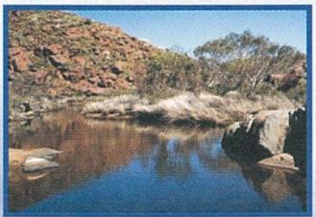
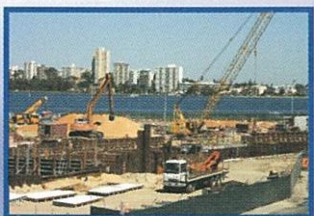
aquaterra

working with you to develop practical
water resources and environmental solutions





GOLDSWORTHY IRON ORE MINING OPERATIONS - CUNDALINE AND CALLAWA MINING OPERATIONS

SURFACE WATER ASSESSMENT

Prepared for: BHP Billiton Iron Ore Pty Ltd

Ref: 980B/215d
Oct 2008

GOLDSWORTHY IRON ORE MINING OPERATIONS
CUNDALINE AND CALLAWA MINING OPERATIONS
SURFACE WATER ASSESSMENT

Document Status

Revision	Date	Revision Description
A	9 October 2008	Issued for Client Review
B	23 October 2008	Final
C	29 October 2008	Final
D	31 October 2008	Final

	Name	Position	Signature	Date
Originator:	Vince Piper	Principal Civil/Water Resources Engineer	V. Piper	31 Oct 2008
Reviewer:	Iain Rea	Senior Water Resources Engineer	pp. Mitchell	31 Oct 2008

aquaterra
Aquaterra Consulting Pty Ltd
ABN 49 082 286 708

Suite 4, 125 Melville Parade
Como, Western Australia, 6152

Tel: (08) 9368 4044
Fax: (08) 9368 4055

EXECUTIVE SUMMARY

BHP Billiton Iron Ore Pty Ltd's (BHPBIO's) exploration programme has identified iron ore deposits at the Cundaline and Callawa ridgelines which are proposed to be developed as satellite mining operations and use the existing Goldsworthy Iron Ore Mining Operations infrastructure and facilities as far as practicable.

Aquaterra Consulting Pty Ltd has been commissioned to undertake a surface water study for the planned Cundaline and Callawa mining operations as supporting documentation to the environmental impact assessment. This report describes the existing surface water resources, identifies the potential impacts of the planned Cundaline and Callawa mining operations on natural drainage systems and discusses management strategies to minimise the impact of the planned Cundaline and Callawa mining operations on drainage systems.

Planned pit and overburden stockpile area (OSA) developments within the planned Cundaline and Callawa mining operations have the potential to impact surface water resources by changing local surface water flow patterns, by affecting surface water runoff volumes and quality, by causing erosion from disturbed areas with downstream sedimentation or by contamination from chemicals/hydrocarbons.

The planned pits are located along the tops of ridge lines and mine plans indicate that minimal if any upstream external catchments would be intercepted by the open pit developments. Where external catchment diversion is required (and is feasible), diversion bunds/channels would be installed. In other areas, pit perimeter safety bunding would be installed. During operations, excess stormwater collected in the pits will be treated to remove the sediments and would then typically be used for ore processing and dust suppression, with any excess discharged to the environment under relevant licence conditions.

The combined Cundaline and Callawa pits intercept a total catchment area of 141 hectares (ha) (1.41 square kilometres [km^2]). Compared with the total Eel Creek's natural catchment area of approximately 500km^2 and the De Grey River's catchment area of approximately of 50,000km^2, the potential loss of runoff volume to the downstream creek systems, due to the pit developments, is not significant to the overall hydrological system, particularly in comparison to the natural seasonal variations in catchment runoff.

Internal runoff from the OSAs is collected by the perimeter bunding and discharged via a sediment basin to the downstream environment. Loss of runoff volume from the OSA structures is estimated to be negligible.

The mining activities will potentially mobilise additional sediments to the natural drainage systems with the main potential sediment sources being the OSAs and ore stockpiles. The most effective method of sediment management is limiting vegetation disturbance and creating stable landforms, however, where sediment is created it will be controlled close to the source. Sediment basins are a means to control surface water sediment, and bunds and sediment basins should be constructed down slope of all OSAs and stockpiles (as appropriate) to manage this issue. The final locations and layouts for these works will need to be determined in association with the detailed mine plans.

BHPBIO will install appropriate diversions and bunding around the mining areas, including sediment basins, as required, downstream of OSAs, stockpiles and other disturbed areas. Any water released off the site will meet relevant licence conditions. The planned Cundaline and Callawa mining operations will have a localised effect on the surface water runoff through the redirection of flow and the development of voids which may intercept minor drainage lines and collect surface water. Surface water management strategies will be implemented to ensure negligible impact on local surface water resources.

TABLE OF CONTENTS

EXECUTIVE SUMMARY 1

SECTION 1 - INTRODUCTION 1

1.1 Project Background and Location 1
1.2 Scope of the Assessment 2

SECTION 2 - HYDROLOGY 3

2.1 Climate 3
2.2 Temperature 3
2.3 Rainfall and Evaporation 3
2.4 Streamflow 4

SECTION 3 - EXISTING ENVIRONMENT 5

3.1 De Grey River 5
3.2 Eel Creek 6

SECTION 4 - POTENTIAL IMPACTS 7

4.1 Potential Impacts from Mining Activities 7
4.2 Interruption to Existing Surface Water Flow Patterns 7
4.3 Increased Risk of Erosion and Sedimentation 9
4.4 Contamination of Surface Water by Chemicals or Hydrocarbons 9

SECTION 5 - SURFACE WATER MANAGEMENT 10

5.1 General Management Objectives 10
5.1.1 General Surface Water Management Objectives 10
5.1.2 Closure Surface Water Management Objectives 10
5.2 Existing Goldsworthy Surface Water Management and Monitoring 10
5.2.1 Existing Environmental Management Programme 10
5.2.2 Existing Surface Water Monitoring Programme 11
5.3 General Water Management Strategies 12
5.4 Surface Water Diversions 13
5.5 Sediment Basins 14
5.6 Specific Cundaline and Callawa Surface Water Management Works 14

SECTION 6 - SUMMARY AND CONCLUSIONS 16

6.1 Project Description 16
6.1.1 General Surface Water Management Objectives 16
6.1.2 Closure Surface Water Management Objectives 16
6.2 Potential Impacts 16
6.3 Management Measures 17

SECTION 7 - REFERENCES 18

TABLES

Table 5.1 Surface Water Monitoring Programme 11

PLATE

Plate 1 Low Flow in the De Grey River

FIGURES

Figure 1 Regional Location
Figure 2 Project Location and Tenements
Figure 3a Planned Cundaline Mining Operations Conceptual General Arrangement
Figure 3b Planned Callawa Mining Operations Conceptual General Arrangement
Figure 4 Cundaline – Callawa Surface Water Management Location Plan
Figure 5 Surface Water Management Regional Flowpaths
Figure 6 Cundaline – Callawa Surface Water Management Cundaline Flowpaths
Figure 7 Cundaline – Callawa Surface Water Management Callawa Flowpaths

SECTION 1 - INTRODUCTION

1.1 PROJECT BACKGROUND AND LOCATION

BHP Billiton Iron Ore Pty Ltd (BHPBIO) operates the Goldsworthy Iron Ore Mining Operations (Goldsworthy) which are located approximately 200 kilometres (km) east of Port Hedland in the north of the Pilbara region of Western Australia (Figure 1).

The development of Goldsworthy has been conducted in phases over the past 50 years. The Mount Goldsworthy Mine was the first mining operation and commenced in the mid 1960s. Once it was mined out, the operations were progressively expanded to other Goldsworthy deposits that include the Shay Gap, Nimingarra, Sunrise Hill, Yarrie and Cattle Gorge deposits. Ore processing and rail loading occurs at facilities located at Yarrie and Nimingarra.

The current mining operations are centred at Yarrie, with some mining still taking place at the Nimingarra, Cattle Gorge and Sunrise Hill deposits (Figure 2). The Mount Goldsworthy and Shay Gap mining areas are no longer operational, with the majority of activities at these sites directed towards the monitoring and maintenance of rehabilitated landforms.

BHPBIO's Goldsworthy operations are conducted under the *Iron Ore (Goldsworthy) Agreement Act, 1964*, and the *Iron Ore (Goldsworthy-Nimingarra) Agreement Act, 1972*. Environmental requirements for the operations are specified in the "Goldsworthy Extension Project Notice of Intent" (Goldsworthy Mining Limited, 1986), and the conditions of Ministerial Statement's No. 000303 and No. 000682, issued by the Minister for the Environment under Part IV of the Western Australia *Environmental Protection Act, 1986* (EP Act), and Licences 5561 and 4412 issued under Part V of the EP Act.

BHPBIO's exploration programme has identified iron ore deposits at the Cundaline and Callawa ridgelines (Figure 2). The Cundaline and Callawa deposits are proposed to be developed as satellite mining operations and would use the existing Goldsworthy infrastructure and facilities as far as practicable.

