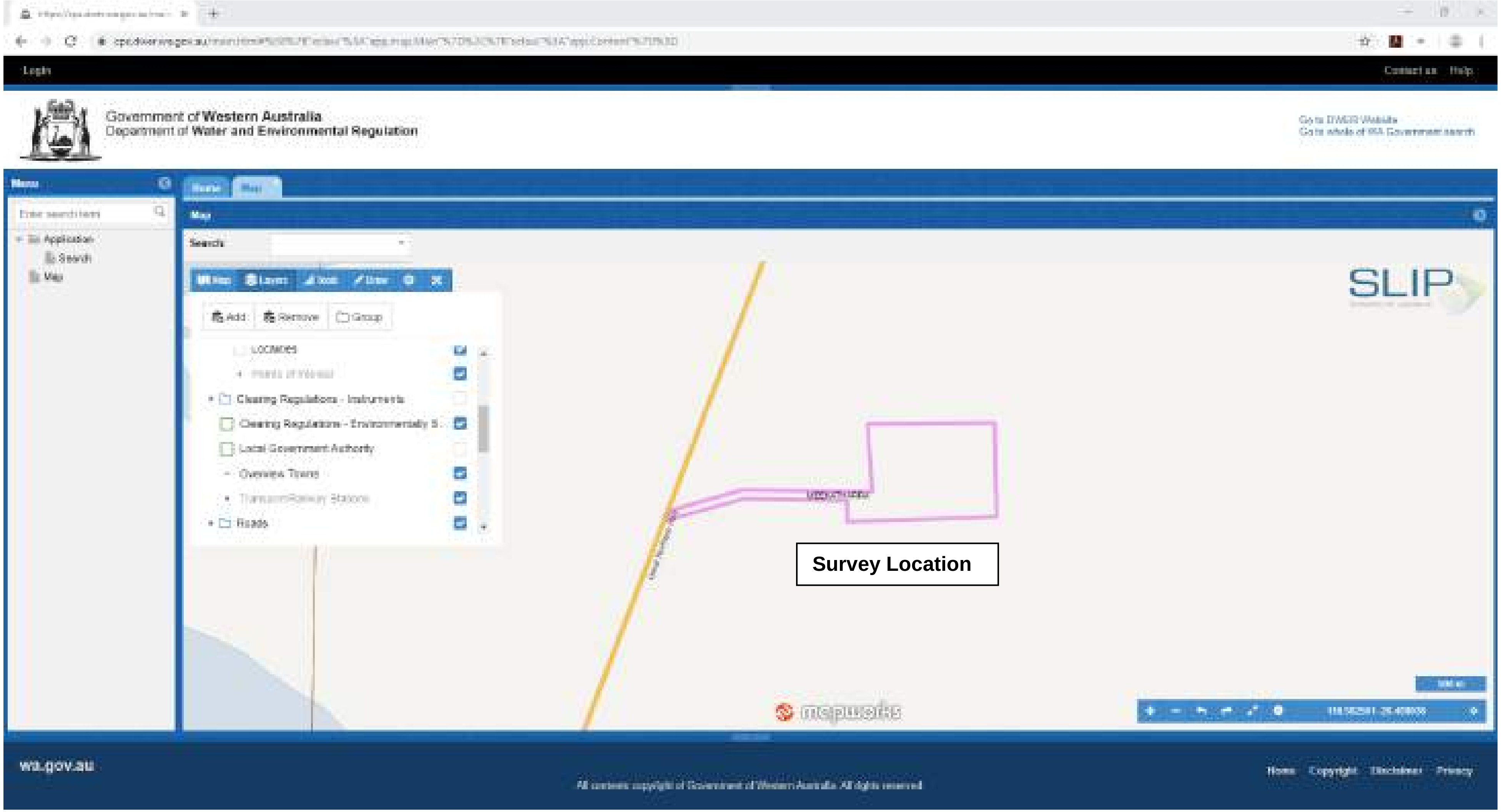
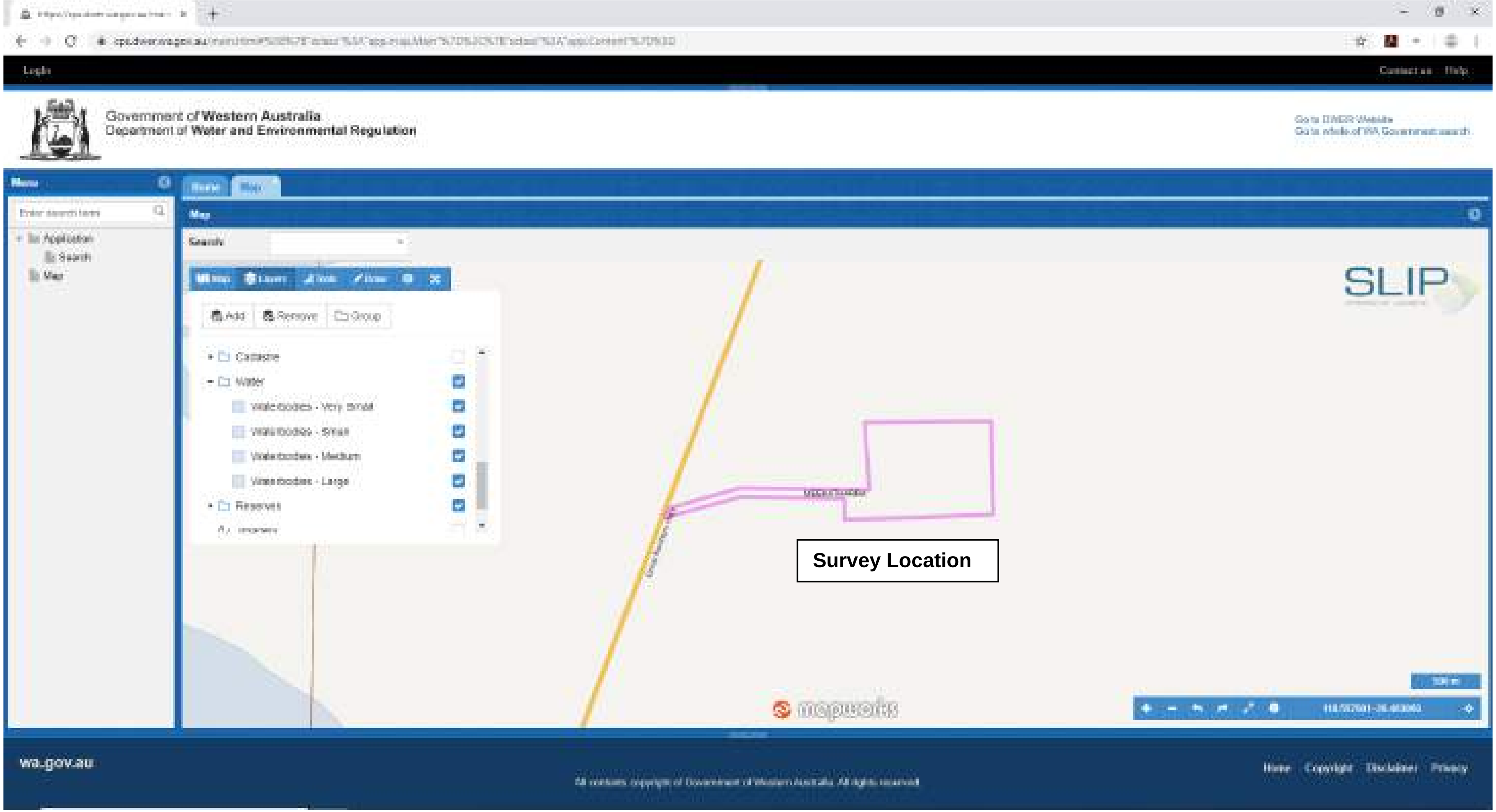
Canberra ACT 2601 Australia
+61 2 6274 1111



