



# Millennium Expansion Project

## Environmental Impact Statement

## CHAPTER 10:

## WATER RESOURCES

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# 10.0 WATER RESOURCES

## 10.1 EXECUTIVE SUMMARY

### 10.1.1 Values

Surface water and groundwater values for the MEP area are taken from the relevant guidelines and include:

- aquatic ecology values consistent with a slightly to moderately disturbed ecosystem;
- agricultural values for water that has quality generally consistent with stock watering guidelines; and
- cultural and spiritual values as identified by the traditional owners of the land.

The values are based on the following knowledge:

- all streams, creeks and natural drainage lines in the MEP are ephemeral;
- the region surrounding the MEP has a long history of agricultural activity;
- water quality, quantity and standing water levels in identified aquifers;
- there are 36 registered bores within a 10 km radius of the MEP of which 26 were drilled for coal and gas exploration purposes and not groundwater extraction or monitoring;
- a bore census identified 12 bores within the vicinity of the MEP, however these including some unregistered bores;
- groundwater usage surrounding the MEP is minimal to non-existent;
- surrounding landholders stock water is predominantly supplied from surface water (i.e. dams) while only small volumes are sourced from the Quaternary alluvial and Rangal Coal Measures aquifers due to the low volume and high salinity of the water in these aquifers;
- no groundwater dependent aquatic ecosystems are known to exist on or nearby the MEP; and
- due to the salinity of the aquifers, stygofauna and troglofauna are not likely to be present.

### 10.1.2 Issues

The MEP's potential surface water issues include:

- establishment of water quality and flow standards for ephemeral water systems;
- preventing the release of non-compliant water to surrounding waterways;
- risk management and protection of mining operations during flood events;
- minimising raw water importation by maximising the use and re-use of mine impacted water on-site;
- instigating an appropriate monitoring program to identify any mining impact trends in surface water quality;
- change to flood velocity along New Chum Creek;
- increased flood levels or velocities outside the MEP area;

- increased water requirement to meet the increased production requirements;
- capture and reuse of water in the mine water management system will result in reductions in flow in the receiving water catchments;
- the final voids are located at the edge of the PMF flood extents, therefore the risk of flood inflows is small; and
- deterioration of water quality in mining voids and the potential for overflow of mining voids to the surrounding environment.

The MEP's potential groundwater issues include:

- quaternary alluvium aquifer will not be impacted by the MEP;
- modelling indicates that the cumulative impacts from surrounding existing coal mines may potentially have a detrimental effect on two existing bores; and
- little or no impact within and surrounding the MEP as a direct result of the EEP.

### 10.1.3 Mitigation Strategies

Strategies to mitigate MEP's surface water issues and impacts include the following:

- a 100 m buffer zone will be maintained along New Chum Creek to reduce direct impacts on the riparian vegetation and stream water quality.
- diversion drains will be built around the site to direct clean water away from mining operations.
- sediment dams will be built to control runoff water from land disturbed ahead of mining and waste rock emplacements.
- pit water will be pumped into a central storage area and re-used.
- mine impacted water will be actively managed to prevent any non-compliant release to surrounding waterways.
- rock mulch of waste rock emplacements and levees to protect the pits will be constructed to protect the operating mine from a 1:2,000 year ARI flood event and to protect the pits at the end of mine life from a Probable Maximum Flood event.
- external dumps adjacent to West Creek will be located such that the impact on flood conditions in West Creek will be minimal.
- flood modelling has shown that:
  - o mining pits are outside the 100 year ARI flood level;
  - o mining voids will be protected by levee banks to protect against the Probably maximum Flood level; and
  - o flood velocities along New Chum Creek remain unchanged from existing conditions with the exception of localised increases in the immediate vicinity of the proposed haul road crossings and at the edge of external waste rock emplacements.
- scour protection will be provided at the New Chum Creek haul road crossings and the toe of waste rock emplacements to manage the increased risk of erosion.
- the Mine Water Management System has a modelled water balance that shows:

  - the existing and proposed mine water storages have sufficient capacity to contain the predicted increase in surface water runoff and in-pit water-make; and
  - there is sufficient water supply in the existing Burdekin Weir allocation and the collection and recycling of mine impacted water to meet the increased water requirements for increased production rates.
- the proposed management will ensure no measurable adverse impacts on riparian and ecological values of watercourses on the site and downstream of the proposed MEP. It is expected that there will be little impact on runoff water quality.
- based on historical simulation analysis, in the long-term, the catchment of the final voids will be insufficient to generate sufficient runoff to exceed evaporative losses from the water surface. Stored water levels in both voids are likely to stabilise at a considerable depth below the edge of the void.
- the salinity of stored water will tend to increase over time. Modelling of the voids shows that the salinity will eventually increase beyond safe stock watering levels.