Major components of mining infrastructure and activities at the planned Cundaline and Callawa mining operations would include:

- pre-stripping, open pit mining and stockpiling of overburden and ore at the Cundaline and Callawa pits;
- placement of overburden in mined-out voids and out-of-pit overburden stockpile areas (OSAs) adjacent to the Cundaline and Callawa pits;
- trucking of the Callawa ore to the Yarrie crushing, screening and rail loading facilities, which are located approximately 2km to the north;
- trucking of the Cundaline ore to the Yarrie crushing, screening and rail loading facilities, which are located approximately 12km to the south-east, or use of a mobile crushing and screening plant to be located at the Cundaline area;
- stockpiling, crushing, screening and load-up of iron ore at the Yarrie processing facilities and/or the mobile Cundaline facilities;

- continued groundwater abstraction from the Shay Gap borefield to meet operational demands, and distribution through the existing water supply system and pipeline extensions to the Cundaline and Callawa areas;
- construction and use of small day rooms, workshop facilities and storage areas at the Cundaline and Callawa areas;
- supply of power to the facilities at the Cundaline and Callawa areas either via connecting electricity lines from the existing power network, or use of on-site diesel generators; and
- construction and use of haul and access roads to the Cundaline and Callawa areas.

The general arrangements of the planned Cundaline and Callawa mining operations are shown on Figures 3a and 3b, respectively.

1.2 SCOPE OF THE ASSESSMENT

BHPBIO commissioned Aquaterra Consulting Pty Ltd (Aquaterra) to undertake a surface water assessment for the planned Cundaline and Callawa mining operations. The scope of works for this assessment comprises:

- Characterisation and description of existing surface water resources.
- Identification of potential impacts of the planned Cundaline and Callawa mining operations on natural drainage systems.
- Discussion of management strategies to minimise the impact of the planned Cundaline and Callawa mining operations on the drainage systems.

2.1 CLIMATE

Western Australia has three broad climate divisions. The northern part is dry tropical and the south-west corner has a Mediterranean climate, with long, hot summers and wet winters. The remainder is mostly arid land or desert climates.

The Pilbara region is characterised by an arid climate resulting from the influence of tropical maritime and tropical continental air masses, receiving summer rainfall. Cyclones occur during this period, bringing heavy rain, causing potential destruction to inland and coastal towns.

2.2 TEMPERATURE

The Pilbara region has an extreme temperature range, potentially rising to 50 degrees Celsius (°C) during the summer, and dropping to around 0°C in winter (Bureau of Meteorology [BOM], 2008). Mean monthly maximum temperatures at Marble Bar range from over 40°C in January to 27°C in July, while mean monthly minimum temperatures range from 26°C in January to 12°C in July (BOM, 2008). The mean monthly maximum temperatures on the coast at Port Hedland are 36°C in January and 27°C in July and mean minimum temperatures are 26°C in January and 12°C in July (BOM, 2008). High summer temperatures and humidity seldom occur together, giving the Pilbara its very dry climate.

2.3 RAINFALL AND EVAPORATION

The Pilbara region has a highly variable rainfall, which is dominated by the occurrence of tropical cyclones mainly from January to March. The moist tropical storms from the north bring sporadic and drenching thunderstorms. With the exception of these large events, rainfall can be erratic, and localised, due to thunderstorm activity. Therefore, rainfall from a single site may not be representative of the spatial variability of rainfall over the entire catchment during an event. The driest months are typically September to November.

During the winter months, cold fronts move in an easterly direction across Western Australia and sometimes reach the Pilbara region producing light rains.

The annual average rainfall at Yarrie Station (1898 to 2008) (BOM, 2008), located close to the planned Cundaline and Callawa mining operations, is 356 millimetres (mm). This is slightly higher than Port Hedland, which has an annual average rainfall of 313mm (BOM, 2008). Variability is high with annual rainfall varying between 39mm (1924) and 1120mm (2000).

The mean annual pan evaporation rate in the planned Cundaline and Callawa mining operations area is estimated at about 3500mm (Department of Agriculture, 1987), which exceeds annual rainfall by over 3000mm. Average monthly pan evaporation rates vary between a minimum 200mm in June and a maximum 400mm in December.

2.4 STREAMFLOW

Streamflow in the Pilbara region is directly correlated to rainfall, with the majority of streamflow occurring during the summer months of December through to March. Streamflow in the smaller flow channels is typically short in duration, and ceases soon after the rainfall passes. In the larger river channels, which drain the larger catchments, runoff can persist for several weeks and possibly months following major rainfall events such as those resulting from tropical cyclones.

Streamflow gauging stations are widely spaced in the Pilbara region, with none located near the immediate Goldsworthy area. The nearest gauging station is on the Coongan River at Marble Bar (Western Australia Department of Water [DoW] gauge S710204) located approximately 80km south from the planned Cundaline and Callawa mining operations. Another gauging station is on the De Grey River at Coolenar Pool (DoW gauge S710003) located approximately 100km west from the planned Cundaline and Callawa mining operations. These gauging stations record streamflow from approximately 3,700 square kilometres (km^2) and 50,000km^2 catchments, respectively. However, due to relative catchment sizes and locations, these streamflow data do not necessarily represent the runoff within the planned Cundaline and Callawa mining operations.

Peak streamflow discharges from ungauged catchments in the Pilbara region can be estimated using empirical techniques, such as those recommended in “Australian Rainfall and Runoff” (Institute of Engineers, 1987).

SECTION 3 - EXISTING ENVIRONMENT

3.1 DE GREY RIVER

The Goldsworthy operations are located within the De Grey River catchment, with the Cundaline and Callawa deposits located on ridgelines around 5 to 10km north from the main river channel. The locations of the Cundaline and Callawa deposits relative to the De Grey River system are shown on Figure 4.

The De Grey River is a major river system that flows in a general north-western direction to discharge on the coast about 60km east of Port Hedland. The De Grey River receives discharges from several large rivers including the Strelley River, Shaw River, Coongan River, Nullagine River and Oakover River, and drains a total catchment area of approximately 50,000km^2. A photograph showing low flow in the De Grey River is given in Plate 1.

Water quality in the De Grey River is measured at the Coolenar Pool gauging station (DoW gauge S710003) located around 100km west from the Cundaline and Callawa deposits. Monitoring data from this station indicates that the river typically has a salinity of between 200 and 1200 milligrams per litre (mg/L) making the water suitable for multiple uses. Within the general Cundaline and Callawa area, there are no known users of surface water, and beneficial use is understood to comprise in-stream support for native flora and fauna, and opportunistic use by stock.

Plate 1
Low Flow in the De Grey River

3.2 EEL CREEK

The Cundaline and Callawa deposits are predominantly located within the Eel Creek catchment which drains southwards into the De Grey River (Figure 5). The Eel Creek catchment extends to around 30km north of the De Grey River and has a total catchment area of approximately 500km^2. The ore deposits and planned mine infrastructure are located on rocky ridgelines and adjacent plains which characterise the southern portion of the catchment, whereas the northern catchment area comprises mainly sandy plains with some isolated rocky outcrops.

The locations of the planned Cundaline pits and OSAs relative to the natural drainage systems are shown on Figure 6. The three planned pits (10K, 13K and 14K) are located on the crest of the ridge with external drainage around the pit perimeters either draining northwards into the Eel Creek catchment or southwards away from the Eel Creek catchment directly towards the De Grey River via a collection of smaller creeks. Locally these smaller creeks have a collective catchment area of around 150km^2 draining towards the De Grey River. The two planned OSAs (10K and 13/14K), stockpile and associated infrastructure are located on the northern side of the ridge crest within the Eel Creek catchment. Drainage from these areas drains northwards into an eastwards flowing tributary to Eel Creek. The Cooneeina Creek lies to the north from the Cundaline deposit and all planned Cundaline pits and OSAs are located outside of this catchment area.

The locations of the planned Callawa pits and OSA relative to the natural drainage systems are shown on Figure 7. The three planned pits (A, B and C) are located on the edge of the ridge with external drainage around the pit perimeters either draining northwards into the Eel Creek catchment or eastwards away from the Eel Creek catchment into an un-named creek. This un-named creek drains southwards to the De Grey River and has a total catchment area of around 80km^2. The planned Callawa OSA wraps around the north and east sides of the planned pits with external drainage discharging either northwards into the Eel Creek catchment or eastwards into the same un-named creek. A temporary waste rock dump is planned to be constructed to the southwest of the planned pits and within a small catchment draining northwards towards the planned OSA.

The existing Yarrie Mine and associated infrastructure are located across the Kimberley Gap north of the Callawa deposit (Figure 7) and are also predominantly located within the Eel Creek catchment, though a small portion does drain eastwards then southwards into the above defined un-named creek. The existing Cattle Gorge Mine (Figure 2) is also fully located within the Eel Creek catchment. Drainage from the existing mine site developments for Shay Gap (closed), Sunrise Hill and Nimingarra (Figure 2) drains to the De Grey River via different creek systems.

4.1 POTENTIAL IMPACTS FROM MINING ACTIVITIES

Potential surface water impacts associated with the planned activities include:

- Interruption to existing surface water flow patterns.
- Increased risk of erosion and sedimentation.
- Contamination of surface water by chemicals or hydrocarbons.

