Water and Environment

MARILLANA SURFACE WATER MANAGEMENT PLAN

Prepared for	Brockman Resources
Date of Issue	10 February 2010
Our Reference	832H/H5/044c

aquaterra

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	Date	Revision Description
Revision A	17/08/09	Draft – Issued for Client Review
Revision B	11/09/09	With Client Comments
Revision C	10/02/10	Monitoring Programme

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EXECUTIVE SUMMARY

Brockman Resources is proposing to develop the Marillana Iron Ore Project located in a flood prone area at the base of the Hamersley Ranges escarpment. The proposed developments are situated on the southern bank of Weeli Wolli Creek, approximately 15km to the south of the southern extent of the Fortescue Marsh.

The Hamersley Ranges are located immediately to the south of the project area. The Hamersley Ranges catchments which impact the project site have very steep upper catchments before forming a delta upon leaving the ranges and draining through the project area. In major events, runoff through the project area would occur as wide, shallow, slow moving sheet flow.

The Weeli Wolli Creek is a major Pilbara drainage system. Upon exiting the ranges, Weeli Wolli Creek has formed an extensive delta with numerous flow paths in major events. From this delta, the Weeli Wolli Creek channels extend northwards into the Fortescue Marsh which is an extensive intermittent wetland located on the floor of the Fortescue River valley.

The Fortescue Marsh acts as a flood storage and occupies an area around 100km long by typically 10km wide. The Department of Water (DoW) considers the upper portion of the Fortescue River which drains to the Marsh as a closed system.

Potential surface water impacts associated with the planned Marillana mining activities include:

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

To prevent flooding of the mine pits and associated infrastructure, bunding and diversion drains will be required to manage these flows. These flows will either connect into Weeli Wolli Creek or discharge upstream of the main creek and reach Weeli Wolli Creek via minor channels and overland flow.

The diversion of this overland flow into diversion drains will potentially impact vegetation downstream of the drain between the drain and Weeli Wolli Creek. The potentially impacted area is largely occupied by the mine developments and consequently the area of vegetation potentially impacted by reduced sheetflow is limited to a small strip between the mine pit and the waste storage areas.

The mine plans have been developed to ensure that Weeli Wolli Creek and its distributaries are not directly impacted by the works. No diversion of Weeli Wolli Creek or its distributaries are required and with the exception of potential modification to road crossings at existing locations, there are no proposed works in the creek channels or on its banks.

The mine developments have the potential to reduce the effective catchment area of Weeli Wolli Creek by $10km^2$ or 0.2%. These changes are not significant to the overall hydrological system, particularly in comparison to the natural seasonal variations in catchment runoff.

Runoff from the planned waste rock disposals (WRDs) and other disturbance areas, and the concentration of flow into diversion drains has the potential to significantly increase erosion and sediment loads in the natural drainage systems if appropriate management measures are not implemented.

To minimise the impact of mining operations on surface water draining from the site and consequently on Weeli Wolli Creek and the Fortescue Marsh, a number of measures will be adopted during construction and operation of the mine. These measures will include the use of buffer zones between mine developments and creek systems, minimisation of clearing, dry season construction where possible, bunding of hydrocarbon storage areas and separation of runoff from disturbed areas.

Sediment basins will be used in conjunction with erosion minimisation strategies such as vegetated batters, coarse sheeting and engineered drainage systems. In areas where sediment basins are constructed within the Weeli Wolli Creek flood plain, measures will be included to ensure that flood events do not scour collected sediment. This may involve design features such as overflow pipes or discharge slots to limit the potential for flooding and scouring.

Around the stockpiles and the process plant, bunding will be installed to protect the infrastructure from flooding in Weeli Wolli Creek as required. The flood bunding will be installed prior to the construction of the WRDs to ensure that flood protection is achieved for the commencement of mining. The toe of the flood bunding will be located a minimum of 50m from the Weeli Wolli Creek bank to provide a 30m non disturbance zone to protect existing riparian vegetation and a 20m access corridor.

A proposed surface water monitoring programme will collect water samples at six stations located on Hamersley Range Catchments and Weeli Wolli Creek, and monitoring stormwater discharge points from hydrocarbon storage areas. Adverse impacts identified from event monitoring will trigger the implementation of a management response

The post closure topography of the pit area will be formed by backfill placement into the mine voids. Most areas will be backfilled above the existing surface level, but there will be some sections that will be below or at the pre-mining level.

Post-closure, it is proposed to construct a series of diversion drains to redirect water around or through the mine site. Once downstream of the minesite, flow would be diverted back to the original drainage course wherever possible. These post-closure diversion drains will include sections re-established over the backfilled pits. As the backfilled pits will have high permeabilities, to enable the drains to convey water across the pit, the drains will be lined with fines reject material under the base of the channels. The channels will be combined with a flood plain zone. Consequently, minor events will be conveyed to Weeli Wolli Creek ensuring environmental flows are maintained while major flow events will be attenuated.

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FIGURES

1 INTRODUCTION

1.1 PROJECT BACKGROUND AND LOCATION

The Marillana Iron Ore Project is located within the Hamersley Province on the southern Pilbara Craton in the Pilbara region of Western Australia approximately 100km northwest of the township of Newman (Figure 1.1). The project is located within Exploration Licence E47/1408 and is subject to Mining Lease applications M47/1414 and M47/1419. All tenements are held by Brockman Iron Pty Ltd (Brockman), a wholly owned subsidiary of ASX listed company Brockman Resources Limited. The tenement covers 95km^2 of the Fortescue Valley and borders the Hamersley Range, where extensive areas of supergene iron ore mineralisation are developed within the dissected Brockman Iron Formation, which caps the range. This is the likely source material for the Tertiary Hematite Detritals and Channel Iron Deposits that comprise the target iron ore within the tenement.

The project area is located in a partially flood prone area at the base of the Hamersley Ranges escarpment. The proposed developments are situated on the southern side of Weeli Wolli Creek, approximately 15km to the south of the southern extent of the Fortescue Marsh.

1.2 SCOPE OF THIS ASSESSMENT

The scope of works for this assessment comprises:

- Characterisation and description of baseline drainage conditions from both a regional and local project-area perspective (catchment area definitions; surface flow directions; flow characterisation).
- Assessment of potential project impacts on natural drainage systems (eg. diversions, starvation, ponding, erosion, siltation) and of the drainage systems impacts on the proposed project infrastructure (inundation, waterways).
- Develop strategies to minimise the impact of the project on the natural drainage systems (maintenance of drainage routes and environmental flows, diversion of drainage lines, erosion and sediment control works).

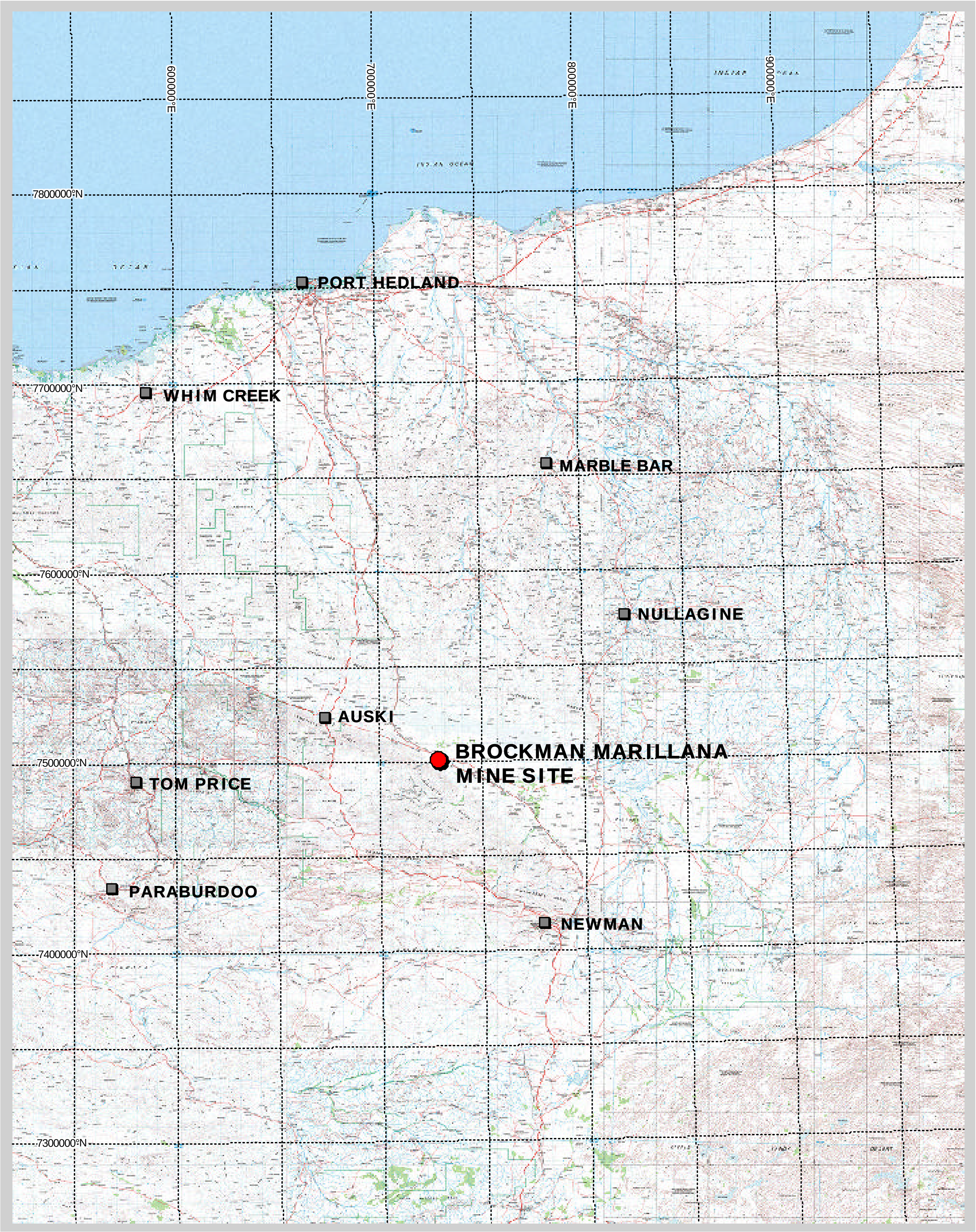
1.3 PREVIOUS DRAINAGE STUDIES

The BHPB railway line extends through the lease area and crosses Weeli Wolli Creek and its distributaries. While the original flood studies completed for the construction of this railway are not available, a study was undertaken by Dufty in 1992. This study examined flood levels from streamflow data and the likelihood of flooding along the railway.