Strategies to mitigate MEP's groundwater issues and impacts include the following:

- Peabody will develop and implement a groundwater monitoring program prior to the MEP commencing operations to monitor the existing groundwater environment and potential impacts; and
- if an impact occurs and is related to the MEP operations, Peabody will seek to reach a mutually agreeable arrangement with affected neighbouring groundwater users for the provision of alternate supplies throughout the mine life, and after mine closure while the aquifer recovers.

## 10.2 BACKGROUND

### 10.2.1 Surface Water

This section identifies the surface water resources and values relevant to the Millennium Expansion Project (MEP) and is based on existing water management processes and studies undertaken for the Millennium Mine, and a technical report for the MEP prepared by WRM Water & Environment Pty Ltd (2010), which is included as **Appendix F3–Surface Water**.

The potential impacts on the surface water resources and values are discussed, and mitigation measures are proposed, where appropriate.

### 10.2.2 Groundwater

The hydrogeological assessment of the MEP area aims to characterise the existing groundwater environment and detail potential impacts resulting from groundwater inflow into the proposed mine pit, and of groundwater drawdown at the end of the mine life.

The hydrogeological assessment includes data extrapolated by 3-D modelling simulations. Supporting literature includes geological and hydrogeological reports for the MEP and immediate surrounds. It should be noted that the existing Millennium Mine and the proposed MEP are disconnected by a geological sub-crop and sufficient distance that groundwater impacts at these two locations are not likely to be inter-related. Modelling results are summarised from a Groundwater Technical Report completed by Matrixplus Consulting (Matrixplus Consulting Pty Ltd, 2010) (refer to **Appendix F4-Groundwater**).

## 10.3 LEGISLATION AND GUIDELINES

The Terms of Reference (TOR) for the MEP indicate a number of legislated Acts, regulatory guidelines and other water management documents to be addressed in this EIS. A summary of the documents that have been reviewed and guidelines incorporated into the MEP Water Management System are included as **Annexure A**.

## 10.4 ENVIRONMENTAL VALUES

### 10.4.1 Surface Water

Environmental values for surface water are set and described under various documents, including the:

- *DERM* Guideline: Establishing draft environmental values and water quality objectives (*DERM Guideline*);
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (*ANZECC & ARMCANZ, 2000*) (*ANZECC Guidelines*); and
- *EPP Water*.

The environmental values for surface water in the MEP area remain relatively consistent between the documents, as shown in **Table 10-1**below.

**Table 10-1 MEP Environmental Values**

| DERM Guideline | ANZECC Guidelines | EPP Water |
|---|---|---|
| Aquatic – Slightly to moderately disturbed (SMD) system<br>Primary Industries – Stock watering<br>Cultural and spiritual | 'Environmental values' of receiving waters as those values or uses of water that the community believes are important for a healthy ecosystem.<br>The receiving waterways relevant for the MEP are classed as slightly to moderately disturbed. | Under Section 7 of the EPP Water, there are no particular environmental values attributed to the specific waterways located within the MEP as they are not listed in Schedule 1.<br>Section 7 (2) however, assigns the environmental values in the receiving water to be protected under the category 'other waters' as:<br>• ecosystem protection (Level 2 – disturbed ecosystems, Queensland Water Quality Guidelines (QWQG) 2006); and<br>• agricultural uses (Irrigation and Stock Watering). |

#### *10.4.1.1 Ephemeral Creek System Consideration*

The Environmental Values listed should be taken in context given the relatively isolated and ephemeral nature of the associated creek systems surrounding the MEP. All waterways in the MEP and surrounding catchment are ephemeral waterways, meaning that there is extreme variability in both water quality and volume as a natural part of the water system. A 'typical' year could see local waterways dry from March through to November, intermittently flowing or flooding following high intensity rainfall events between November to March, with this flow slowing and developing into pools of stagnant water that slowly dry out until the more typical dry conditions return.