4.2 INTERRUPTION TO EXISTING SURFACE WATER FLOW PATTERNS

Interruption to the natural surface water flow patterns has the potential to reduce and in some cases, locally increase the surface water runoff volume. The potential secondary impact of changes to the surface water runoff volumes is the impact on the ecology of vegetation communities which rely on streamflow and sheetflow.

The natural flowpaths around the planned Cundaline and Callawa mining operations and the existing Yarrie Mine all drain to the De Grey River, as shown in Figure 5. It is noted that the existing mining infrastructure developed for the Yarrie Mine already impacts on the natural drainage systems. Natural flowpaths in the area have been diverted and the impacts are being managed.

The planned Cundaline 10K, 13K and 14K pits will be developed on the crest of the Cundaline Ridge, as shown in Figure 6. Being constructed on a ridge crest, the planned pit developments will have no external catchments and will not block any external catchment runoff from draining to the valley floors. However, the area occupied by the pit developments will be inwardly draining, capturing incident rainfall, and reducing the volume of rainfall runoff discharging to the natural drainage systems. Stormwater captured in the pits will tend to seep into the pit floor with the excess removed by pumping. Where viable, the pumped water will be used for dust suppression with the remainder discharged (after treatment) back into the natural drainage system. If all of the collected in-pit water was pumped back to the environment, there would be no water loss to the natural hydrological cycle. However, as some water will likely be lost to groundwater seepage and some used for dust suppression (likely to be small as dust suppression volumes are relatively small compared to a main runoff event), there will be a net water loss from the surface water system.

The planned Cundaline 10K and 13/14K OSAs and associated stockpile will be developed on the upper north flank of the Cundaline Ridge just downgradient from the planned pits, as shown in Figure 6. With this layout, there will effectively be no external catchment upgradient from the OSAs, as the upgradient area will be occupied by the pits. Although the OSAs will block the natural drainage system under their footprint, internal runoff from the OSAs will be collected by the perimeter bunding and discharged via a sediment basin to the downstream environment. Loss of runoff volume from the OSA areas to the downstream environment is estimated to be negligible, though there will be some redistribution of the runoff. A drainage corridor will be maintained, between the two OSAs, to enable stormwater runoff to drain to the downstream areas.

The planned Callawa A, B and C pits will be developed on the crest of the Callawa Ridge, in the north-east corner, as shown in Figure 7. These three pits are located together on a high level spur and collectively they potentially block a small external catchment area. Hence the pit developments will potentially block runoff from a minimal external catchment area from draining off the ridge. Additionally as with all pits, the area occupied by the pit developments will be inwardly draining, capturing incident rainfall, and reducing the volume of rainfall runoff directly discharging to the natural drainage systems. Stormwater captured in the three pits will tend to seep into the pit floors with the excess removed by pumping. Where viable, the pumped water will be used for dust suppression with the remainder discharged (after treatment) back into the natural drainage system.

The planned Callawa OSA wraps around the north and east sides of the planned Callawa pits on the north-east corner of the Callawa Ridge, as shown on Figure 7. As the OSA will be just downgradient from the planned pits, there will be minimal external catchment upgradient from the OSA adjacent to the pits. However the planned OSA will intercept a small external catchment located to the west of the pits and containing a temporary waste rock dump. Runoff from this catchment will be diverted around the OSA and discharged via a sediment basin to the downstream environment. Although the OSA will block the natural drainage system under its footprint, internal runoff from the OSAs will be collected by the perimeter bunding and discharged via a sediment basin to the downstream environment. Loss of runoff volume from the OSA areas and intercepted external catchments to the downstream environment is estimated to be negligible, though there will be some redistribution of the runoff.

The planned Cundaline pit development areas and the estimated maximum catchment areas intercepted (not diverted) by the pit developments total 125 hectares (ha). Similarly for the planned Callawa pit developments, the estimated pit and intercepted catchment areas total 16ha. The planned combined Cundaline and Callawa pits intercepted areas total 141ha (1.41km^2). Although during mining operations, runoff water will be removed by pumping from the pit, on closure this pumping would cease. Assuming 100% runoff loss from the pit and intercepted upslope catchment areas, then the effective runoff volume loss from the Eel Creek and De Grey River catchment is that from the total 1.41km^2 intercepted area. This compares with the total natural catchment to Eel Creek of around 500km^2 and the total De Grey River catchment of around 50,000km^2. Hence, the potential loss of runoff volume to the downstream creek systems, due to the pit developments, is not significant to the overall hydrological system, particularly in comparison to the natural seasonal variations in catchment runoff.

A haul road and access road will be constructed to transport ore from the planned Callawa pits to the existing Yarrie crushing, screening and rail loading facilities located approximately 2km to the north (Figure 3b). These roads will cross several minor drainage lines.

A haul road may also be constructed to transport ore from the planned Cundaline pits to the existing Yarrie crushing, screening and rail loading facilities located approximately 12km to the south-east. If constructed this haul road would run along the same general alignment as the existing railway route directly to the Yarrie processing facilities. Eel Creek and several drainage lines would be crossed by the haul road.

Runoff from the planned Cundaline and Callawa OSAs is collected by the perimeter bunding and discharged via sediment basins to the downstream environment. Loss of runoff volume from the catchment areas containing the OSA structures is estimated to be negligible.

4.3 INCREASED RISK OF EROSION AND SEDIMENTATION

Runoff from the planned OSAs and other disturbance areas has the potential to significantly increase erosion within the development areas and sediment loads in the natural drainage systems, if appropriate management measures are not implemented.

4.4 CONTAMINATION OF SURFACE WATER BY CHEMICALS OR HYDROCARBONS

Spillage of chemicals or hydrocarbons from storage and/or transfer areas is possible if appropriate control measures and operating procedures are not used.

SECTION 5 - SURFACE WATER MANAGEMENT

5.1 GENERAL MANAGEMENT OBJECTIVES

Surface water management objectives for the planned Cundaline and Callawa mining operations include 'general objectives' which primarily relate to operational management activities, and 'closure objectives' which relate to rehabilitation, decommissioning and mine closure.

5.1.1 General Surface Water Management Objectives

- To prevent or minimise impacts on the quality of surface water resulting from mining operations and contain any contaminated water on-site.
- To ensure that the quality of water returned to local and regional surface water resources will not result in significant deterioration of those resources.

5.1.2 Closure Surface Water Management Objectives

- Baseline surface water quality and flow regimes in Eel and Egg Creek will be maintained.

The following sub-sections describe management strategies that will be used by BHPBIO to meet the above management objectives, and to minimise the potential impacts identified in Section 4.

5.2 EXISTING GOLDSWORTHY SURFACE WATER MANAGEMENT AND MONITORING

5.2.1 Existing Environmental Management Programme

In 1993 BHPBIO prepared and implemented a Water Management Plan for the Yarrie mining operations in order to satisfy Condition 3-1 of Ministerial Statement of Approval No. 000303. The 1993 Water Management Plan described the surface water and groundwater management and monitoring procedures for Yarrie, as well as potential impacts to groundwater resources and long-term management procedures for pit salinity development. Since mining activities at Yarrie are now substantially completed, a large proportion of the monitoring and management measures contained in the 1993 Water Management Plan are no longer relevant (e.g. construction water management, monitoring of pit dewatering). However, the Plan does contain relevant information regarding post closure water management (in particular, the management of pit lake water quality at Y2/3).

An Environmental Management Plan (EMP) has been prepared to satisfy the relevant conditions of Ministerial Statement of Approval No. 000682 (issued in August 2005), and the relevant conditions included in Ministerial Statement of Approval No. 000303 (issued in February 1993). The EMP describes the overall environmental management programme that will be used to manage potential impacts of Goldsworthy on environmental aspects relevant to the site. These include soil resources, landforms, surface water, groundwater, air quality, noise, flora, fauna and Aboriginal heritage. For each aspect, the EMP identifies potential impacts, establishes management objectives, outlines relevant strategies/practices/procedures to minimise impacts, establishes performance indicators and sets out monitoring requirements.

BHPBIO has current licences to discharge excess water generated by mine dewatering activities into the creeks adjacent to the Sunrise Hill - Nimingarra and Yarrie mining areas. The water is transferred to the approved discharge points from turkeys nest dams that act as stilling ponds to reduce sediment loads prior to discharge.

5.2.2 Existing Surface Water Monitoring Programme

Water samples are collected from discharge points to assess compliance with the requirements of the EP Act Licences and at locations upstream and downstream of the mining areas. The existing surface water monitoring programme for Goldsworthy is summarised in Table 5-1.

Mining at the planned Cundaline pits will be above the watertable and no dewatering will be required, however, as mining is planned to extend below the watertable at the planned Callawa pits some minor dewatering will be required. The planned Callawa mining operations dewatering discharges will be used for dust suppression and a licence for discharge to the environment is not required.