An initial assessment into the surface water characteristics through the mine site was undertaken by David Flavell in November 2007. This report evaluated flood levels in the Fortescue Marsh and provided preliminary comments on the impact of flooding on mining infrastructure.

Aquaterra was commissioned by Brockman Resources in October 2008 to undertake a detailed hydrological assessment of the proposed project area. This study outlined the characteristics of the catchment areas, design discharge estimates for the Weeli Wolli Creek together with ten Hamersley Ranges catchments and undertook detailed hydraulic modelling of the flood levels throughout the lease areas under pre development and post development conditions.

In June 2009 a study was completed by Aquaterra to determine the requirements for diversion of Hamersley Ranges catchments and flood protection bunding in order to protect the proposed development from surface water flows.



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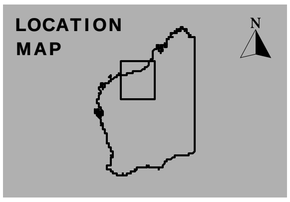

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JOB NO:	832H
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REVISION:	a
SCALE:	2,500,000 at A4
PROJECTION:	GDA94

SCALE

50 0 50 100 150

Kilometers

Scale: 1:2,500,000

Figure 1.1

Regional Location Plan

Location: F:\Jobs\832H\SWMP\044a Figure 1.1

2 HYDROLOGY

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. Mean monthly maximum temperatures at Newman range from 39°C in January to 22°C in July, while mean monthly minimum temperatures range from 25°C in January to 8°C in July (Bureau of Meteorology [BOM], 2009). High summer temperatures and humidity seldom occur together, giving the Pilbara its very dry climate. Light frosts occasionally occur during the winter season.

2.3 RAINFALL AND EVAPORATION

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

During May and June, cold fronts move in an easterly direction across Western Australia and sometimes reach the Pilbara region producing light winter rains. The driest months in the Pilbara are September to November.

The closest Bureau of Meteorology (BOM) weather station to the project area is at Sand Hill (22.78°S, 119.62°E) (BOM, 2009).

The average annual rainfall at Sand Hill is 337mm, occurring over an average of 40 rain days. Most of the rainfall occurs in the summer period, with over 70% of total annual precipitation occurring between December and March.

This is slightly higher than Newman and Paraburdoo, which have annual average rainfalls of 310mm and 284mm, respectively (BOM, 2009). Variability is high with recorded annual rainfall at Newman varying between 135mm (1976) and 538mm (1997).

The mean evaporation rate at Newman as measured by a Class A pan is estimated at 3,400mm (Department of Agriculture, 1987), which exceeds annual rainfall by around 3,000mm. Average monthly pan evaporation rates vary between a minimum 160mm in June and a maximum 430mm 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 event 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 generally widely spaced in the Pilbara region, however the Department of Water (DoW) Gauge Number 708013, Waterloo Bore is located 10 km upstream of the eastern lease boundary at the point at which the creek system leaves the Hamersley Ranges escarpment.

This gauging station records streamflow from a catchment of 3,991km^2 (DoW, 2009) (excluding the Coondawanna Flats sub-catchment area) and has a record of 1984/1985 to 2009.

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).

3 EXISTING ENVIRONMENT

3.1 HAMERSLEY RANGE

The Hamersley Ranges are located immediately to the south of the project area. The ranges extend from an elevation of 440m in the project area to include peaks of up to 775m within the catchments which drain through the project area. Outside of the project area catchments, the Hamersley Ranges contain Western Australia's highest peak Mt Meharry reaching 1253m. The Hamersley Ranges catchments which impact the project site have a moderately dense network of streams which generally have very steep upper catchments and bed slopes ranging from 3% to 19%. Drainage from these areas occurs via incised, topographically controlled channel.

The catchments typically level out to a wide, flatter plain with bed slopes of 1% to 2% before forming a delta upon leaving the ranges and draining through the project area. Slopes through the project area range from 0.2% to 1%. The flow occurs within numerous small and shallow distributary channels which often become indistinct. In major events, runoff through the project area would occur as wide, shallow slow moving sheet flow.

Small scale, localised storm events that are not large enough to produce flow in Weeli Wolli Creek are still capable of generating significant peak discharges from the Hamersley Ranges. As a consequence of the creeks overtopping their banks and occurring as sheet flow, the peak flow upon reaching Weeli Wolli Creek will generally be lower than at the upper end of the plain as the flow velocities are reduced and the peak attenuated

3.2 WEELI WOLLI CREEK

The Weeli Wolli Creek is a major Pilbara drainage system with a catchment area of 4,769km^2 (including Coondawanna Flats sub-catchment area, as used in Flavell 2005) as it leaves the Hamersley Ranges. The creek length is 71km measured along Weeli Wolli Creek and 130km as measured up the creeks major tributary, Marillana Creek.

Weeli Wolli Creek is recharged mainly from Weeli Wolli Springs, located approximately 40km upstream of the mine site, and Yandicoogina and Marillana Creeks which discharge into Weeli Wolli Creek at approximately 25km upstream of the mine site (Figure 3.1). Upon exiting the ranges, Weeli Wolli Creek has formed an extensive delta with numerous flow paths in major events. The split of flow between the channels will vary with the intensity of the event. For example, during low flow events, flow will be confined exclusively to the main Weeli Wolli Creek channel, however during large events, the flow within the main channel would only represent a small proportion of the total flow. From this delta, the Weeli Wolli Creek channels extend northwards into the Fortescue Marsh, which is an extensive intermittent wetland located on the floor of the Fortescue River valley.

The main creek channel flows in a north westerly direction through the project area. The channel is typically trapezoidal in shape with steep banks and a flat wide channel. The typical creek width is 50m with banks typically 1.5 to 2m high. In places the width between creek banks extends to as much as 200m. This width typically includes a main channel of around 50m and islands which typically support eucalypts. Bed slopes through the project area are typically low at around 0.1%. With the exception of the in-stream islands, and occasional isolated eucalypts, there is little in-stream vegetation. Eucalypts are common on the bank of the creek channel. These typically occur within 20-30m of the creek bank.

3.3 FORTESCUE MARSH

The proposed development is located in the Fortescue Marsh catchment, as shown in Figure 3.1. The marsh area is in the physiographic unit known as the Fortescue Valley, and occupies a trough between the Chichester and Hamersley Plateaux (Beard, 1975).

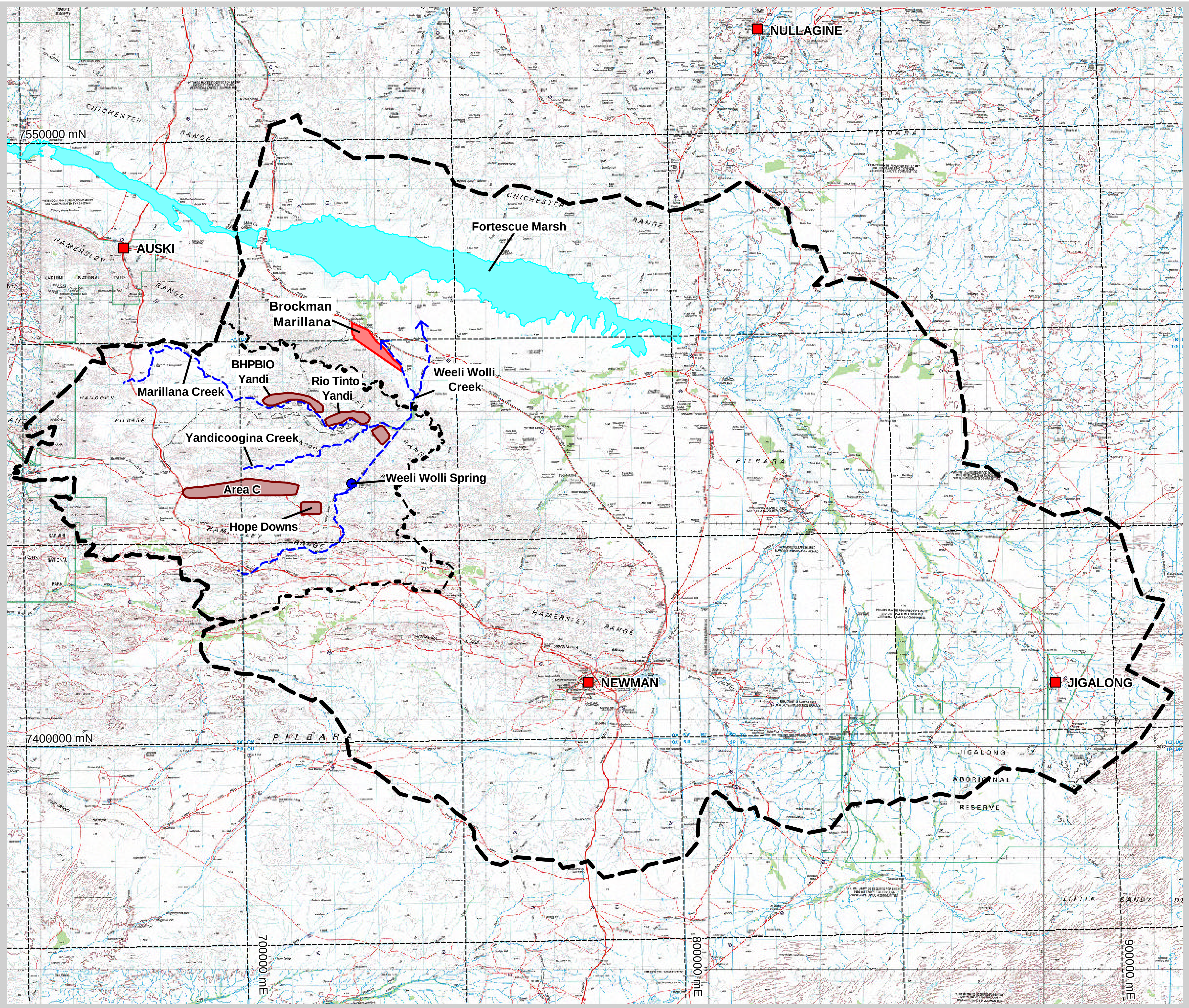
The Goodiadarrie Hills, located on the valley floor just west from the marsh rail crossing, effectively cuts the Fortescue River into two separate river systems. West from the Goodiadarrie Hills, the Lower Fortescue River Catchment drains in a general north-westerly direction to the coast, whereas east of the hills the Fortescue Marsh receives drainage from the Upper Fortescue River Catchment.