The variability of flow in ephemeral streams can lead to changes in the physical and chemical properties of the water compared to perennial streams. The current *ANZECC Guidelines* therefore are not well suited to determine the characteristics of water quality for ephemeral streams. The *Queensland Water Quality Guidelines* state *'The application of guidelines to ephemeral waters is undoubtedly problematical. The ANZECC 2000 Guidelines mention the lack of good data on these stream types but in general offer little advice on how to approach the issue.'*

An Australian Centre for Mining Environmental Research (ACMER) report, *Review of Methods for Water Quality Assessment of Temporary Lake and Stream Systems* (Smith *et al*., 2004) states '*it is noteworthy that the underlying assumption of steady-state conditions inherent in the ANZECC/ARMCANZ (2000) water quality trigger values can be readily misapplied to temporary waters*'. One example given is that *'Salinity increases up to 10 times during the drying period in the hydrocycle in the inland salt lakes.'* This is a similar scenario to the drying period in ephemeral waterways surrounding the MEP following rainfall events, indicating the salinity (measured as EC), could regularly and naturally be up to 10 times higher than that recorded in permanent streams or waterholes in the region, on which ANZECC guidelines are based.

Environmental values must also consider that the Isaac River catchment has seen significant changes in land use over the past 50 years. Widespread land clearing for both agricultural use and coal mine development have occurred throughout much of the receiving water catchments.

### 10.4.2 Groundwater

For this study, the MEP and the surrounding area has been hydrogeologically assessed and modelled. The environmental values considered in this section include the water quality, quantity and standing water levels relating to both the existing and potentially impacted values for the local and regional groundwater area.

## 10.5 EXISTING NATURAL ENVIRONMENT

### 10.5.1 Surface Water

*10.5.1.1 Regional Drainage Network*

The MEP is located in the Isaac River catchment which flows into the Fitzroy River Basin via the Mackenzie River as shown in **Figure 10-1**. New Chum Creek, North Creek and West Creek are the waterways within the MEP area, all of which flow directly into the Isaac River.

The water resources of the Isaac River are relatively undeveloped, with Burton Gorge Dam being the only significant water retaining structure. The Burton Gorge Dam is located approximately 45 km to the north of the MEP.

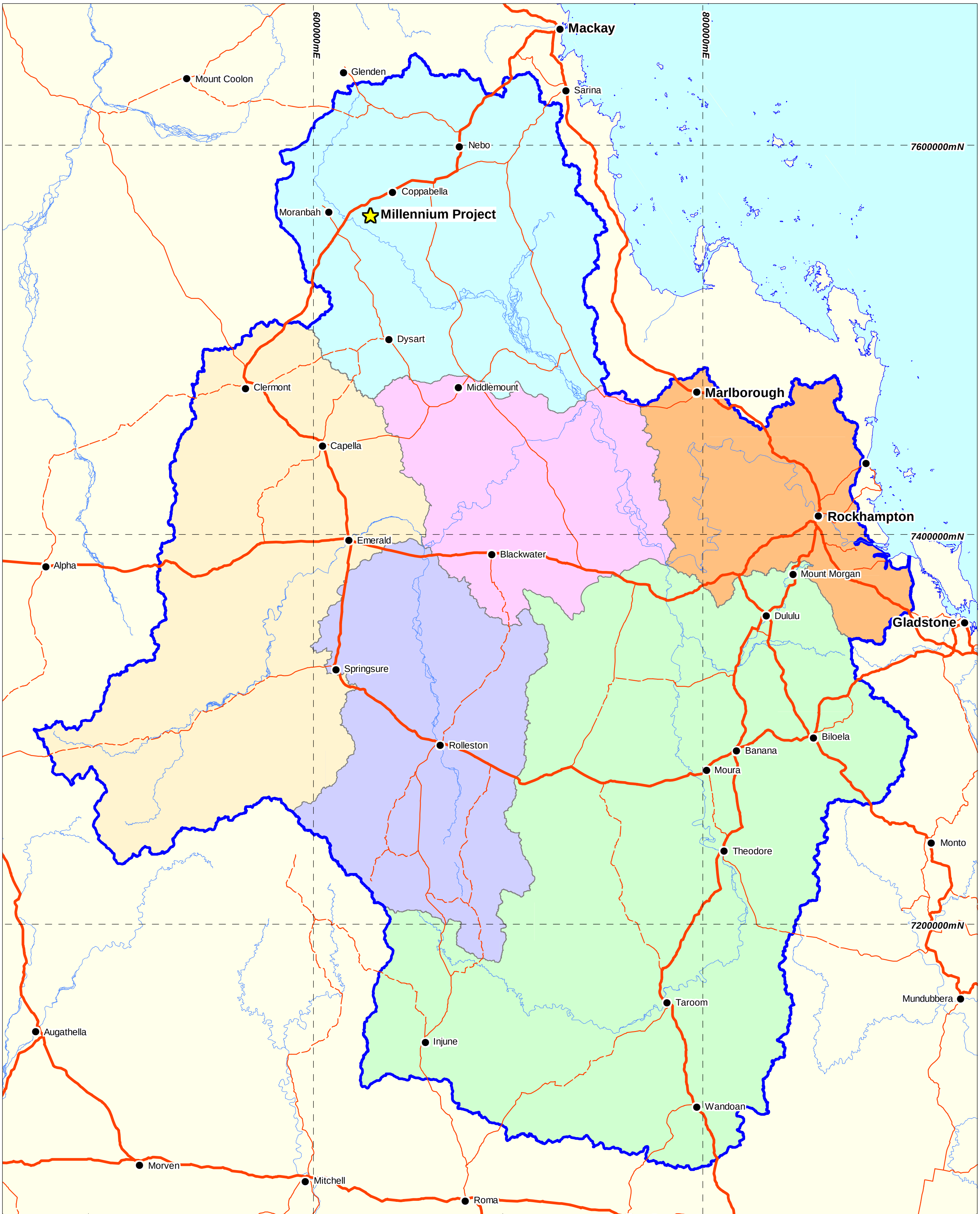
The MEP covers 29.9 km² (0.15%) of the Isaac River catchment area of approximately 20,000 km².