DWER's Clearing Permit System Map Viewer showing no ESA's (dark green shaded areas) within the survey area (DWER, 2019)



DWER Clearing Permit System Map Viewer showing no wetland areas within the survey area (DWER, 2019).

Appendix 2

DBCA Threatened Flora Database Search Results

Acacia speckii	P4
Calytrix verruculosa	P3
Dicrastylis mitchellii	P1
Drummondita miniata	P3
Eragrostis sp. Erect spikelets (P.K. Latz 2122)	P3
Eremophila fasciata	P3
Eremophila retropila	P1
Goodenia berringbinensis	P4
Grevillea inconspicua	P4
Hemigenia virescens	P3
Homalocalyx echinulatus	P3
Menkea draboides	P3
Ptilotus luteolus	P3
Tribulus adelacanthus	P3

Appendix 3

Vegetation Condition Scale (Keighery, 1994)

Pristine (1). Pristine or nearly so, no obvious signs of disturbance.

Excellent (2). Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.

Very Good (3). Vegetation structure altered, obvious signs of disturbance.
For example, disturbance to vegetation structure caused by repeating fires, the presence of some more aggressive weeds, dieback, logging and grazing.

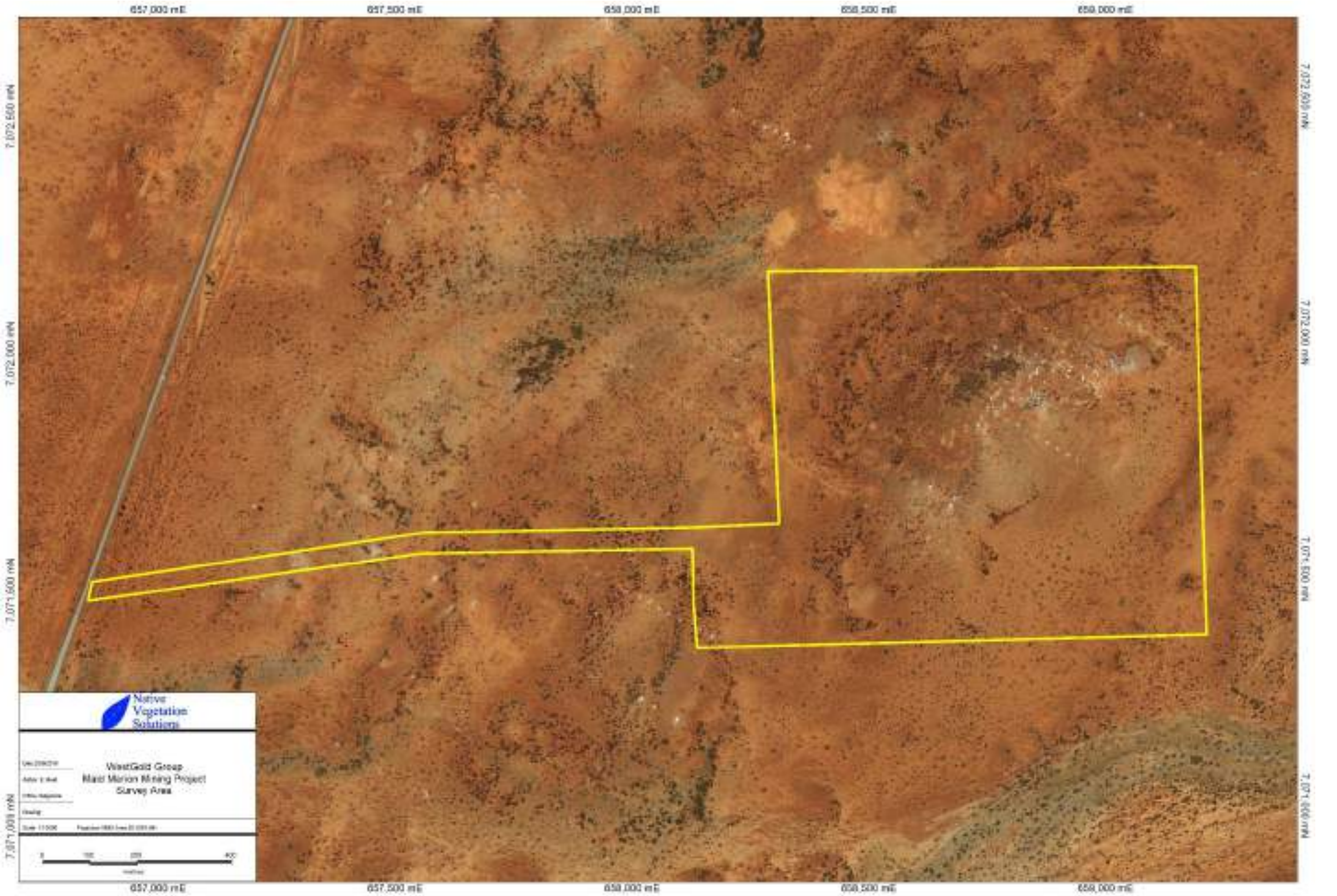
Good (4). Vegetation structure significantly altered by very obvious signs of multiple disturbance.
Retains basic vegetation structure or ability to regenerate it.
For example, disturbance to vegetation structure caused by frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.