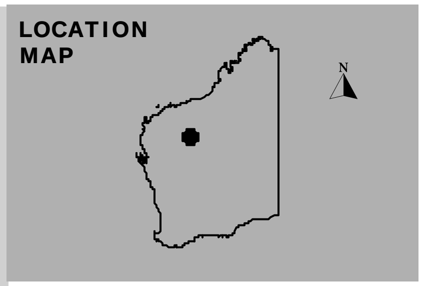
Several large creek systems discharge to the Fortescue Marsh with a total catchment area of approximately 31,000km^2. These systems include the Fortescue River, Weeli Wolli Creek, Marillana Creek, Caramulla Creek, Jigalong Creek, Kondy Creek and Kulkinbah Creek (Figure 3.1). The alluvial outwash fan from the Weeli Wolli Creek and other smaller creek systems abutting the Goodiadarrie Hills is believed to be partially responsible for this obstruction to the Fortescue River and forming the Fortescue Marsh. The DoW considers the upper portion of the Fortescue River which drains to the Marsh as a closed system.

The Fortescue Marsh is an extensive intermittent wetland acting as a flood storage and occupying an area around 100km long by typically 10km wide, located on the floor of the Fortescue Valley. The marsh has an elevation around 400m AHD. To the north, the Chichester Plateau rises to over 500m AHD, whereas to the south the Hamersley Ranges rises to over 1000m AHD. Following significant rainfall events, runoff from the creeks drains to the marsh. For the smaller runoff events, isolated pools form on the marsh opposite the main drainage inlets, whereas for the larger events the whole marsh area has the potential to flood.

Published topographical mapping indicates that the lower bed levels in the Fortescue Marsh predominantly lie between 400m and 405m AHD. Data provided by the DoW states that the flood level in the marsh would need to be marginally higher than 413m AHD to overspill westwards past the Goodiadarrie Hills. No published flood level data are available for the marsh. Anecdotal evidence suggests that over the last 50 years, following major cyclonic events, flood levels of approx 410m AHD have occurred.

Surface water runoff to the marsh is of low salinity and turbidity, though the runoff turbidity typically increases significantly during peak periods of flooding (WRC, 2000). Following a major flood event (that flooded the whole marsh area), anecdotal data indicates that the water could pond up to 10m depth in the lowest elevation marsh areas. Water stored in the marsh slowly dissipates through the processes of seepage and evaporation. During the evaporation process, the water salinity increases and as the flooded areas recede, traces of surface salt can be seen. During the seepage process, the increasingly more saline water is believed to seep into the valley floor alluvial deposits.





LEGEND

- Drainage Basin
- Creeks
- Fortescue Marsh Catchment Boundary
- Weeli Wolli Creek Sub Catchment Boundary
- Brockman Marillana Mining Area
- Other Mining Areas

SCALE

10 0 10 20 30
Kilometers
Scale: 1:850,000

aquaterra

Figure 3.1

Regional Catchment Plan

AUTHOR:	LC	REPORT NO:	044a
DRAWN:	LC	REVISION:	a
DATE:	13/08/2009	SCALE:	1:850,000 at A3
JOB NO:	832H/H5	PROJECTION:	GDA94 Z50

Location: F:\Jobs\832H\SWMP\044a Figure 3.1

4 PROPOSED DEVELOPMENT

4.1 PROJECT LOCATION

As previously discussed, the Project is located within the Pilbara region of Western Australia approximately 100km north west of the township of Newman. The main access to the project site is via the Great Northern Highway and the unsealed Munjina – Roy Hill Road.

Key relevant components of the development are discussed below.

4.2 MINING AND PROCESSING

4.2.1 MINE PITS

Mining will commence in pits along the strike length. Waste overburden will be removed to waste dumps to access the Tertiary Hematite Detrital (THD) and Channel Iron Deposits (CID).

Overburden material will be stored in waste stockpiles adjacent to the pit in the initial years of operation, or in mined-out pits later in the life of mine.

4.2.2 DEWATERING

The mine pit will intersect the water table during the Project. Various dewatering options will be investigated to achieve dewatering of the ore body suitable for conventional dry mining using shovels and haul trucks. Water from pit dewatering will be directed in the first instance for re-use in the process plant and for dust suppression. Any excess water will be released within the mine tenement via discharge to Weeli Wolli Creek or adjacent drainage lines downstream of the mine site (after treatment to remove sediments) or reinjection.

4.2.3 POTABLE WATER

Potable water for the accommodation village (45MLpa / 120L/d) and mine facility will be supplied on site from bores via a suitable treatment system. Suitably sized water treatment plants for potable water treatment will be installed at both locations.

4.2.4 PROCESS WATER

Process water will be sourced from pit dewatering. Process water will be supplied to the processing plant, vehicle wash down area and potable water treatment plant at the mine facility. Additional water may be extracted from production bores established within the mining area and in close proximity to the mining and processing operations within the tenement if required.

Water stand pipes will be provided for filling of water trucks for dust suppression.

4.2.5 CRUSHING AND SCREENING

Ore will be crushed and wet screened to a size suitable for beneficiation, nominally less than 8mm in size. The crushing and screening plant will have a capacity of 45 Mtpa involving separate streams for CID and detrital ores.

4.2.6 PROCESSING FACILITIES

Crushed and screened ore will be processed in a wet process beneficiation plant to produce 25Mtpa of iron ore product. Water used in the beneficiation plant will be sourced from the local aquifer through pit dewatering, supplemented by abstraction bores if required.

4.2.7 WASTE ROCK AND TAILINGS

Approximately 82 Mtpa of waste material will be produced. Of this, 19.4Mtpa will be tailings from a wet process beneficiation plant. Rejects waste from the beneficiation plant will be pumped to a fines rejects storage (FRS). Decant water from the rejects storage will be returned to the processing plant for re-use.

Waste rock disposals (WRDs) and FRSs will be established north of the pits in the initial years of operation. In-pit waste disposal will be employed once mined-out pit voids become available, after approximately 3 years of operation.

Initial indications are that the material has a sulphur content of less than 0.02%, therefore, the waste rock and rejects are classified as "NAF" according to guidelines set out by DMP and are not expected to have significant potential for acid generation (Graham Campbell and Associates 2009).

4.2.8 STOCKPILING AND RECLAIMING

Finished product will be stockpiled in a storage area on site and reclaimed for loading into trains for transport.

4.2.9 TRAIN LOADING FACILITY

A loading facility will be constructed consisting of a train loop and product reclamation systems for the loading of iron ore product from the product stockpile onto trains for transport to Port Hedland.

4.2.10 ACCOMMODATION VILLAGE

A 550 person accommodation village will be constructed within the tenement boundary and situated away from the mining operations. This facility will include a first aid room, a dry mess, wet mess, recreation facilities, gym, sewage treatment and potable water supply to current Pilbara standards.

4.2.11 WASTE WATER TREATMENT

Sewage will be directed to packaged sewage treatment facilities at the accommodation village & administration complex for treatment. The treated water from the plant will either be reticulated to landscaping, or pumped to the fine tailings hopper for discharge to the tailings dam. The treated discharge from the waste water treatment plant at the village will be disposed of via reticulation to spray fields. This spray field is to be located approximately 500m to the north of the wastewater treatment plant. The spray area will have fencing and signage to meet HDWA guidleines.

4.2.12 LANDFILL

Domestic and industrial waste will be segregated into general (inert) waste and hazardous waste. A landfill will be established on the site to deal with non-hazardous waste. Hazardous waste will be removed from site by a licensed contractor to suitably licensed facility.

5 POTENTIAL IMPACTS

5.1 POTENTIAL IMPACTS FROM MINING ACTIVITIES

Potential surface water impacts associated with the planned Marillana mining activities include:

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

5.2 INTERRUPTION TO EXISTING SURFACE WATER FLOW PATTERNS

The interruption of surface water flow patterns has the potential to reduce and in some cases, increase the surface water runoff volumes.

The catchment boundaries and flowpaths around the planned Marillana Iron Ore Project are shown on Figure 5.1. The planned development area naturally drains to Weeli Wolli Creek upstream (south) from the Fortescue Marsh.

The mine plans have been developed to ensure that Weeli Wolli Creek and its distributaries are not directly impacted by the works. No diversion of Weeli Wolli Creek or its distributaries are required and with the exception of potential modification to road crossings at existing locations, there is no requirement for any works in the creek channels or on its banks.

As discussed in Section 3.1, drainage paths from the Hamersley Ranges extend through the proposed mine area. To prevent flooding of the mine pits and associated infrastructure, bunding and diversion drains will be required to manage these flows. Indicative locations of the required bunding and diversion drains are shown in Figures 5.2 and 5.3. The operational life of diversion drains and bunds will vary from a few years to permanent structures. The drains and bunds will be designed based on an Average Recurrence Interval (ARI) event selected with consideration to the expected life and consequences of failure. The diversion drains will either connect into Weeli Wolli Creek or discharge upstream of the main creek and reach Weeli Wolli Creek via minor channels and overland flow.

Where the defined drainage channels from the steeper Hamersley Ranges slopes enter the lower slope areas, the channels typically have a reduced discharge capacity and in many instances become less well defined and braided or may even completely disperse in flat areas. In these reducing slope channels, runoff tends to overspill the main channel flow zones and spread over a wider front. This overland flow can be important for soil moisture replenishment in mulga grove areas. It is generally reported by the Department of Environment and Conservation (DEC) and others that groved mulga community areas are partially dependent on moisture replacement through sheetflow.

The diversion of this overland flow into diversion drains will potentially impact vegetation downstream of the drain between the drain and Weeli Wolli Creek. The potentially impacted area is largely occupied by the mine developments.

The area to the north of the railway and west of the main Weeli Wolli Creek railway crossing, is not expected to be impacted by the proposed diversions. This area receives surface flow via two bridges located to the west of the main Weeli Wolli Creek channel. The eastern of these two openings receives floodwater from Weeli Wolli Creek and does not receive surface water from the Hamersley Ranges as it is blocked by a sand dune. The Weeli Wolli Creek flow regime will not be impacted in a way which would change the flow through this bridge. The western opening receives overland flow from the Hamersley Range creeks, this bridge will be utilised as a discharge point for one of the diversion drains and flow through this location is not expected to be lower than the pre-mining state.