#### *10.5.1.2 Local Drainage Network*

**Figure 10-2** shows the drainage division over the MEP area, with the majority of the MEP area located in the headwaters of New Chum Creek.

The existing Millennium Mine operations are located in small headwater catchments on the southern side of New Chum Creek and will be approaching West Creek catchment. The proposed MEP will see disturbance on the northern side of New Chum Creek and over the catchment divide into the North Creek catchment. The catchment area of New Chum Creek to the downstream boundary of the MEP, is approximately 29.9 $km^2$, including 1.8 $km^2$ draining onto the MEP from the neighbouring Carborough Downs mine. New Chum Creek has a total catchment area of approximately 51 $km^2$ at the Isaac River confluence. The MEP covers 17.6 $km^2$ (35%) of the total New Chum Creek catchment with Poitrel and Daunia Mines encompassing the remainder of the catchment.

**Plate 10-1** and **Plate 10-2** show the New Chum Creek main channel at Locations A and B within the MLA. In the vicinity of the MLA, the creek is characterised by a sandy bed channel incised within a wide floodplain.

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MET SERVE

**LEGEND**

- Principal road
- Road (sealed)
- Road (unsealed)
- Town
- Fitzroy Drainage Basin
- Isaac River Catchment
- Nogoa River Catchment
- Mackenzie River Catchment
- Fitzroy River Catchment
- Comet River Catchment
- Dawson River Catchment

Data Source:
Catchments - WRM Water. Topography - Geoscience Australia.

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# Millennium Expansion Project