Table 5.1
Surface Water Monitoring Programme

Area/Aspect to be Monitored	Parameter	Location	Frequency
Mine Dewatering Discharge[1,2]	Flow Rate	Sunrise Hill West 7 (SHW7) Nimingarra B (Nim B) Nimingarra I (Nim I) Nimingarra F East (Nim FE) (emergency discharge point) West Nimingarra B (emergency discharge point) Y2/3 Y10 W1 (contingency discharge point)	Continuous
	Water Quality[a]	Sunrise Hill West 7 (SHW7) Nimingarra B (Nim B) Nimingarra I (Nim I) Y2/3 Y10	Quarterly (Nov, Feb, May, Aug)
	Water Quality[a]	West Nimingarra B (emergency discharge point) Nimingarra F East (Nim FE) (emergency discharge point) W1 (contingency discharge point)	Monthly (during discharge periods)
Stormwater Discharge from Hydrocarbon Storage Area[1]	Total Petroleum Hydrocarbon (TPH) Concentration	Hydrocarbon storage areas	Event Basic (as required)
Surface Water at Egg Creek, Eel Creek, Yarrie OSA[3]	Water Quality[a]	Egg Creek (NMSW003 and NMSW004) and Eel Creek (YASW005 and YASW006), base of the Yarrie W1 OSA (YASW003) and Chinaman Springs (YASW001), Cattle Gorge Creek	Quarterly (when surface flow is present)
Water Use Efficiency[3]	Site Water Balance	Calculate	Annual
Erosion and Sediment Control	Integrity of mine landforms and water management structures	All active and rehabilitated mine landforms and disturbance areas.	After major rainfall events

[1] Programme required as per EP Act Licence No. 4412.
[2] Programme required as per EP Act Licence No. 5611.
[3] Programme internally developed and implemented by BHPBIO.
[a] Water Quality Suite: pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), As, Cr, Cd, Cu, Hg, Mn,

Two existing surface water monitoring sites have been established on Eel Creek. No additional sampling sites are likely to be required as a result of the planned Cundaline and Callawa mining operations.

5.3 GENERAL WATER MANAGEMENT STRATEGIES

The planned Cundaline and Callawa mining operations would have a localised effect on the surface water runoff through the redirection of flow and the development of voids which may intercept minor drainage lines and collect surface water. The implementation of the management strategies outlined below is expected to result in a negligible impact on local surface water resources.

Experience in the Pilbara region has found that the following general surface water management strategies can be used to effectively manage mining related impacts on the hydrological conditions of the region:

- Limiting Clearing: Vegetation is the most effective method of minimising erosion and sedimentation. Initial clearing would be limited to areas of workable size actively being used for construction.
- Vehicle Movements: Keep vehicle movements to the minimum necessary and use existing tracks where possible.
- Buffer Zones: Adequate buffer zones should be provided between the areas of disturbance and the natural drainage lines where possible; to place a high priority on the protection of natural drainage lines from impacts resulting from construction activities.
- Dry Season Construction: Construction on or near natural flowpaths to be planned for the dry season where practicable. Temporary stabilisation measures should be used in high erosion risk zones.
- Topsoil Storage: Topsoil to be stored such that it is protected from internal rainfall and runoff by temporary vegetation or mulching, and protected from external runoff by diversion banks/catch drains. Topsoil should also be located away from drainage lines and upstream of sediment basins.
- Separate Flowpaths: Flows from undisturbed areas should be kept separate from disturbed areas.
- Upstream Diversions: Where feasible, upstream surface water flows to be diverted around structures with appropriate grades into adjacent or downstream defined surface water flow pathways.
- Flow Dispersion: If it is necessary for flow diversions to discharge to sheet flow zones, the diverted surface water should be discharged over spreader mechanisms (e.g. a riprap pad) to encourage the flows to slow and disperse.
- Bunding: All waste dumps and stockpiles have the potential to generate sediment laden runoff water which may require treatment in sediment basins prior to discharge to the environment. Bunding should be provided as appropriate to contain internal surface water runoff for treatment, plus to divert external surface water runoff.
- Culverts: Culverts should be installed where haul and access roads cross main creeks to allow drainage to pass.
- Sediment Basins: Sediment basins should be designed and implemented as required, to intercept sediments and limit their transportation downstream. They should be located within drainage lines downstream of active mine areas, waste dumps and other disturbance areas, and sized appropriately for the rainfall events and catchment area. Sediment basins are generally more effective when they are

located close to the source of sediment, and the sediment laden water is not allowed to mix with the "clean water" (so as to reduce the volume of water to be treated).

- Temporary Works: Surface runoff from disturbed areas will typically contain some sediment, and may also include pollutant loads such as oil and grease. Temporary erosion and sediment control structures should be provided such as diversion banks, drains and sediment traps.
- Internal Stormwater Provisions: Internal stormwater runoff in the development areas may cause localised flow velocity increases around the mine infrastructure, as water is concentrated in diversion channels, or alongside flood bunds or raised pads. This flow is to be handled by the internal stormwater provisions for the developed areas. Formalised drainage networks to be installed in plant site areas.
- Hydrocarbon Management: Hydrocarbon storage areas to be bunded. Potentially hydrocarbon polluted runoff to be directed to basins fitted with baffle mechanisms (e.g. underflow/overflow baffle weirs) to trap possible pollutants before discharge to the downstream environment.

5.4 SURFACE WATER DIVERSIONS

Diversion requires a combination of bunding and excavated channels to carry runoff via a flowpath different from the natural water course. The diverted water is directed into a defined water course, preferably the original water course at a point downstream. Energy may need to be removed from the flow at the entry point (e.g. riprap lining) to match the receiving channel characteristics.

The design capacity selected for the constructed diversion depends on the impacts of failure of the diversion. If there are potential adverse impacts of flood flow in areas normally flood free, or on other mine infrastructure or the environment, then diverted water needs to remain confined within its diversion (e.g. 100 year Average Recurrence Interval [ARI] capacity). If flood flow in areas normally flood free is acceptable or otherwise only represents nuisance flows, then a lesser ARI capacity and less costly diversion (e.g. two year ARI capacity) may be suitable.

Where diversion structures are required, bunding should typically consist of a level top section (minimum) 3 metres (m) wide with side batters of 1:2.5, and be built to an engineering specification using competent materials. Bunding dimensions should be capable of containing or diverting runoff flows up the design flood event, in combination with the diversion channel, where provided, plus a freeboard allowance. Excavated channels should typically have side batters of 1:2 and be of sufficient bottom width and depth to contain the design flood event. Larger flows would overtop the channel and potentially become overbank flow.

5.5 SEDIMENT BASINS

The planned Cundaline and Callawa mining operations would potentially mobilise additional sediments to the natural drainage systems with the main potential sediment sources being the OSAs and stockpiles. The most effective method of sediment management is limiting vegetation disturbance and creating stable landforms, however, where sediment is created it will be controlled close to the source. Sediment basins are a means to control surface water sediment, and should be constructed down slope of all OSAs and stockpiles (as appropriate) to manage this issue. Sediment basins should be used in conjunction with erosion minimisation strategies such as vegetating batters and engineered drainage systems.

Sediment basins collect internal runoff and treat to remove sediments to acceptable levels prior to release to the natural environment. Bunds and drainage diversion works would be constructed around the perimeter of all OSAs and stockpile areas, to divert and prevent natural runoff from outside the development sites from mixing with internal site runoff. Basins are typically located at a low point on the infrastructure perimeter and constructed by a combination of excavation and earth bunds. For design of the sediment basins, a target sediment size of medium sized silt particles > 0.02mm (20 micrometres [µm]) is common for the design storm event. The sediment trap is then expected to be effective in removing sand and medium to coarse silt. The removal of fine silt and clay is generally not as effective.

5.6 SPECIFIC CUNDALINE AND CALLAWA SURFACE WATER MANAGEMENT WORKS

Surface water management measures have been implemented in the existing Goldsworthy mining areas. Management works for the planned Cundaline and Callawa mining operations would include new works, which are described below.

Being constructed on a ridge, the planned Cundaline 10K, 13K and 14K pits would have no external catchments draining towards the pits and would not block any external catchment runoff from draining to the valley floors. Perimeter safety bunding would be installed around the pits which would also protect against, and potentially divert, any minor nuisance runoff from the surrounding areas. During operations, excess stormwater collected in the pit would be treated to remove the sediments and then would typically be used for ore processing and dust suppression, with any excess discharged to the environment under relevant licence conditions.

Perimeter bunding would be installed around the downgradient sides of the planned Cundaline 10K and 13/14K OSAs to catch internal potentially sediment laden runoff. Due to the pits being located adjacent and on the upgradient side of the OSAs, upstream diversion bunding is not required around the OSAs. Drainage within the OSAs would be designed to cater for the design rainfall event and to channel internal runoff through a local sediment basin(s) prior to discharge to an existing creek flowpath to the downstream environment. In the zone between the pits, stormwater drainage works would be installed to manage runoff from the planned stockpile and other development works and discharged via a sediment basin to the environment under relevant licence conditions.

The planned Callawa A, B and C pits would be developed as a cluster on the north-east crest of the Callawa Ridge and would potentially block runoff from a small external catchment area (located south of Pit B) from draining off the ridge (Figure 7). To drain this blocked area to the downstream environment, a small diversion bund/channel would be installed around the south and west side of Pit B. In other areas, perimeter safety bunding would be installed around the pits, as there would be no external catchments draining towards the pits. These safety bunds would also protect against, and potentially divert, any minor nuisance runoff from the surrounding areas. As at the planned Cundaline mining operations, excess stormwater collected in the pit during mining would be treated to remove the sediments and then would typically be used for ore processing and dust suppression, with any excess discharged to the environment under relevant licence conditions.