The area in the vicinity of the rail loop and the product stockpile will receive a reduced surface water flow as a result of the mine developments. This area contains an estimated 1.1km^2 classified as *acacia aneura* low woodland, over *Acacia synchronia* tall shrubland, over *Cenchrus spp.* Tussock grassland which is potentially partially sheetflow dependent.

In the pre-mining state, this area receives surface water from Weeli Wolli Creek overflow and Hamersley Range overland flow. This area will continue to receive Weeli Wolli Creek overflow, however the overland flow from the Hamersley Range catchments will be diverted further upstream and consequently not flow through this area.

The mine pits and WRDs developments are located to the south of Weeli Wolli Creek. All runoff from internal catchments will be treated to reduce sediment levels prior to controlled discharge to the downstream zones.

5.3 RUNOFF LOSS TO DOWNSTREAM ENVIRONMENT

The interruption of surface water flow patterns has the potential to reduce and in some cases, increase the surface water runoff volume. As previously discussed, the Hamersley Ranges creeks upstream of the pits will be diverted around the pits towards Weeli Wolli Creek. Consequently no reduction in the surface water runoff from these creeks is expected. It is possible that where diversion drains are constructed in native material that a slight increase in the runoff quantity will occur due to the more direct flow path and reduction in overland flow.

The reduction in surface water volume will be related to the planned mine developments which will reduce discharges flowing northwards to Weeli Wolli Creek. As these developments occupy the downstream extent of the Hamersley Ranges creeks, the impact of any reduction in runoff is limited to Weeli Wolli Creek.

The planned pit development areas and their estimated maximum catchment areas intercepted are provided in Table 5.1.

Table 5.1: Catchment Areas Intercepted by Pits and WRDs

Location	Development Area (km^2)	Adopted Runoff Loss	Catchment Area Loss Estimate (km^2)
Mine Pits	16.0	50%	8.0
WRDs	3.8	50%	1.9
Other Infrastructure	1.8	25%	0.4
Total	21.6		10.3

The intercepted areas, as distinct to the diverted catchment areas, total approximately 22km^2 in the Weeli Wolli Creek catchment. This corresponds to approximately 0.5% of the total natural catchment to Weeli Wolli Creek (above the Marsh) (i.e. approximately 4,769km^2).

Adopting a maximum 50% runoff loss from the pit and WRDs, the effective runoff volume loss from the Weeli Wolli Creek catchment is 10km^2 (~50% of 22km^2), which represents a maximum 0.2% of the total catchment. Therefore, the effects of planned pit and WRD developments at Marillana are a potential decrease in runoff volume to the Weeli Wolli Creek catchment by up to 0.2%. These changes are not significant to the overall hydrological system, particularly in comparison to the natural seasonal variations in catchment runoff.

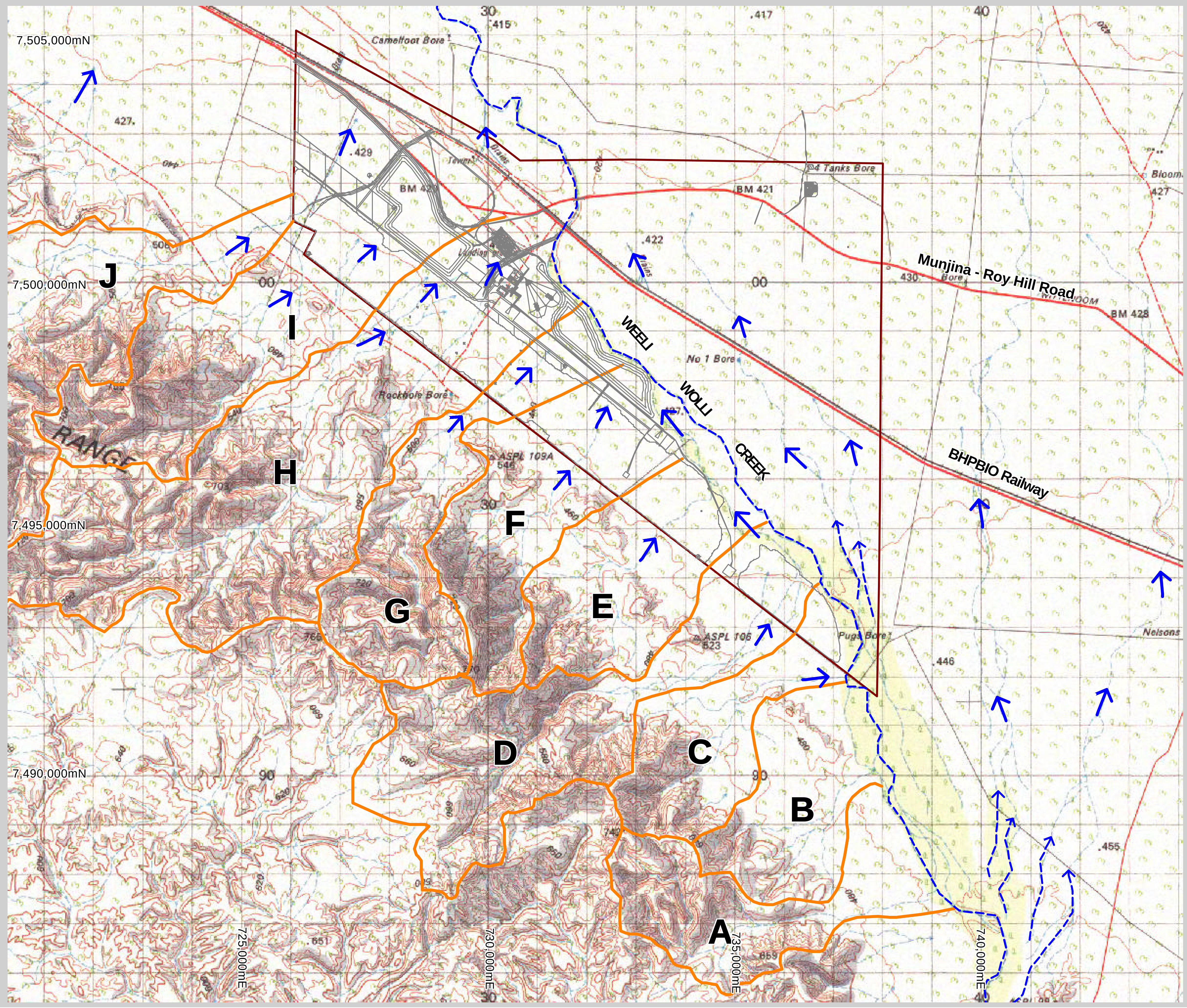
5.4 INCREASED RISK OF EROSION AND SEDIMENTATION

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

The concentration of flows from overland flow into diversion drains has the potential to increase peak flow rates and consequently increase the potential for erosion and sedimentation at locations with increased or decreased velocities.

5.5 CONTAMINATION OF SURFACE WATER BY CHEMICALS OR HYDROCARBONS

Appropriate control measures and operating procedures will be put in place to manage any spillage of chemicals or hydrocarbons from storage or transfer areas.



LOCATION MAP

LEGEND

- Weeli Wolli Creek and Distributaries
- Existing Flow Paths
- Hamersley Ranges Catchments
- Brockman Mining Lease Boundary
- Proposed Mine Infrastructure

SCALE

1 0 1 2 3
Kilometers

Scale: 1:75,000

aquaterra

Figure 5.1

Pre Development Surface Water Drainage

AUTHOR:	LC	REPORT NO:	044a
DRAWN:	LC	REVISION:	a
DATE:	13/08/2009	SCALE:	1:75,000 at A3
JOB NO:	832H/H5	PROJECTION:	GDA94 Z50