**Fitzroy River Basin**

0 50 100

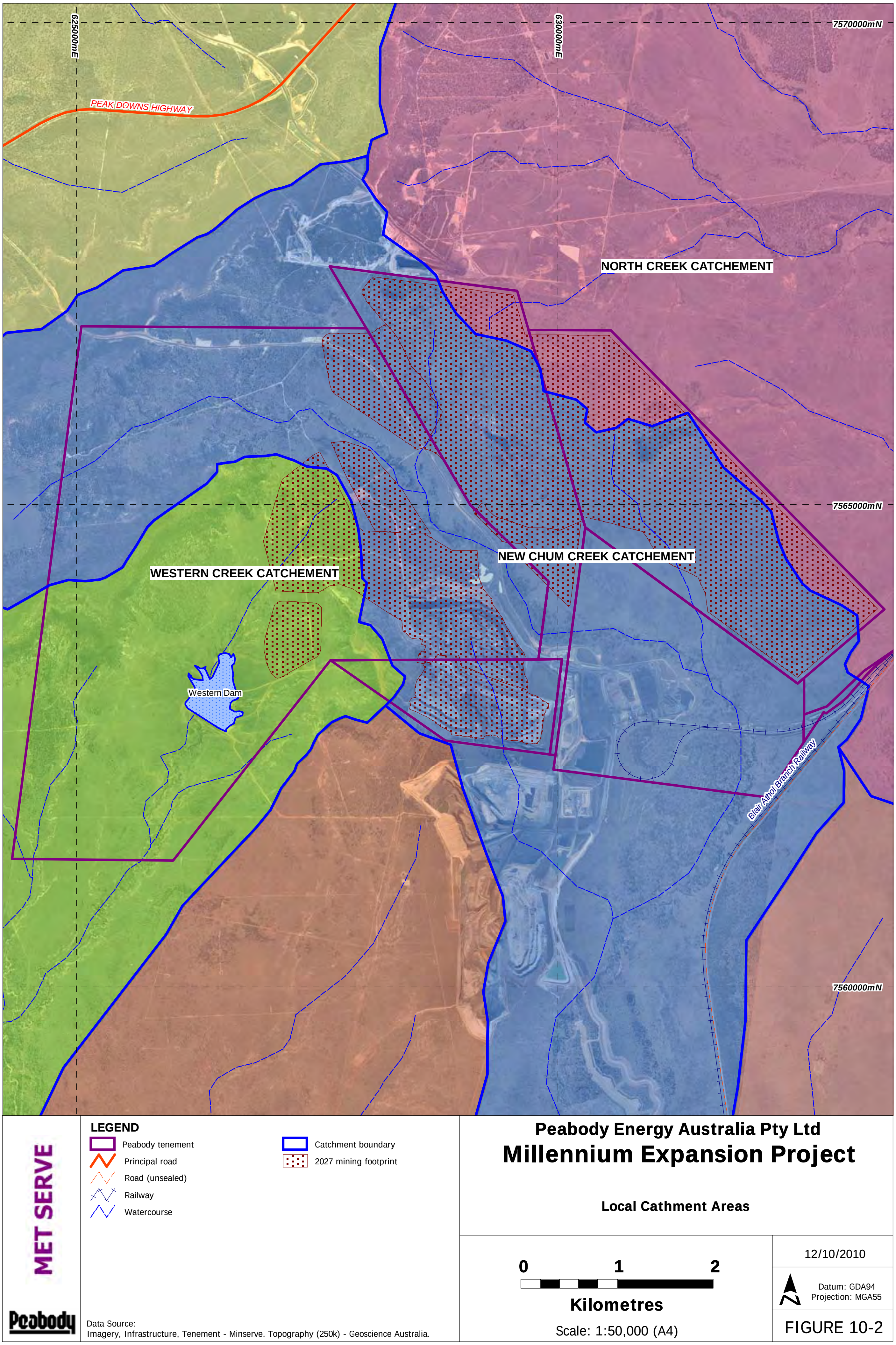
**Kilometres**

Scale: 1:2,700,000 (A4)

20/10/2010

Datum: GDA94
Projection: MGA55

FIGURE 10-1

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MET SERVE

Peabody

Data Source:
Imagery, Infrastructure, Tenement - Minserve. Topography (250k) - Geoscience Australia.

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# Millennium Expansion Project

**Local Cathment Areas**

12/10/2010

FIGURE 10-2

**Plate 10-1 New Chum Creek in the Vicinity of the MEP Area, Location A (2009)**

**Plate 10-2 New Chum Creek in the Vicinity of the MEP Area, Location B (2009)**

The main channel typically has a base width of approximately three metre and a depth of two metres. The capacity of the channel is sufficient to convey flows up to the two year Average Recurrence Interval (ARI) flow before significant overbank flow occurs. The banks are well covered by trees and grass and appear stable. The bed material is coarse sand. Some waterholes persist in the channel for several weeks following rainfall, however the stream is ephemeral, and there is little aquatic vegetation.

As shown in **Plate 10-2**, the floodplain area is vegetated by scattered trees. The floodplain also contains a number of remnant channels of similar dimensions to the main channel.

New Chum Creek is crossed by two road culvert crossings within the ML boundary and a railway culvert crossing at the downstream boundary. New Chum Creek has been diverted downstream of the MEP as part of a neighbouring mine operation.