The planned Callawa OSA wraps around the north and east sides of the planned Callawa pits and perimeter bunding would be installed around the OSA downgradient sides. As the planned pits would be just upgradient from the OSA, there would be minimal external catchment draining towards the OSA from the pits area, though a small external catchment containing the planned temporary waste rock dump area would drain towards the OSA. Drainage around the OSA would be designed to cater for the design rainfall event and to channel internal and intercepted external runoff through local sediment basins prior to discharge to an existing creek flowpath to the downstream environment.

.

SECTION 6 - SUMMARY AND CONCLUSIONS

6.1 PROJECT DESCRIPTION

BHPBIO operates Goldsworthy which is located approximately 200km east of Port Hedland. Operations have progressively expanded from the initial Mount Goldsworthy Mine to other deposits that include the Shay Gap, Nimingarra, Sunrise Hill, Yarrie and Cattle Gorge deposits. Ore processing and rail loading occurs at facilities located at Yarrie and Nimingarra. BHPBIO's exploration programme has identified iron ore deposits at the Cundaline and Callawa ridgelines which are proposed to be developed as satellite mining operations and use the existing Goldsworthy infrastructure and facilities as far as practicable.

BHPBIO is in the process of seeking environmental approval for planned future mining at the Cundaline and Callawa deposits. This report details the results of a surface water assessment to characterise the existing surface water resources, identify potential impacts of the project on natural drainage systems and discuss management strategies to minimise the impact of the project on the drainage systems.

Surface water management objectives for the planned Cundaline and Callawa mining operations include 'general objectives' which primarily relate to operational management activities, and 'closure objectives' which relate to rehabilitation, decommissioning and closure.

6.1.1 General Surface Water Management Objectives

- To prevent or minimise impacts on the quality of surface water resulting from mining operations and contain any contaminated water on-site.
- To ensure that the quality of water returned to local and regional surface water resources will not result in significant deterioration of those resources.

6.1.2 Closure Surface Water Management Objectives

- Baseline surface water quality and flow regimes in Eel Creek and Egg Creek will be maintained.

6.2 POTENTIAL IMPACTS

Planned pit and OSA developments within the planned Cundaline and Callawa mining operations have the potential to impact surface water resources by changing local surface water flow patterns, by affecting surface water runoff volumes and quality, by causing erosion from disturbed areas with downstream sedimentation or by contamination from chemicals/hydrocarbons.

The planned pits are located along the tops of ridge lines and mine plans indicate that minimal if any upstream external catchments would be intercepted by the open pit developments. Where external catchment diversion is required (and is feasible), diversion bunds/channels would be installed. In other areas, pit perimeter safety bunding would be installed. During operations, excess stormwater collected in the pits will be treated to remove the sediments and would then typically be used for ore processing and dust suppression, with any excess discharged to the environment under relevant licence conditions. Hence some water will be lost from the natural hydrological cycle due to groundwater seepage, dust suppression usage (likely to be small) and long term capture within disused pits.

The combined Cundaline and Callawa pits intercept a total catchment area of 141ha (1.41km^2). Compared with Eel Creek's natural catchment area of approximately 500km^2 and the De Grey River's catchment area of approximately 50,000km^2, the potential loss of runoff volume to the downstream creek systems, due to the pit developments, is not significant to the overall hydrological system, particularly in comparison to the natural seasonal variations in catchment runoff.

Internal runoff from the OSAs (and any intercepted external runoff) would be collected by the perimeter bunding and discharged via a sediment basin to the downstream environment. Loss of runoff volume to the downstream catchments from the OSA structures is estimated to be negligible.

The mining activities will potentially mobilise additional sediments to the natural drainage systems with the main potential sediment sources being the OSAs and stockpiles. The most effective method of sediment management is limiting vegetation disturbance and creating stable landforms, however, where sediment is created it will be controlled close to the source. Sediment basins are a means to control surface water sediment, and bunds and sediment basins should be constructed down slope of all OSAs and stockpiles (as appropriate) to manage this issue. The final locations and layouts for these works will need to be determined in association with the detailed mine plans.

6.3 MANAGEMENT MEASURES

BHPBIO will install appropriate diversions and bunding around the mining areas, including sediment basins, as required, downstream of OSAs, stockpiles and other disturbed areas. Any water released from the site will meet relevant licence conditions. The planned Cundaline and Callawa mining operations will have a localised effect on the surface water runoff through the redirection of flow and the development of voids which may intercept minor drainage lines and collect surface water. Surface water management strategies will be implemented to ensure negligible impact on local surface water resources.

Surface water management measures for the planned Cundaline and Callawa mining operations include:

- Perimeter safety bunding around all pits.
- Diversion bunding where appropriate along pit perimeters to divert local runoff to the valley floor.
- Perimeter bunding around the planned OSAs to catch internal potentially sediment laden runoff and divert external runoff, as appropriate.
- Culverts installed where haul and access roads cross creeks and drainage lines.
- Sediment basin(s) installed at each OSA to treat internal runoff prior to discharge to the downstream environment.
- Catchment runoff and internal stormwater collected in pits to be treated to remove sediments prior to pumping for discharge to the environment.

SECTION 7 - REFERENCES

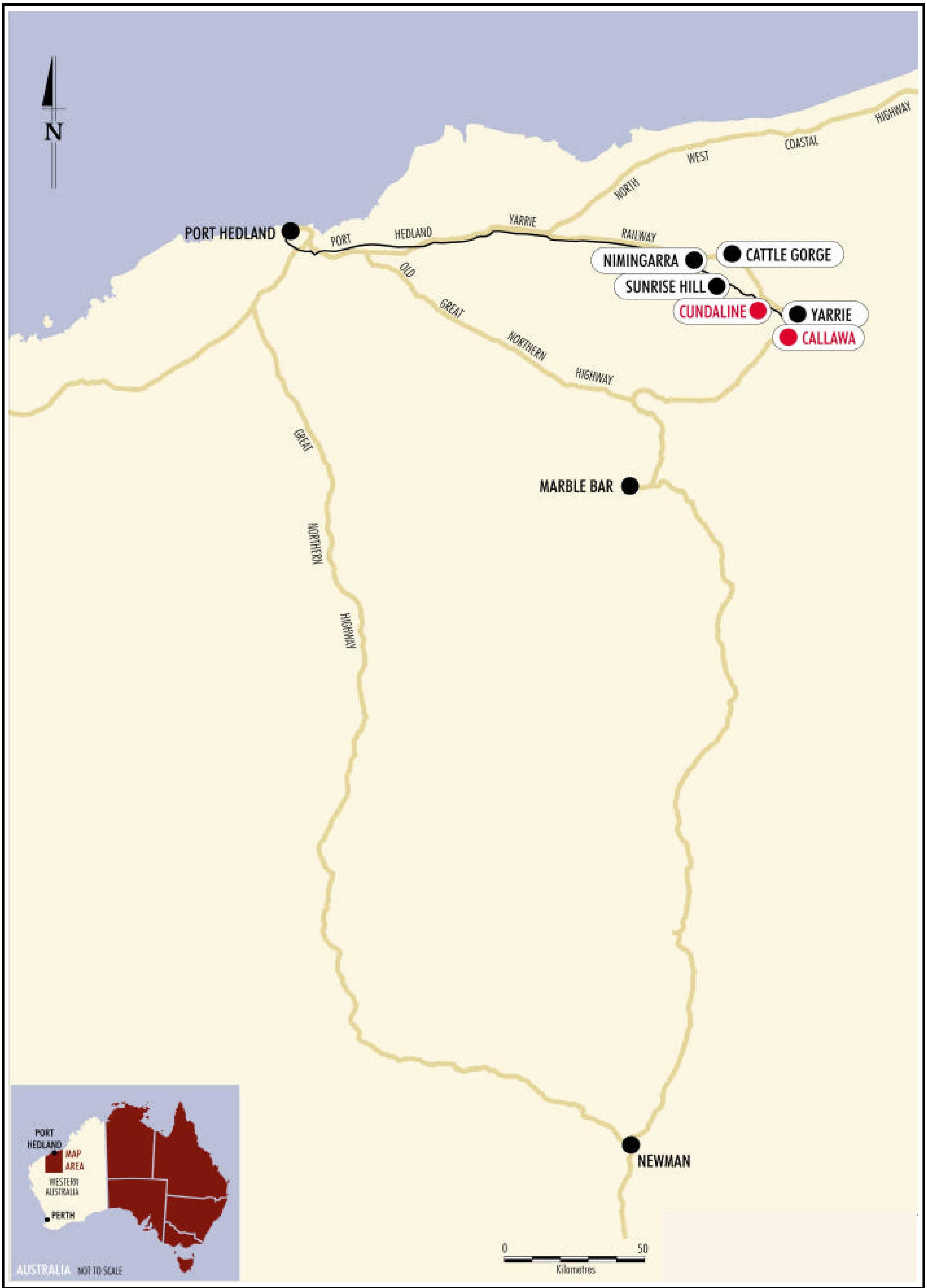
Bureau of Meteorology (2008) Monthly Climatic Statistics for Marble Bar (004020), Yarrie Station (004046) and Port Hedland (004032).