Degraded (5). Basic vegetation structure severely impacted by disturbance.
Scope for regeneration but not to a state approaching good condition without intensive management.
For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.

Completely Degraded (6). The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.
These areas are often described as 'parkland cleared' with the flora compromising weed or crop species with isolated trees or shrubs.

Appendix 4

Vegetation Mapping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7,072,000 mN
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7,071,000 mN
Native Vegetation Solutions
WestGold Group
Maid Marion Mining Project
Survey Area


Acacia aneura shrubland over Ironstone outcrop
Open Acacia aneura shrubland
Native Vegetation Solutions
WestGold Group
Maid Marion Mining Project
Vegetation Groups
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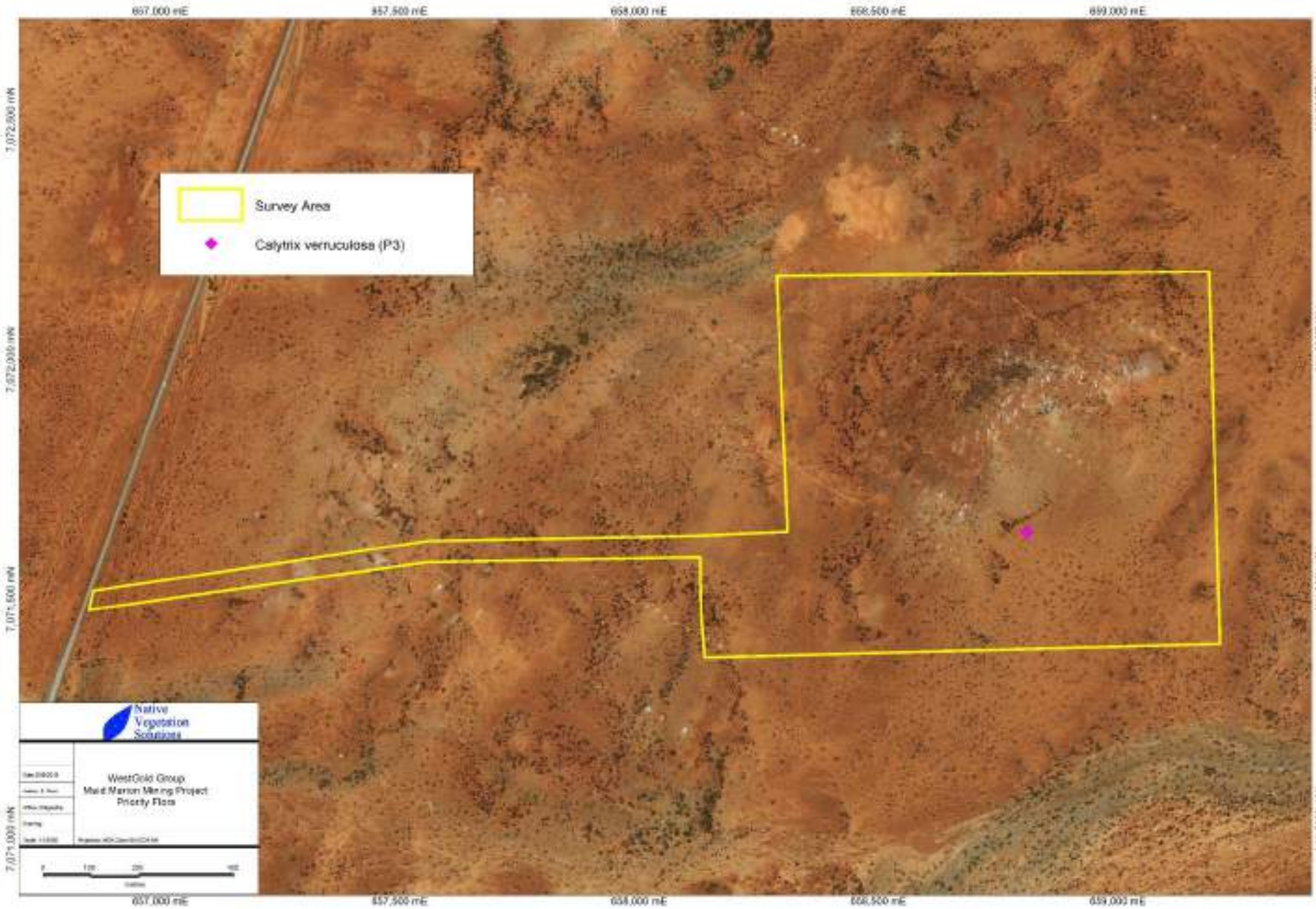
Degraded
Good
Native Vegetation Solutions
WestGold Group
Maid Marion Mining Project
Vegetation Condition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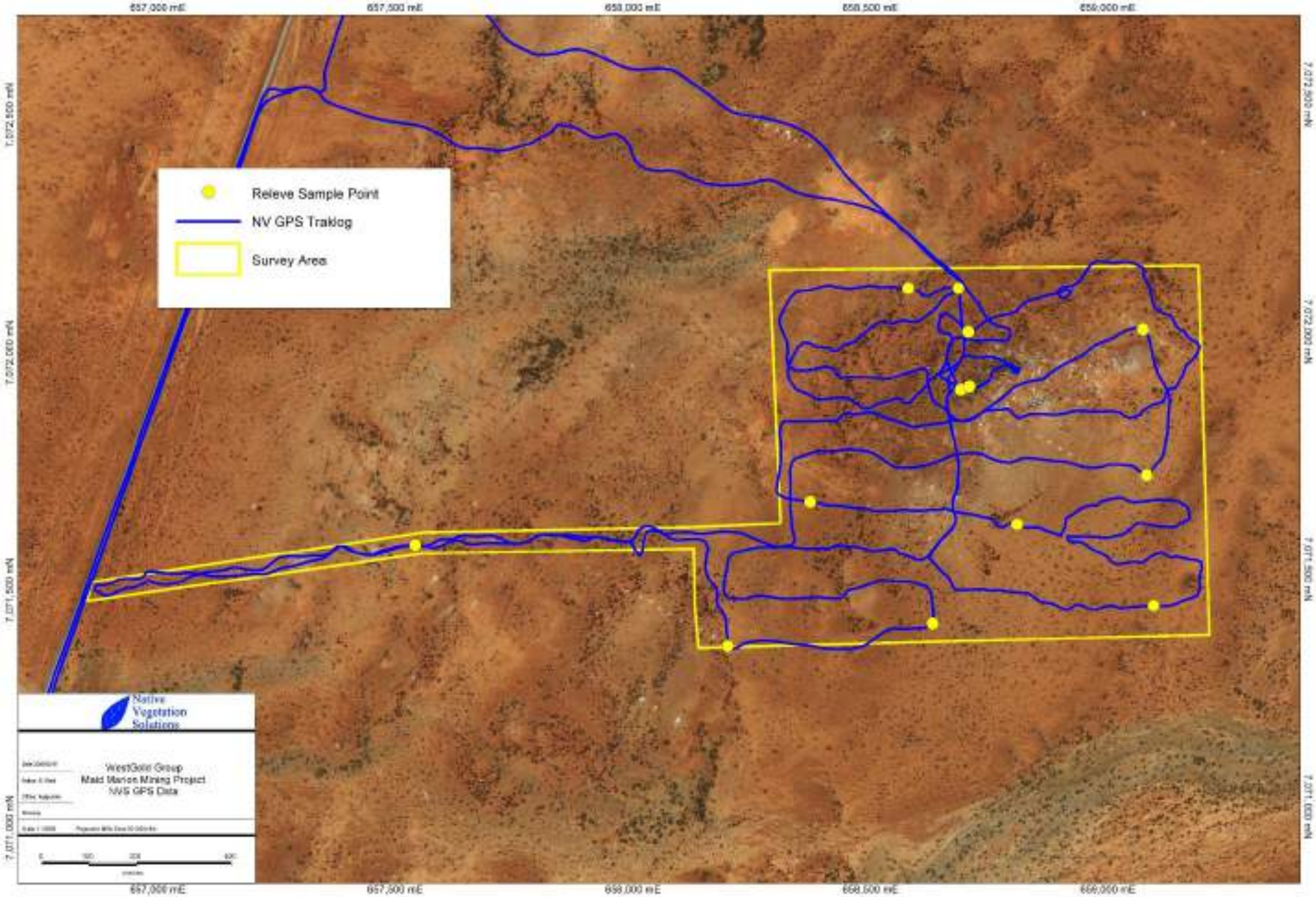
Survey Area
Calytrix verruculosa (P3)
Native Vegetation Solutions
WestGold Group
Maid Marion Mining Project
Priority Flora