Further details of the geomorphic conditions in New Chum Creek and West Creek are provided in **Table 10-2 – Geomorphological Description of Streams** and **Appendix F3-Surface Water.**

The south-western portion of the MEP drains south via West Creek to the Isaac River. West Creek joins the Isaac River approximately 9 km upstream of the New Chum Creek confluence. West Creek has a catchment area of approximately 22 $km^2$. The MEP covers 10.2 $km^2$ (46%) of the total West Creek catchment. A surface water impoundment known as the Western Dam is located on West Creek collecting runoff from about 6.4 $km^2$.

A small, north-eastern portion of the site drains into the headwaters of North Creek, which joins the Isaac River approximately 15 km downstream of New Chum Creek. The portions of the North Creek catchment disturbed by the MEP are in small headwater gullies, on the north-eastern edge of the MEP area. North Creek has a total catchment area of approximately 338 $km^2$. The MEP covers 2.1 $km^2$ (0.6%) of the total North Creek catchment.

## Table 10-2 Millennium Creek Photos

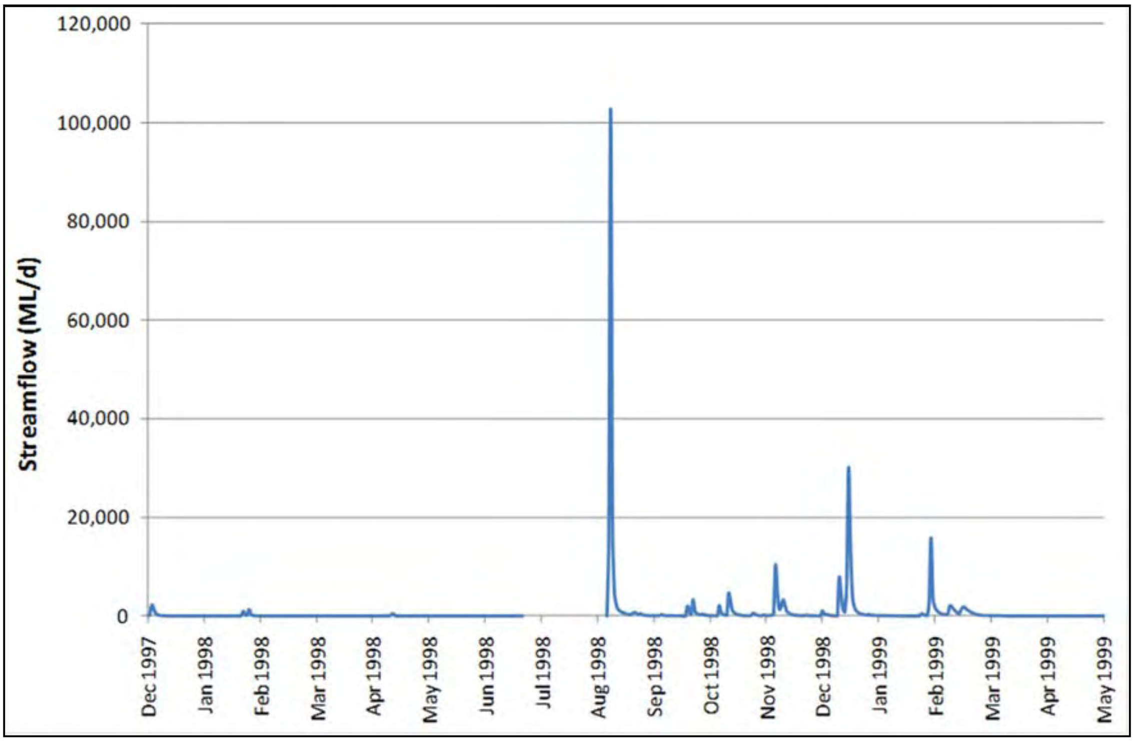
| Millennium Mine Creek Photos | | | | | |
|---|---|---|---|---|---|
| Location No | AGD 84 Coordinates | | Location Description | Field Notes | |
| | S | E | | | |
| L1 | 631,879 | 7,562,552 | New Chum Creek u/s of railway crossing | - Channel is 4-5 m wide and 1.5-2.0 m high<br>- Unshaded waterhole within creek channel<br>- Channel has steep sides (nearly vertical) - bank erosion is evident<br>- banks are grassed with some trees |   |
| L2 | | | West Creek ~50 d/s of dam | - Channel is 4-5 m wide and 2-3 m high<br>- Fine silty/clay soil creek bed<br>- flat side slopes About 1(V):4(H) - banks are grassed with some trees |   |
| L3 | | | WC u/s of dam - backwater affected reach | - Channel is 4-5 m wide and 2 m high<br>- Steep banks<br>- Submerged by West Dam<br>- Some trees are located on the bank and within overbank areas |   |
| L4 | 627,100 | 7,564,242 | WC u/s of dam - & d/s of road | - Channel is 2-3 m wide and 1 m high - Dry creek bed consisting of fine gravel - Some small trees located along the bank - Course bed material is located downstream of this location |    |
| L5 | 628,115 | 7,565,288 | NCC u/s of proposed road crossing | - Channel is 4-5 m wide and up to 1 m high<br>- sandy creek bed<br>- flat side slopes About 1(V):4(H) - banks are grassed with some trees - floodplain is grassed with a scatter of trees - floodplain is flat |  |