Department of Agriculture (1987) Evaporation Data for Western Australia. Resource Management Technical Report No. 65.

Goldsworthy Mining Limited (1986) Goldsworthy Extension Project Notice of Intent.

The Institution of Engineers, Australia (1987) Australian Rainfall and Runoff. A Guide to Flood Estimation. National Committee on Water Engineering.

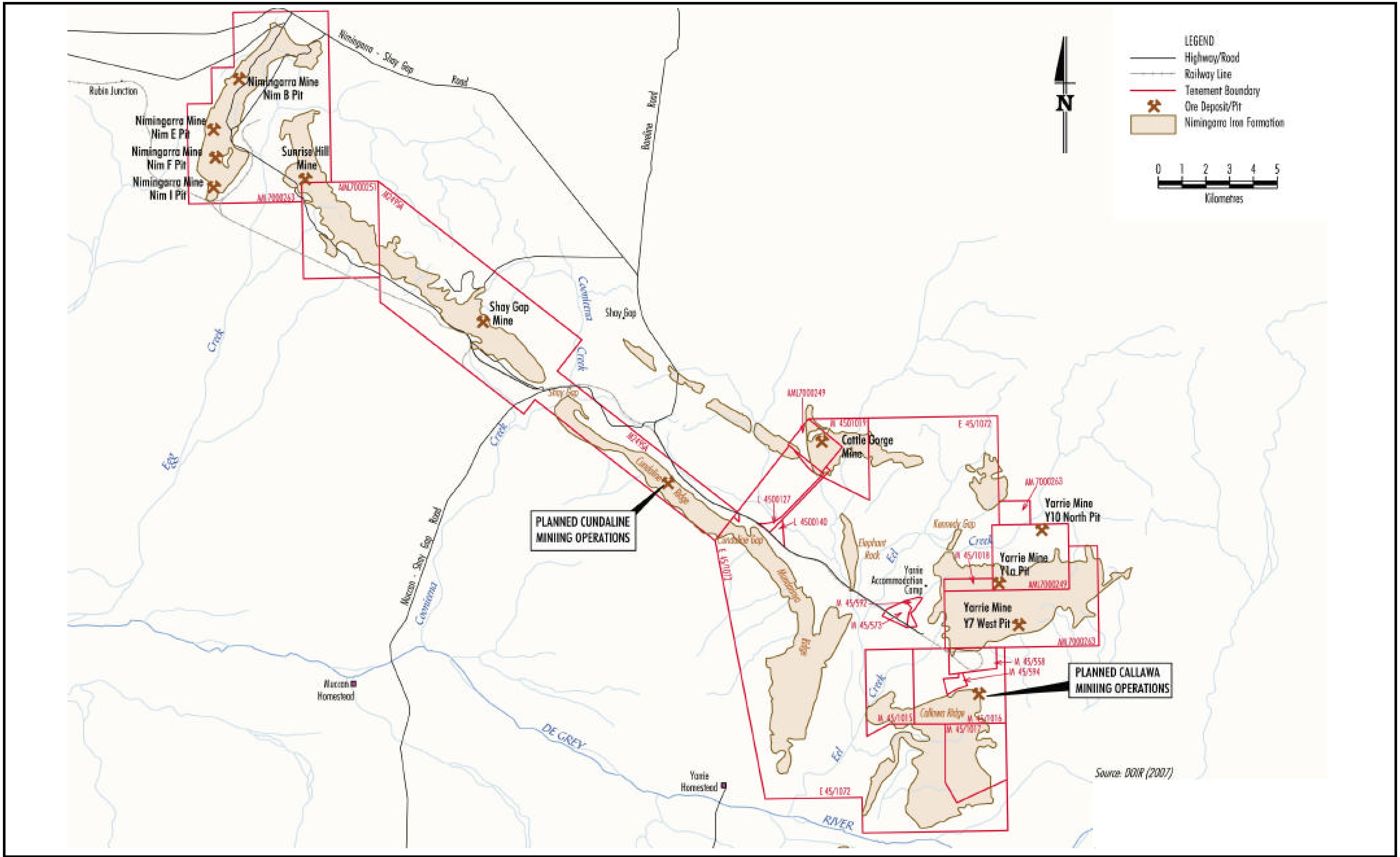
FIGURES



aquaterra

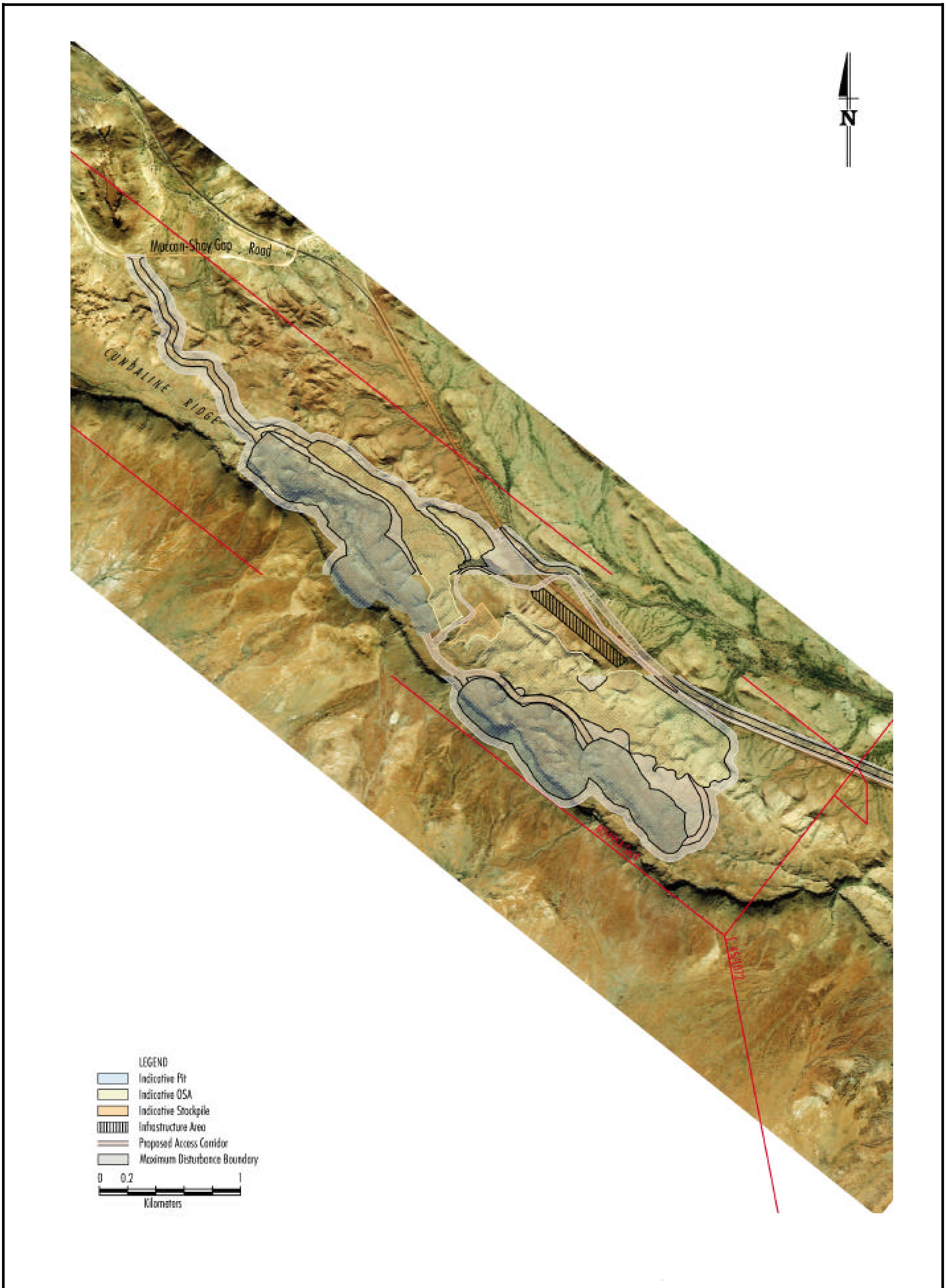
Regional Location
Figure 1

F:\Jobs\980\Report\215c\Figure 1.doc



Project Location and Tenements
Figure 2

aquaterra



aquaterra

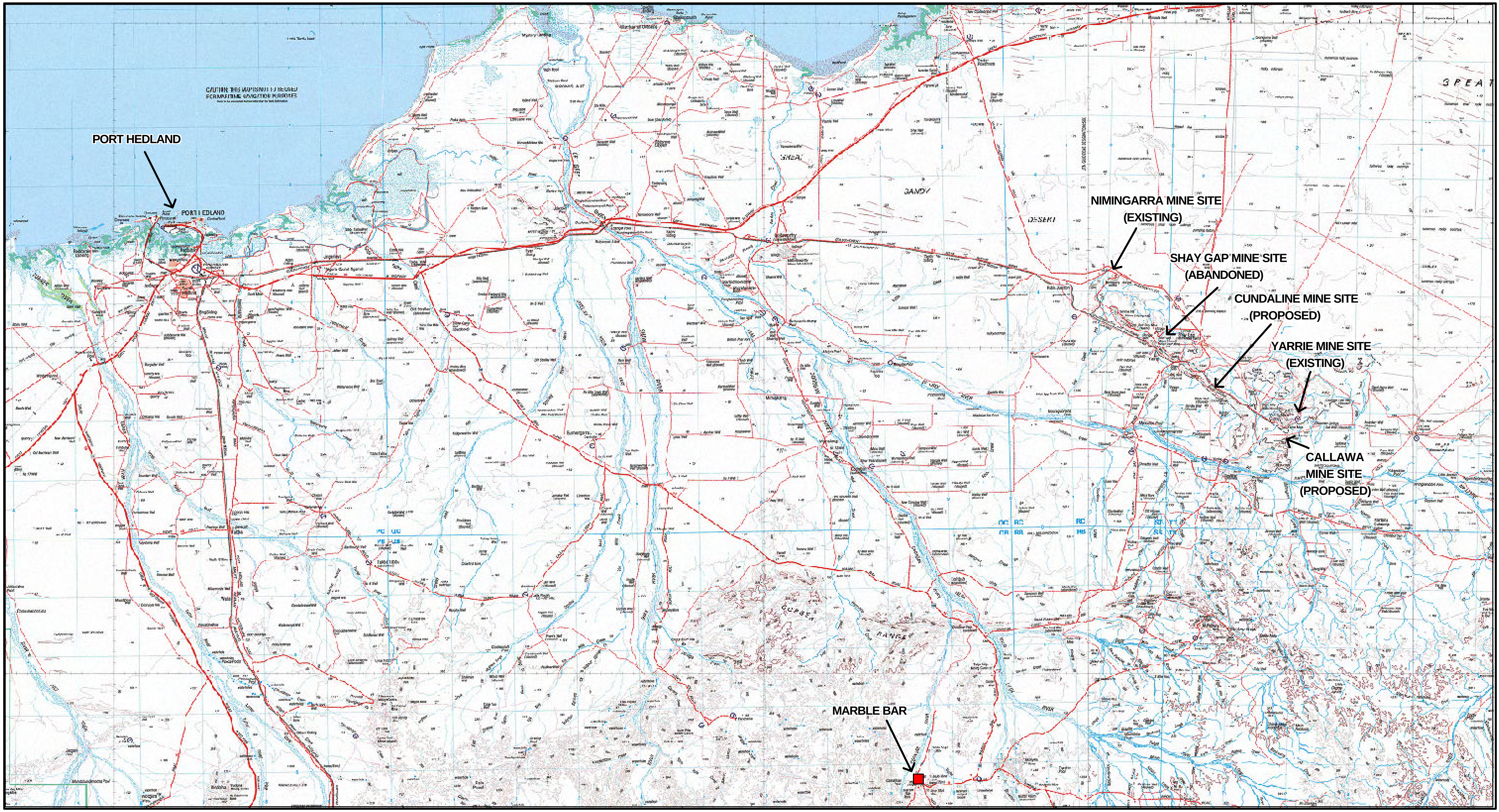