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Releve Sample Point
NV GPS Traklog
Survey Area
Native Vegetation Solutions
WestGold Group
Maid Marion Mining Project
NVS GPS Data

Appendix 5

Species List

Family	Genus	Species	Annual, Perennial or Non-Native	Open *Acacia aneura* shrubland	***Acacia aneura*** **shrubland over irionstone outcrop**
Amaranthaceae	*Ptilotus*	*rotundifolius*	P	*	*
Amaranthaceae	*Ptilotus*	*schwartzii*	P		*
Asparagaceae	*Thysanotus*	*manglesianus*	P		*
Chenopodiaceae	*Dysphania*	*kalpari*	A		*
Chenopodiaceae	*Maireana*	*georgei*	P	*	
Chenopodiaceae	*Maireana*	*triptera*	P	*	
Fabaceae	*Acacia*	*aneura*	P	*	*
Fabaceae	*Acacia*	*craspedocarpa*	P	*	
Fabaceae	*Acacia*	*minyura*	P	*	
Fabaceae	*Acacia*	*mulganeura*	P	*	
Fabaceae	*Acacia*	*pruinocarpa*	P	*	*
Fabaceae	*Acacia*	*pteraneura*	P	*	
Fabaceae	*Acacia*	*quadrimarginea*	P	*	*
Fabaceae	*Acacia*	*ramulosa subsp. linophylla*	P	*	
Fabaceae	*Acacia*	*tetragonophylla*	P	*	
Fabaceae	*Acacia*	*victoriae*	P	*	
Fabaceae	*Senna*	*artemisioides subsp. helmsii*	P	*	
Fabaceae	*Senna*	*artemisioides subsp. sturtii*	P	*	
Goodeniaceae	*Goodenia*	*tenuiloba*	A		*
Goodeniaceae	*Scaevola*	*spinescens*	P	*	
Myrtaceae	*Calytrix*	*verruculosa (P3)*	P	*	
Myrtaceae	*Thryptomene*	*decussata*	P		*
Poaceae	*Aristida*	*contorta*	A		*
Poaceae	*Eragrostis*	*eriopoda*	P		*
Poaceae	*Eragrostis*	*setifolia*	P		*
Proteaceae	*Grevillea*	*berryana*	P		*
Proteaceae	*Hakea*	*preissii*	P	*	
Pteridaceae	*Cheilanthes*	*lasiophylla*	P		*
Rubiaceae	*Psydrax*	*latifolia*	P	*	
Rubiaceae	*Psydrax*	*rigidula*	P	*	
Rubiaceae	*Psydrax*	*suaveolens*	P		*
Scrophulariaceae	*Eremophila*	*compacta subsp. fecunda*	P	*	
Scrophulariaceae	*Eremophila*	*eriocalyx*	P		*
Scrophulariaceae	*Eremophila*	*foliosissima*	P	*	
Scrophulariaceae	*Eremophila*	*forrestii subsp. hastieana*	P	*	
Scrophulariaceae	*Eremophila*	*galeata*	P	*	
Scrophulariaceae	*Eremophila*	*glutinosa*	P	*	*
Scrophulariaceae	*Eremophila*	*granitica*	P		*
Scrophulariaceae	*Eremophila*	*lachnocalyx*	P	*	
Scrophulariaceae	*Eremophila*	*latrobei subsp. latrobei*	P		*
Scrophulariaceae	*Eremophila*	*metallicorum*	P	*	
Scrophulariaceae	*Eremophila*	*spectabilis* subsp. *spectabilis*	P	*	
Scrophulariaceae	*Eremophila*	*youngii subsp. youngii*	P	*	