Location: F:\Jobs\832H\SWMP\044a Figure 5.1

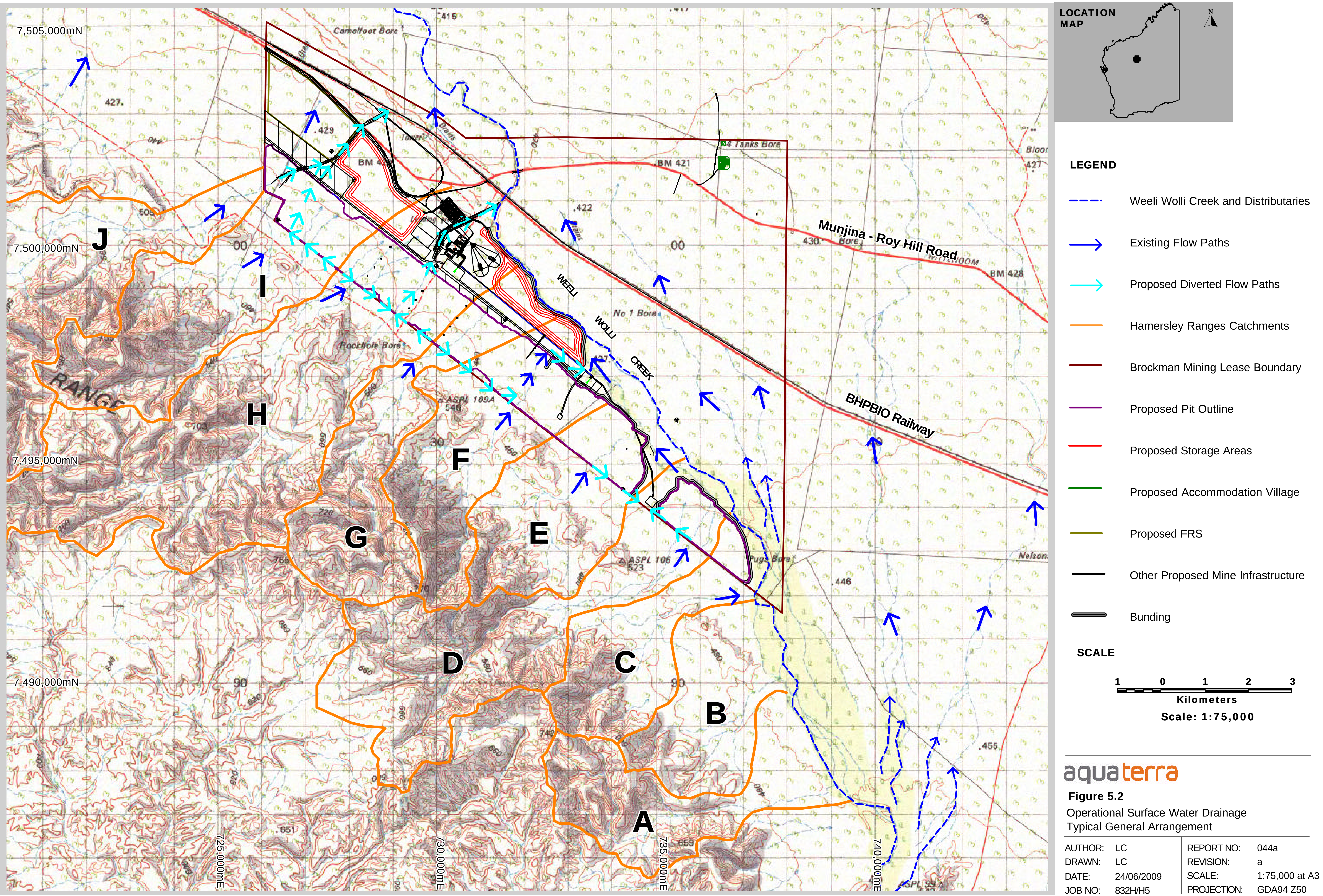


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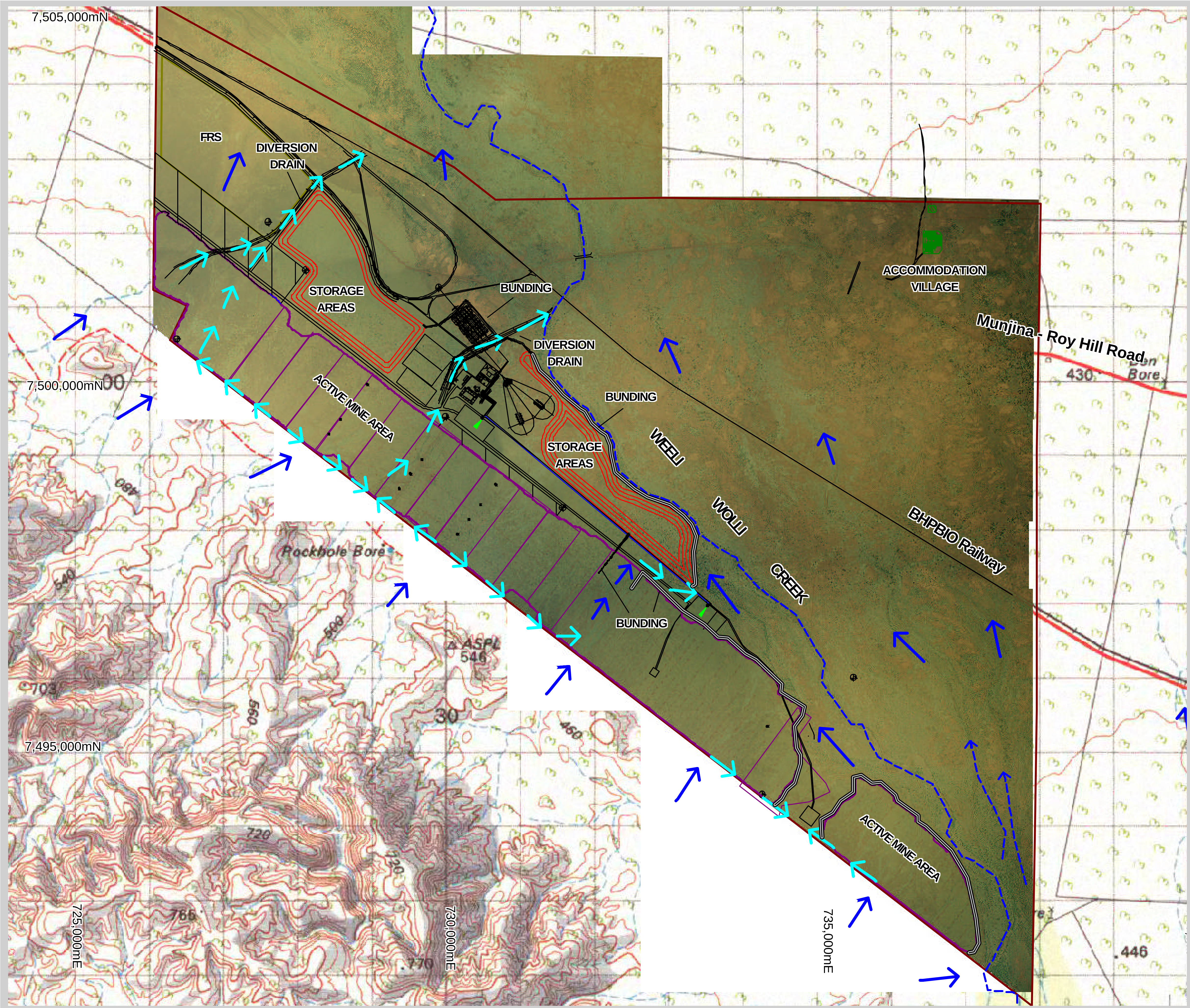
Figure 5.2
Operational Surface Water Drainage
Typical General Arrangement

AUTHOR:	LC	REPORT NO:	044a
DRAWN:	LC	REVISION:	a
DATE:	24/06/2009	SCALE:	1:75,000 at A3
JOB NO:	832H/H5	PROJECTION:	GDA94 Z50

Location: F:\Jobs\832H\SWMP\044a Figure 5.2



LEGEND

- Weeli Wolli Creek and Distributaries
- Existing Flow Paths
- Proposed Diverted Flow Paths
- Brockman Mining Lease Boundary
- Proposed Pit Outline
- Proposed Storage Areas
- Proposed Accommodation Village
- Proposed FRS
- Other Proposed Mine Infrastructure
- Bunding

SCALE

0.5 0 0.5 1 1.5
Kilometers

Scale: 1:50,000

aquaterra

Figure 5.3
Operational Surface Water Drainage
Typical Bund and Drain Arrangement

AUTHOR:	LC	REPORT NO:	044a
DRAWN:	LC	REVISION:	a
DATE:	13/08/2009	SCALE:	1:50,000 at A3
JOB NO:	832H/H5	PROJECTION:	GDA94 Z50

Location: F:\Jobs\832H\SWMP\044a Figure 5.3

6 SURFACE WATER MANAGEMENT

6.1 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.
- To prevent or minimise mining related impacts on Weeli Wolli Creek and Fortescue Marsh.

The following sub-sections describe management strategies that will be used by Brockman Resources to meet the above management objectives, and to minimise the potential impacts identified in Section 5.

6.2 GENERAL WATER MANAGEMENT STRATEGIES

The planned development of the Marillana Iron Ore Project would have a localised effect on the surface water runoff through the redirection of flow and the development of bunded off areas which may intercept minor drainage lines and collect some surface water. The implementation of the general surface water management strategies outlined below is expected to effectively manage mining related impacts on the existing hydrology so that the Project will have negligible impact on local surface water resources.

- Vehicle Movements: Vehicle movements will be kept to the minimum necessary and existing tracks will be used where possible.
- Buffer Zones: Where possible, adequate buffer zones will be provided between the areas of disturbance and the natural drainage lines to protect the drainage lines from impacts resulting from construction activities.
- Limiting Clearing: Vegetation is the most effective method of minimising erosion and sedimentation. Initial clearing will be limited to areas of workable size actively being used for construction.
- Topsoil Storage: Topsoil storage will be located away from drainage lines and upstream of sediment basins. Topsoil will be stored such that it is protected from internal rainfall and runoff using temporary vegetation or mulching, and protected from external runoff using diversion banks/drains.
- Dry Season Construction: Construction on or near natural flowpaths will be planned for the dry season where practicable. Temporary stabilisation measures will be used in areas where there is a high risk of erosion.
- Internal Stormwater Provisions: Internal stormwater runoff in the development areas may cause localised flow velocities to increase 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 are to be installed in plant site areas.
- Flow Dispersion: If it is necessary for flow diversions to discharge to sheet flow zones, the diverted surface water will be discharged over spreader mechanisms to encourage the flows to slow and disperse.
- Separate Flowpaths: Flows from undisturbed areas will be kept separate from disturbed areas.
- Bunding: All WRDs 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 will be provided as appropriate to contain internal surface water runoff for treatment, plus to divert external surface water runoff.

- 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 will be provided such as diversion banks, drains and sediment traps.
- Hydrocarbon Management: Hydrocarbon storage areas are to be bunded to prevent uncontrolled release. Potentially hydrocarbon polluted runoff such as from workshop areas will be directed to basins fitted with baffle mechanisms to trap possible pollutants before discharge to the downstream environment.

6.2.1 SURFACE WATER DIVERSIONS

Diversions require a combination of bunding and excavated channels to carry floodwaters 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 flow in areas that are normally flood free, or negatively impact on mine infrastructure or the environment, then diverted water needs to remain confined within its diversion flowpath (e.g. 100 year ARI capacity). If flow in areas that are normally flood free is acceptable or otherwise only represents nuisance flow, then a lesser ARI capacity and less costly diversion (e.g. 2 year ARI capacity) may be suitable.

Where diversion structures are required, bunding should typically consist of a level top section (minimum) 3m wide with side batters of 1:2.5, and be built to an engineering specification using competent materials. Bunding dimensions and the diversion channel should be capable of containing or diverting runoff flows up to the design flood event, 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.

6.2.2 SEDIMENT BASINS

The planned mining operations for the Marillana Iron Ore Project would potentially mobilise additional sediments to the natural drainage systems with the main potential sediment sources being the WRDs and stockpiles. The most effective method of sediment management is to control sediment at their sources. Sediment basins are one such method, and should be constructed down slope of all WRDs and stockpiles (as appropriate) to help manage surface water sediment. Sediment basins should be used in conjunction with erosion minimisation strategies such as vegetated batters, coarse sheeting and engineered drainage systems.