F:\Jobs\980\Report\215c Figures\Figure 3a

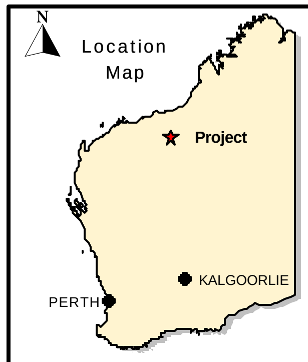
Planned Cundaline Mining Operations
Conceptual General Arrangement
Figure 3a

aquaterra

F:\Jobs\980\Report\215c Figures\Figure 3b.doc

Planned Callawa Mining Operation
Conceptual General Arrangement
Figure 3b





10 0 10 20 30

Kilometers

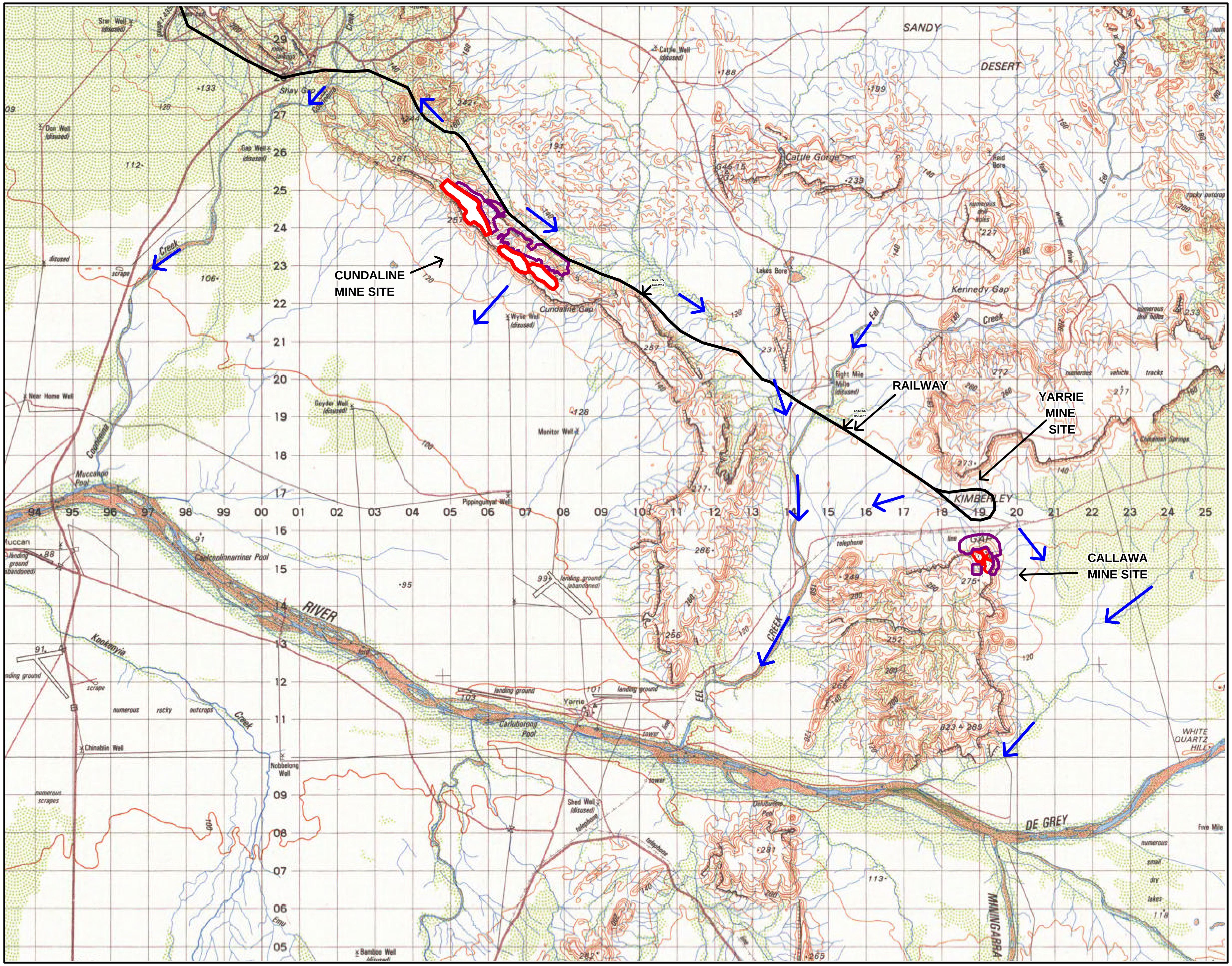
Scale: 1:600,000

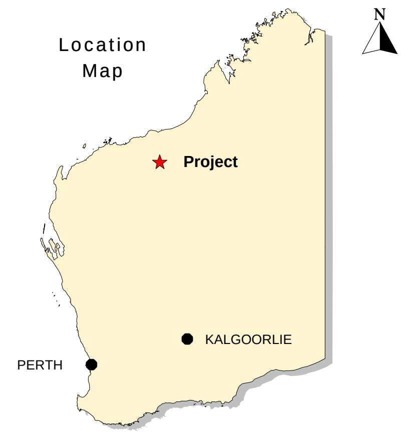
aquaterra

CUNDALINE - CALLAWA
SURFACE WATER MANAGEMENT
LOCATION PLAN
FIGURE 4

Author: VP	Date: 31/10/08
Drawn: PO	Revised:
Job No: 980/B3	Report No: 215c
Projection: GDA 94	Scale: As Shown