Note:
A= Annual, P= Perennial, NN= Non Native

APPENDIX F – MAID MARION EPBC ACT PROTECTED MATTERS SEARCH

Australian Government

Department of the Environment and Energy

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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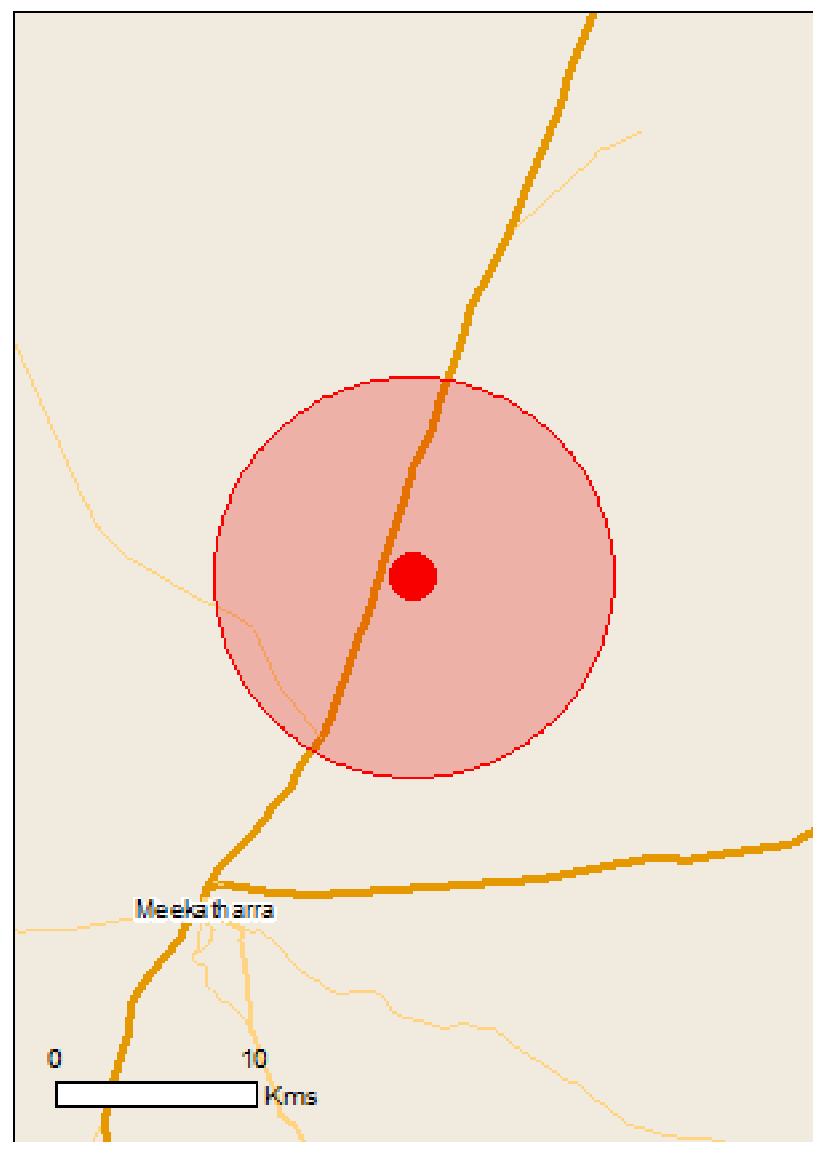
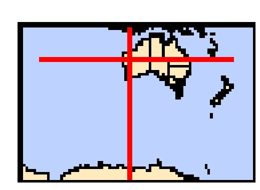


Coordinates

Buffer: 10.0Km



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Listed Threatened Species:	3
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A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	10
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	10
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

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Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Carrichtera annua Ward's Weed [9511]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

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Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-26.46139 118.59167

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government – Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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