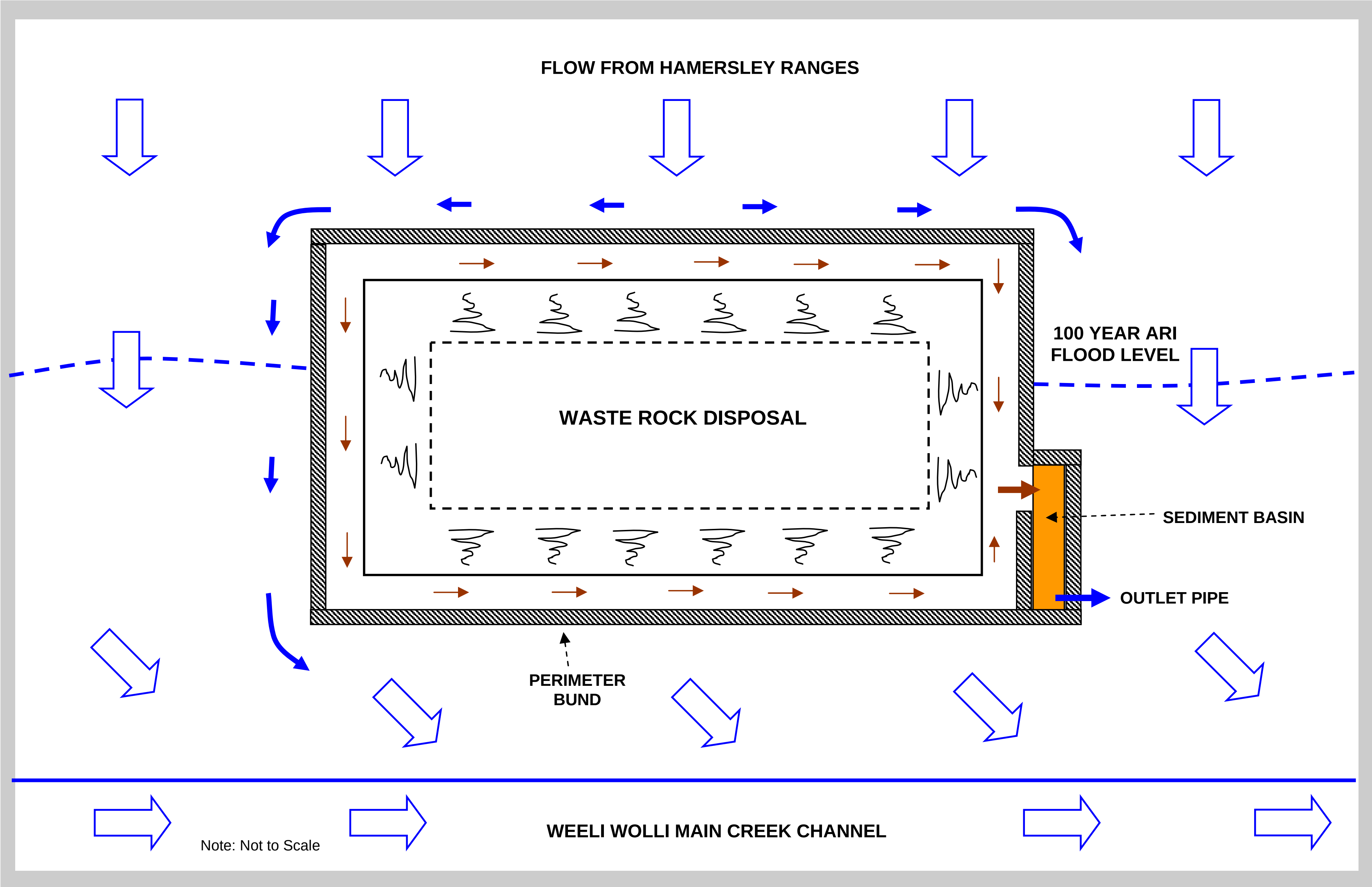
Sediment basins collect internal runoff and remove sediments to acceptable levels prior to release to the natural environment. Bunds and drainage diversion works will be constructed around the perimeter of all WRDs and stockpile areas, to divert and separate the natural runoff outside the development sites from the 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. Sediment basin designs are based on the removal of a target sediment size. Removal of medium sized silt particles > 0.02mm (20 micrometres [µm]) for the design storm event is commonly used. 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.

Sediment basins should be constructed to treat the runoff from each WRD and stockpile area in the development area. Each of these areas should be locally bunded to contain the internal runoff and direct runoff to a sediment basin prior to disposal to the main drainage system. The final locations and layouts for these bunds and sediment basins will need to be determined in association with the detailed mine plans. A conceptual layout for bunding and sediment control around a WRD is provided in Figure 6.1.

6.2.3 IN-PIT STORMWATER MANAGEMENT

Following significant rainfall events, water falling within the footprint of the mine pits would collect on the pit floor.

This stormwater will be captured and is proposed to be pumped to the plant site to supplement mine dewatering uses in the process plant and for dust suppression. Any excess water will be discharged to Weeli Wolli Creek or adjacent drainage lines downstream of the mine site or reinjected within the mine tenement. Should short term sump pumping rates be greater than demand, water will be stored on site in locations such as tailings dam or non active pits for subsequent reuse.



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f:\jobs\832h\swmp\044a figure 6.1.doc

WRD Water Management: Conceptual Layout **Figure 6.1**

6.3 SPECIFIC SURFACE WATER MANAGEMENT WORKS

6.3.1 SURFACE WATER DIVERSIONS

For development of the planned pits, main surface water diversion works are required. In the development of concept designs for the required diversions, consistent with the principles described above, the following criteria were adopted:

- Reduce the likelihood of flooding of the mine areas due to surface water inflow.
- Minimise the volume of surface water to be dewatered from active mine areas.
- Reduce the volume of water which could potentially be contaminated as a result of contact with mining activities.
- Where possible diverted water course will be directed into the original water course at a point downstream or to the downstream water course.

The required diversion works include the diversion of Hamersley Ranges catchments around or through the mine site. Runoff from Catchments I and J will be diverted to the west of the proposed pit then north to Weeli Wolli Creek. Runoff from Catchments F, G and H will be diverted through the pit footprint/process plant area via constructed channels, while Catchments D and E runoff will be diverted through an unmined area between the mining blocks and into Weeli Wolli Creek. These proposed diversion works are shown in Figures 5.2 and 5.3.

Brockman plans to use a staged mining approach to maintain a continuous drainage outlet for the Hamersley Ranges sub-catchments towards Weeli Wolli Creek. Dependent on final plans, creek diversions will typically initially occur through areas either not scheduled for mining or with a late start date.

As mining progresses, it is proposed that selected pits will be used for the storage of waste material and fine rejects. The creek(s) would then be permanently re-established over infilled section(s) of the pit. It is anticipated that approximately four such drainage corridors will be required. In-situ weakly cemented detrital material will be used in the construction of the channel base. After removing, storing and backfill, the backfill material is estimated to have a permeability of about $1x10^{-2}$m/s. To permit the conveyance of surface water from the Hamersley Ranges catchments across the backfilled material it is proposed to install a 1m thick layer of fines reject beneath the channel base. This material has an estimated permeability of $1x10^{-8}$m/s which will ensure that the majority of water reaching the upstream boundary of the backfilled pit section will discharge downstream.

In order to limit the potential for erosion of diversion drains downstream of the backfilled section, the drain section will be designed for a 1 in 10 year ARI event. Flows in excess of this will overtop the drain and flow within a confined “flood plain” zone. As this zone will be highly permeable and located well above the groundwater table, it is expected that the majority of this water will infiltrate, reducing the peak flood rate.

This combination of fines reject lined drain and high permeability flood plain will result in the conveyance of low flow events which may have environmental significance (such as supporting riparian vegetation) whilst reducing potential flows and erosion during major flood events.

6.3.2 BUNDING

For all WRDs, as appropriate, Brockman proposes to bund their perimeters to prevent natural runoff from outside the WRD sites from mixing with internal site runoff. Internal runoff would be collected and treated in sediment basins to remove sediments prior to release to the natural environment. The WRDs would be located within potential Weeli Wolli Creek flood zones and would be designed to ensure that flood events do not scour collected sediment. This may involve design features such as overflow pipes or discharge slots to limit the potential for flooding and scouring.

Direct rainfall on the pit floor would be removed by pumping as discussed above. After treatment to remove the sediments, the in-pit water would typically be used for ore processing and dust suppression.

Around the stockpiles and the process plant, bunding will be installed to protect the infrastructure from flooding in Weeli Wolli Creek, as required. Similarly, bunding will be required to extend upslope (south) from the south east corner of the WRD. This bunding will prevent flooding from Weeli Wolli Creek from extending westwards along the southern edge of the WRD and potentially impacting the plant area.

The flood bunding will be installed prior to the construction of the WRDs to ensure that flood protection is achieved for the commencement of mining. The toe of the flood bunding will be located a minimum of 50m from the Weeli Wolli Creek bank to provide a 30m non disturbance zone to protect existing riparian vegetation and a 20m access corridor. Flood modelling indicates that velocities are steady with distance from the creek bank and hence the use of a larger set back would not reduce flood velocities adjacent to the bund.

The flood bunding height will vary across the site dependent on local topography. Typically to provide protection against 1 in 100 year flooding with appropriate freeboard, the bund height will be 3-4m high. The bund would require construction and compaction to an engineering specification, whilst the slopes will be dependent on the material used and the achievable compaction, indicative slopes are 1 Vertical : 3 Horizontal. Flood modelling indicates that the 1 in 100 year flood velocity against the bunds average 0.7m/s. Based on this velocity, an appropriately constructed bund is expected to remain stable and scour protection is not required.

Upon completion of the WRD, the flood protection bund would be incorporated into the toe of the waste dump at an angle appropriate to provide long term stability and rehabilitated.

A typical cross section of the operation and post closure profile between the WRDs and Weeli Wolli Creek is shown in Figure 6.2. The landform slopes used in the figure are based upon the Marillana Preliminary Geotechnical Assessment (Coffey 2009).

6.4 MONITORING AND MEASUREMENT

6.4.1 MONITORING PROGRAMME

The proposed surface water monitoring programme includes collecting water samples via rising stage samplers at six stations located on Hamersley Range Catchments and Weeli Wolli Creek, and monitoring stormwater discharge points from hydrocarbon storage areas.

The proposed locations for the rising stage samplers are:

- Weeli Wolli Creek adjacent to the upstream lease boundary.
- Weeli Wolli Creek downstream of the mine operations and south of the BHPB railway.
- Undisturbed Hamersley Range catchment at southern lease boundary.
- Undisturbed Hamersley Range catchment near Weeli Wolli Creek confluence.
- Diverted Hamersley Range catchment at southern lease boundary.
- Diverted Hamersley Range catchment near Weeli Wolli Creek confluence.

Stormwater collected from the hydrocarbon storage areas will be assessed using a grab sample prior to release.

A summary of the proposed surface water monitoring programme is provided in Table 6.1.