F:\Jobs\980\Mapinfo\Surface Water Management - 215c Fig 4.wor





LEGEND

- FLOW PATHS
- RAILWAY
- PIT
- OSA

0 2 4 6

Kilometers

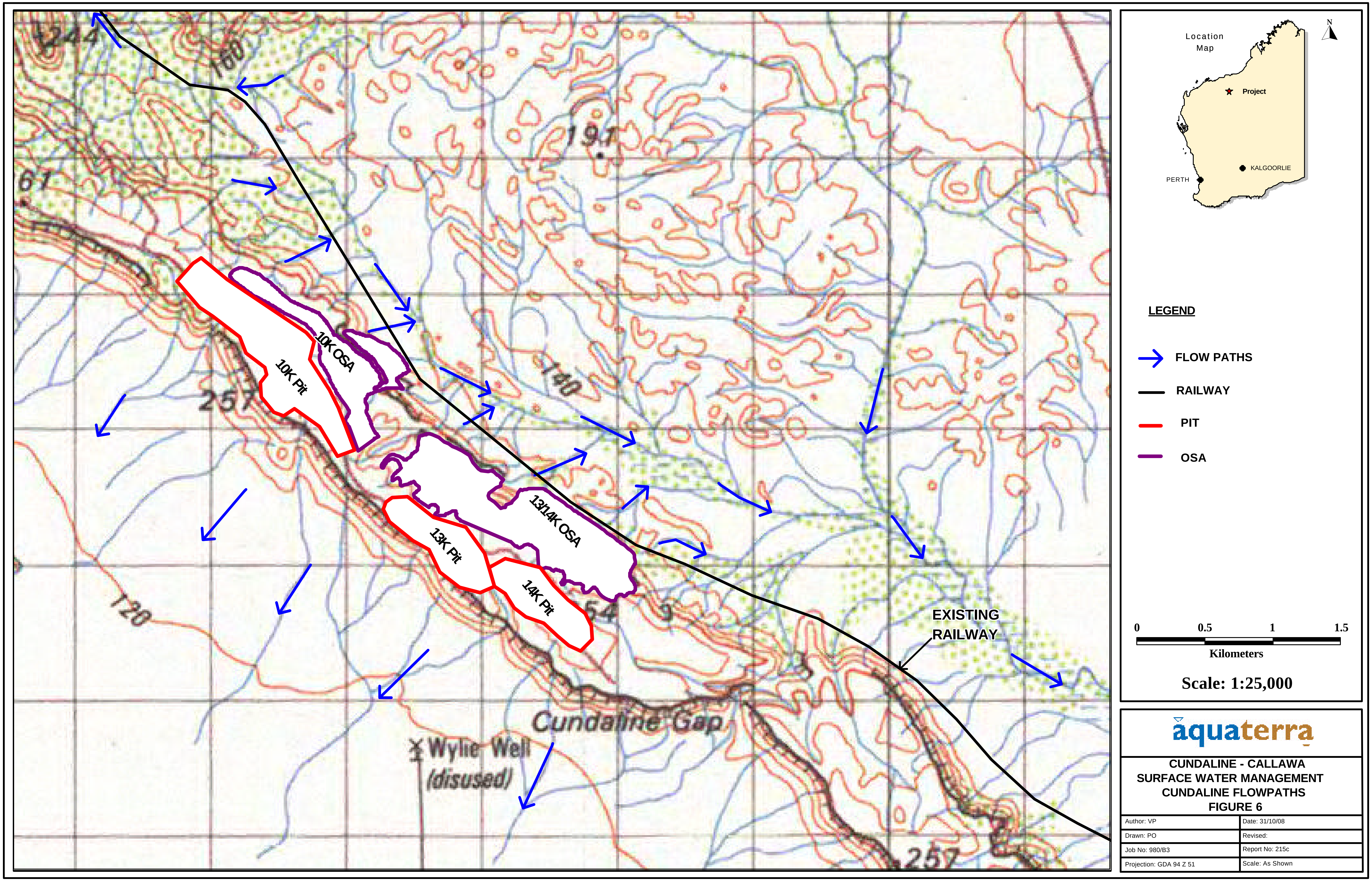
Scale: 1:100,000

aquaterra

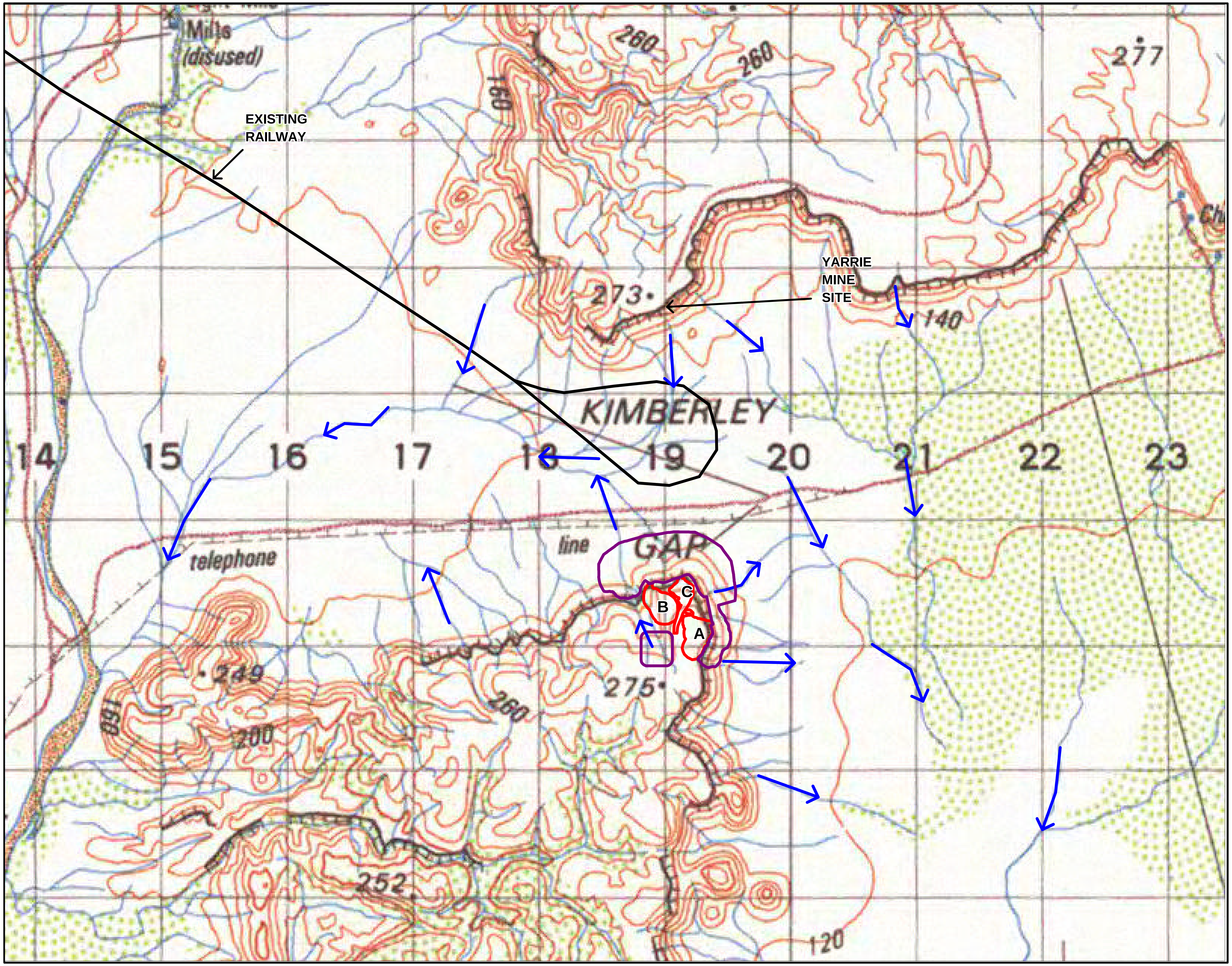
CUNDALINE - CALLAWA
SURFACE WATER MANAGEMENT
REGIONAL FLOWPATHS
FIGURE 5

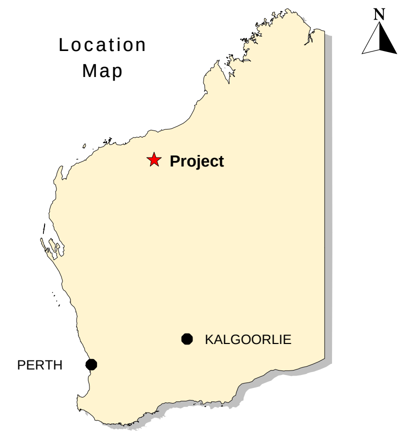
Author: VP	Date: 31/10/08
Drawn: PO	Revised:
Job No: 980/B3	Report No: 215c
Projection: GDA 94 Z 51	Scale: As shown

F:\Jobs\980\Mapinfo\Regional Flowpaths - 215c Fig 5.wor



F:\Jobs\980\Mapinfo\Cundaline Flow Paths - 215c Fig 6.wor





LEGEND

- FLOW PATHS
- RAILWAY
- PIT
- OSA

0 0.5 1 1.5

Kilometers

Scale: 1:30,000

aquaterra

CUNDALINE - CALLAWA
SURFACE WATER MANAGEMENT
CALLAWA FLOWPATHS
FIGURE 7

Author: VP	Date: 31/10/08
Drawn: PO	Revised:
Job No: 980/B3	Report No: 215c
Projection: GDA 94 Z 51	Scale: As Shown

F:\Jobs\980\Mapinfo\Callawa Flow Path - 215c Fig 7.wor