| | | | | | |
|---|---|---|---|---|---|
| L6 | 627,152 | 7,565,661 | NCC at u/s road crossing | - Channel is variable<br>- looking upstream: defined channel about 4 m wide and 2-4 m high. Gradual, grassed side slopes and trees within creek banks<br>- looking downstream: divided channel around trees. Sandy gravel bed and eroded bend with steep slopes. Channel height at bend is 2-4 m high.<br>- immediately downstream: some shaded and unshaded waterholes and bends. Sandy/gravely creek bed. erosion evident at the bends. Stable straight section. |    |
| L7 | 627,461 | 7,566,643 | Culverts on NCC tributary across access rd | - 4 x 1050 mm diameter culverts through access road.<br>- Grassed channel. Bed of channel not visible |  |
| L8 | | | NCC at Main Rd crossing | - Channel is 4-5 m wide and 3-4 m high<br>- Side slopes about 1:1 to 1(V):2(H)<br>- Waterholes present<br>- Creek bed is littered with tree branches and root debris<br>- Some trees located along the bank - evidence of bed and some bank erosion - grassed banks with trees<br>- disturbed by road crossing. There is evidence of erosion an the channels is generally degraded. |   |
| L9 | 630,027 | 7,563,477 | NCC at lease boundary to the north of the office | - Channel is 4-5 m wide and 3-4 m high<br>- Steep side slopes<br>- Sandy Creek bed. Littered with tree branches, roots and woody debris. A number of trees/obstructions within the channel<br>- Some trees located along the bank - evidence of bed and some bank erosion - grassed banks and overbanks with medium density of trees<br>- evidence of bed erosion. |   |

*10.5.1.3 Streamflow*

Streamflow records are available from DERM gauging stations. Streamflow for the Isaac River and associated tributaries are highly variable. Most Isaac River streamflow occurs between December and March, with long dry spells interspersed between flow events, as shown in **Figure 10-3** below.