Table 6.1: Surface Water Monitoring Programme

Location to be Monitored	Parameter	Location	Aim	Monitoring Programme/ Requirements	Frequency
Weeli Wolli Creek	Water Quality	Adjacent to the upstream (east) lease boundary; Downstream (northwest) of the mine operations	Monitor changes in water quality across the mine lease	Water Quality Suite: pH, EC, TDS, Turbidity, Total Suspended Solids (TSS), HCO3, CO3, Cl, SO4, Na, K, Ca, Mg, Fe, Mn, Zn, Cu, Al, Cd, Pb, As, Hg, Se, Ba, Cr, Ni, Mo and Alkalinity (CaCO3).	Flow Event Basis
Diverted Hamersley Range catchment	Sediment Load	Adjacent to the upstream (south) lease boundary; Downstream prior to Weeli Wolli Creek confluence	Monitor changes in turbidity and suspended solids across the lease area	Turbidity, Total Suspended Solids	Flow Event Basis
Undisturbed Hamersley Range catchment	Sediment Load	Adjacent to the upstream (south) lease boundary; Downstream prior to Weeli Wolli Creek confluence	Provide baseline data as to changes in turbidity and suspended solids across the lease area	Turbidity, Total Suspended Solids	Flow Event Basis
Hydrocarbon Storage Area	Total Petroleum Hydrocarbon (TPD) Concentration	Hydrocarbon Storage Areas	Monitor levels of hydrocarbon discharge	If discharge of stormwater is required, conduct monitoring to ensure a hydrocarbon concentration of less than 5mg/L.	Event Basis (If Required)

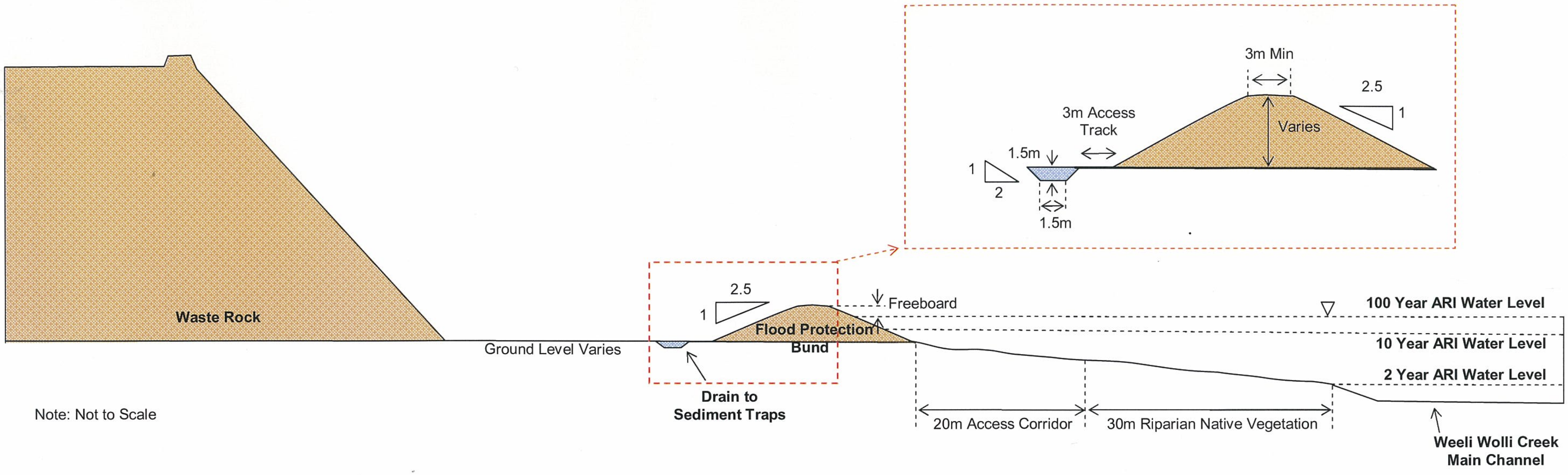
6.4.2 CONTINGENCY

Adverse impacts identified from event monitoring will trigger the implementation of a management response. Table 6.2 provides a summary of the identified triggers and associated management response.

Table 6.2 –Management Response to Monitoring Results

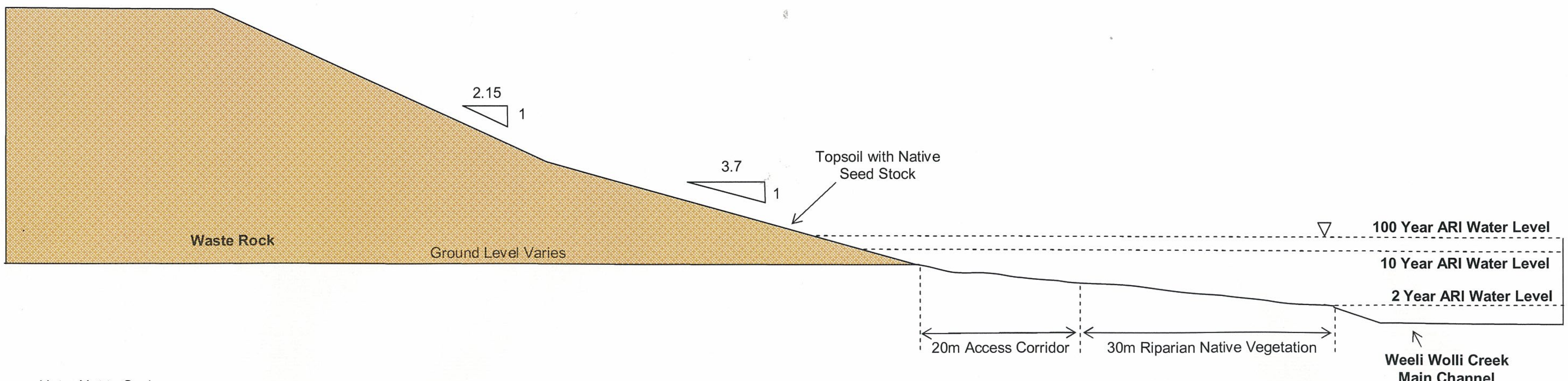
Location	Target	Triggers	Management Response
Weeli Wolli Creek	No change in water quality of the creek beyond +/- 10% of natural seasonal background range	Water quality in creek is above the +/-10% variation from background range	Investigate cause of water quality change and appropriate remedial action
Diverted Hamersley Range Catchment	Minimise increases in turbidity and total suspended solids in mine site drainage water	Turbidity and total suspended solids is greater than 50% above background levels	Improve stormwater drainage to decrease sediment loads and/or turbidity
Hydrocarbon Storage Area	No release of water with hydrocarbon concentration greater than 5mg/L.	Collected stormwater with hydrocarbon concentration greater than 5mg/L needing to be released	Further treat water prior to release. Investigate options to reduce potential for hydrocarbon contamination.

Cross Section - Operational



Note: Not to Scale

Cross Section – Post Mine Closure



Note: Not to Scale

Figure 6.2
Typical Cross Section of Waste Rock Disposal to Weeli Wolli creek

7 CLOSURE SURFACE WATER MANAGEMENT

7.1 CLOSURE SURFACE WATER MANAGEMENT OBJECTIVES

The post closure topography of the pit area will be formed by in-pit overburden placement into the mine voids. Most areas will be backfilled above the existing surface level, but there will be some sections that will be below or at the pre-mining level. The majority of the backfill will comprise of waste rock but in areas built up above the existing topography, fine reject waste will also be used.

The change in topography post mine closure will particularly impact on surface water flow from the Hamersley Ranges. Such impacts include:

- Drainage stability and erosion of mine closure landforms.
- Permanent changes to the pattern of overland and sheet flow.

To mitigate the risk of these impacts, the following closure surface water management objectives will be implemented:

- Restoration of baseline flow regimes in areas affected by mining and closure works.
- Maintainenance of baseline surface water quality.
- Ensure stability of permanent diversions, creek reconstructions and other constructed water management works left after mine closure.
- Ensure stability of drainage from landforms created by mining.

Permanent changes to the pattern of flows due to post closure landforms are likely to result in geomorphic changes to drainage lines around and downstream of the mine site. The degree of change would depend on how post closure flows would be distributed compared to the natural distribution of flows with the aim to ensure post closure flows are as close as possible to natural conditions.

Much of the runoff from the Hamersley Ranges would be unable to flow along the entire length of their original drainage lines as the majority of the post closure landforms will be above or below the natural ground level, preventing flow from discharging further downstream. It is proposed to construct a series of diversion drains to redirect water around or through the mine site in areas where the post closure ground level is restored back to its natural, pre-mining elevation. Once downstream of the minesite, flow would be diverted back to the original drainage course wherever possible.

Conceptually, four diversion drains have been nominated to direct flow from the Hamersley Ranges through the post closure mine site. These can be seen in Figure 7.1. Diversion 1 would divert flows around the mine site and not be impacted by the post closure mine forms. Runoff would be redirected from the catchments nominated as I and J around the north west corner of the mine area and discharged back into the original creek formed by the runoff. After exiting the diversion channel, flows should be discharged over spreader mechanisms to encourage water to slow and disperse.

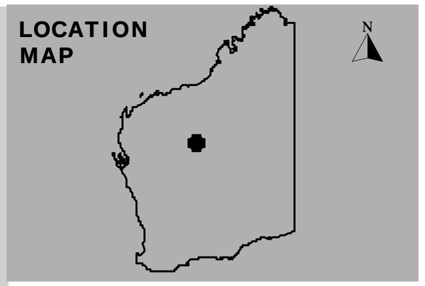
Diversions 2 and 3 would be constructed through the mine site in areas where the backfill is expected to be at the pre-mining ground level. Flows from adjacent catchments, prevented from flowing downstream due to the post closure landforms, would be diverted to these constructed drains.

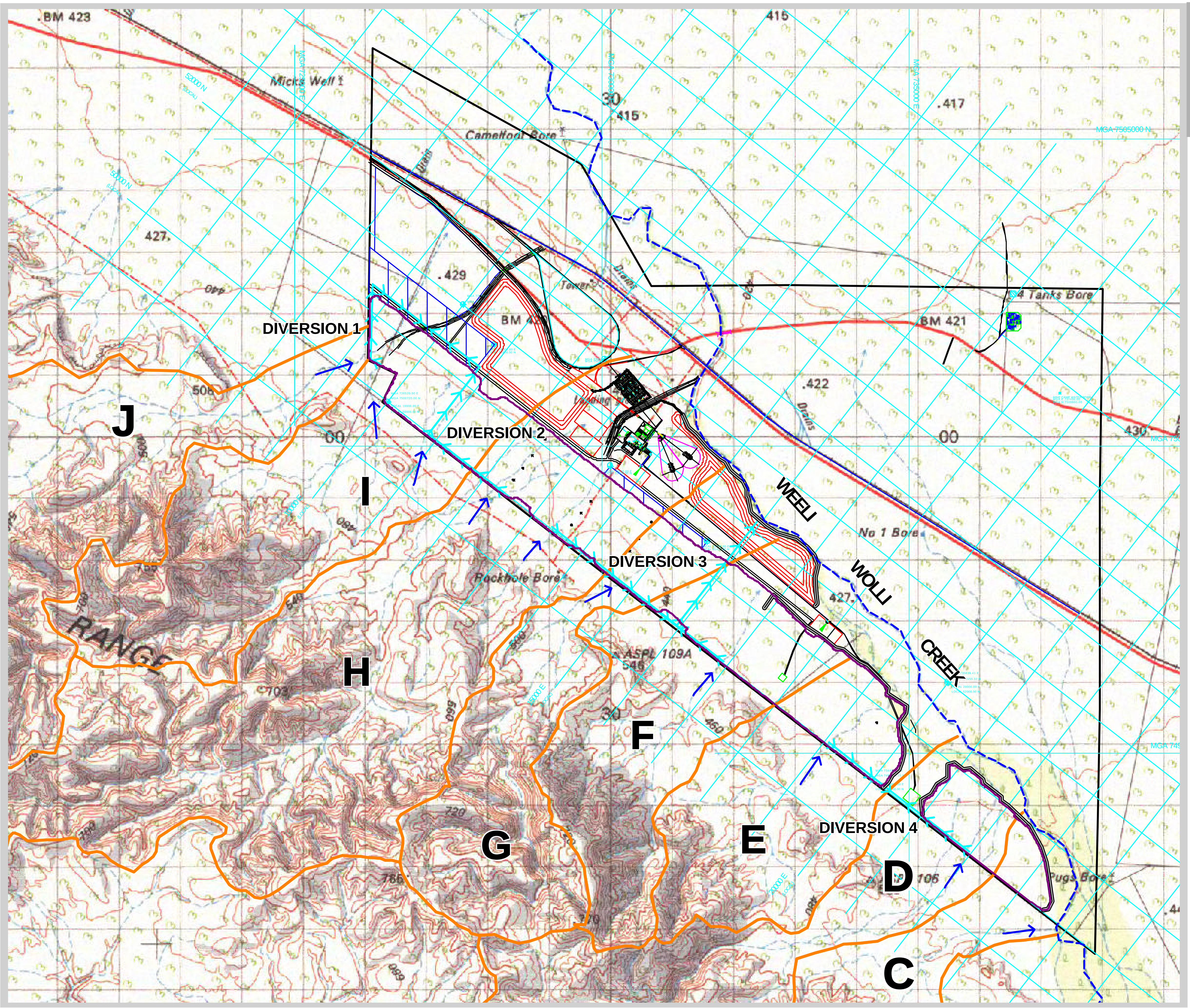
Diversion 2 would mainly redirect flow from Catchment H and is proposed to discharge into another diversion channel, previously constructed to divert Hamersley Ranges runoff during operation of the mine site. Diversion 3 would redirect flow from Catchments F and G and is proposed to pass through a flow path provided within the waste dump outline and discharge into Weeli Wolli Creek. The final section of this diversion would be at a shallower gradient which would encourage sedimentation prior to discharge to Weeli Wolli Creek.

Construction of these channels could take place once the area has been backfilled (estimated at Year 8 for Diversion 2, and Year 5 for Diversion 3). Prior to this, runoff from these catchments would be diverted through previously constructed channels, intended for use during mine operation.

Diversion 4 discharges flow through the unmined area between the mining blocks and would not be impacted by the final mine forms. The diversion would collect runoff from Catchments D and E and discharge the flow into a natural tributary of Weeli Wolli Creek. Spreader mechanisms would be required at the discharge point. Catchment C is not impacted by mining and does not require a diversion drain.

Diversion channels would be designed with sufficient capacity for a nominated rainfall event, while minimising earthworks and the channel footprint. The channel would be an appropriate width and depth, and have a bed gradient and side batters to minimise channel velocities and ensure a stable channel profile. Using material similar to natural creek bed sediment and establishing local riparian vegetation on the flood plains encourages the diversion channels to behave like natural drainage lines.





LEGEND

- Weeli Wolli Creek and Distributaries
- Mine Closure Diversion Channels
- Existing Flow Paths
- Hamersley Ranges Catchments
- Brockman Mining Lease Boundary
- Bunding

SCALE

1 0 1 2 3

Kilometers

Scale: 1:60,000

aquaterra

Figure 7.1

Proposed Mine Closure Surface Water Diversion Channels

AUTHOR:	LC	REPORT NO:	044a
DRAWN:	LC	REVISION:	a
DATE:	31/07/2009	SCALE:	1:60,000 (at A3)
JOB NO:	832H	PROJECTION:	MGA94 Z50

Location: F:\Jobs\832H\SWMP\044a Figure 7.1

8 SUMMARY

8.1 PROJECT DESCRIPTION

The project area is located in a flood prone area at the base of the Hamersley Ranges escarpment. The proposed developments are situated on the southern bank of Weeli Wolli Creek, approximately 15km to the south of the southern extent of the Fortescue Marsh.

The Hamersley Ranges are located immediately to the south of the project area. The ranges extend from an elevation of 440m in the project area to include peaks of up to 775m within the catchments which drain through the project area. The Hamersley Ranges catchments which impact the project site have a moderately dense network of streams which generally have very steep upper catchments before forming a delta upon leaving the ranges and draining through the project area. In major events, runoff through the project area would occur as wide, shallow, slow moving sheet flow.

The Weeli Wolli Creek is a major Pilbara drainage system with a catchment area of 4,769km^2 as it leaves the Hamersley Ranges. The Weeli Wolli Creek flow rate has been gauged at the Waterloo Bore gauging station located 10km upstream of the eastern lease boundary at the point at which the creek system leaves the Hamersley Ranges escarpment.

Upon exiting the ranges, Weeli Wolli Creek has formed an extensive delta with numerous flow paths in major events. The split of flow between the channels will vary with the intensity of the event. For example, during low flow events, flow will be confined exclusively to the main Weeli Wolli Creek channel, however during large events, the flow within the main channel would only represent a small proportion of the total flow. From this delta, the Weeli Wolli Creek channels extend northwards into the Fortescue Marsh, which is an extensive intermittent wetland located on the floor of the Fortescue River valley.

The Fortescue Marsh acts as a flood storage and occupies an area around 100km long by typically 10km wide. The DoW considers the upper portion of the Fortescue River which drains to the Marsh as a closed system.

8.2 POTENTIAL IMPACTS

Potential surface water impacts associated with the planned Marillana mining activities include:

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

Drainage paths from the Hamersley Ranges extend through the proposed mine area. To prevent flooding of the mine pits and associated infrastructure, bunding and diversion drains will be required to manage these flows. These flows will either connect into Weeli Wolli Creek or discharge upstream of the main creek and reach Weeli Wolli Creek via minor channels and overland flow.

The diversion of this overland flow into diversion drains will potentially impact vegetation downstream of the drain between the drain and Weeli Wolli Creek. The potentially impacted partially sheet flow dependent vegetated area is limited to a 1.1km^2 area around the rail loop and product stockpiles. This area will continue to receive Weeli Wolli Creek overflow, however the overland flow from the Hamersley range catchments will be diverted upstream of this area.

The mine plans have been developed to ensure that Weeli Wolli Creek and its distributaries are not directly impacted by the works. No diversion of Weeli Wolli Creek or its distributaries are required and with the exception of potential modification to road crossings at existing locations, there are no proposed works in the creek channels or on its banks.

The mine developments have the potential to reduce the effective catchment area of Weeli Wolli Creek by 10km^2 or 0.2%. These changes are not significant to the overall hydrological system, particularly in comparison to the natural seasonal variations in catchment runoff.

Runoff from the planned WRDs and other disturbance areas and the concentration of flow into diversion drains has the potential to significantly increase erosion and sediment loads in the natural drainage systems if appropriate management measures are not implemented.

The post closure topography of the pit area will be formed by backfill placement into the mine voids. Most areas will be backfilled above the existing surface level, but there will be some sections that will be below or at the pre-mining level. The majority of the backfill will comprise of waste rock, however fine reject waste will also be used. This change in topography will impact on the surface water flow regime from the Hamersley Ranges.

8.3 MANAGEMENT MEASURES

To minimise the impact of mining operations on surface water draining from the site and consequently on Weeli Wolli Creek and the Fortescue Marsh, a number of measures will be adopted during construction and operation of the mine. These measures will include the use of buffer zones between mine developments and creek systems, minimisation of clearing, dry season construction where possible, bunding of hydrocarbon storage areas and separation of runoff from disturbed areas.

Sediment basins will be used in conjunction with erosion minimisation strategies such as vegetated batters, coarse sheeting and engineered drainage systems. In areas where sediment basins are constructed within the Weeli Wolli Creek flood plain, measures will be included to ensure that flood events do not scour collected sediment. This may involve design features such as overflow pipes or discharge slots to limit the potential for flooding and scouring.

Around the stockpile areas and the process plant, bunding will be installed to protect the infrastructure from flooding in Weeli Wolli Creek as required. The flood bunding will be installed prior to the construction of the WRDs to ensure that flood protection is achieved for the commencement of mining. The toe of the flood bunding will be located a minimum of 50m from the Weeli Wolli Creek bank to provide a 30m non disturbance zone to protect existing riparian vegetation and a 20m access corridor.

A proposed surface water monitoring programme will collect water samples at six stations located on Hamersley Range Catchments and Weeli Wolli Creek, and monitoring stormwater discharge points from hydrocarbon storage areas. Adverse impacts identified from event monitoring will trigger the implementation of a management response

Post-closure, it is proposed to construct a series of diversion drains to redirect water around or through the mine site. Once downstream of the minesite, flow would be diverted back to the original drainage course wherever possible. These post-closure diversion drains will include sections re-established over the backfilled pits. As the backfilled pits will have high permeabilities, to enable the drains to convey water across the pit, the drains will be lined with fines reject materials under the base of the channels. The channels will be combined with a flood plain zone. Consequently, minor events will be conveyed to Weeli Wolli Creek ensuring environmental flows are maintained while major flow events will be attenuated.

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