**Figure 10-3 18 Month Sample of Streamflow Record: Isaac River at Deverill**

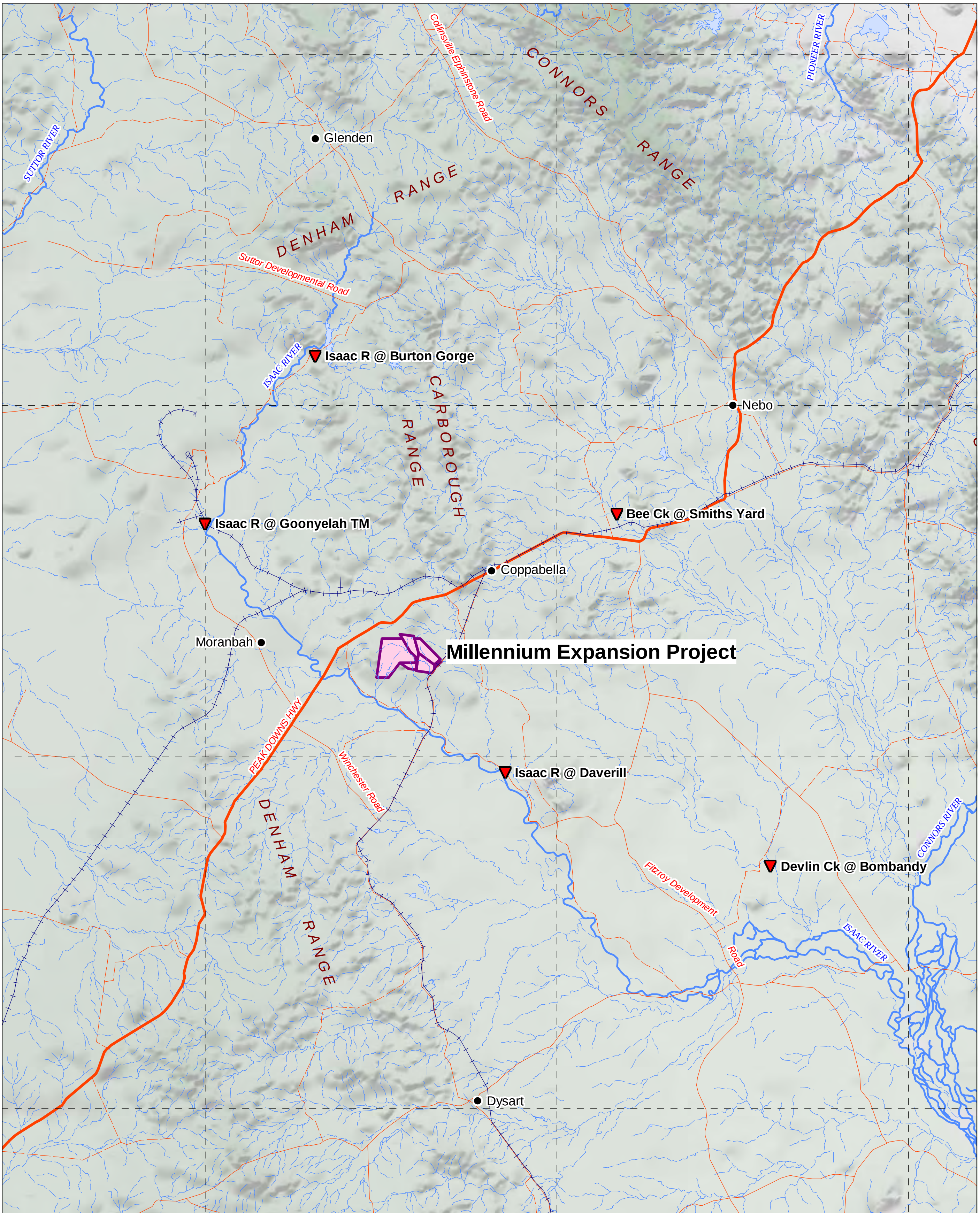



Flow frequency curves produced from all gauging stations in the region (refer **Appendix F3 – Surface Water**) show that all gauged streams in the region are ephemeral. The curves suggest that streams originating in the east of the Isaac River catchment have more persistent flows than those originating in the west (such as New Chum Creek), where streamflow typically occurs less than 30% of the time. The higher flow in the eastern catchments is likely due to higher rainfall.

Flood modelling for New Chum Creek calculated the upstream and downstream peak discharges within the MEP area as 69.4 and 121.3 $m^3/s$ respectively (WRM Water & Environment Pty Ltd, 2010).

*10.5.1.4 Water Quality*

Water quality monitoring results for the area surrounding the MEP are available from a number of DERM-operated gauging stations, in addition to the monitoring that has been undertaken by Peabody at the Millennium Mine, as shown in **Figure 10-4** and detailed in **Table 10-3** below.

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MET SERVE

Peabody

**LEGEND**

- Peabody tenement
- Principal road
- Road (sealed)
- Road (unsealed)
- Railway
- River
- Watercourse
- Town
- DERM streamflow gauge

Data Source:
Tenement - Minserve. Topography - Geoscience Australia.

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**DERM Streamflow Gauges in the vicinity of the MEP**

0 15 30

**Kilometres**

Scale: 1:750,000 (A4)

12/10/2010

Datum: GDA94
Projection: MGA55

FIGURE 10-4

**Table 10-3 Regional Surface Water Quality Monitoring Locations**

| Surface Water Monitoring Site | Location Description | Sampled By | Results Available For |
|---|---|---|---|
| Isaac River: | | | |
| - Deverill | Downstream of North Creek confluence | DERM Gauging Station | 1964–2000 |
| - Goonyella | 70 km upstream of Deverill | DERM Gauging Station | 1982–2002 |
| - Burton Gorge | 40 km upstream of Goonyella | DERM Gauging Station | 1964–1988 |
| Devlin Creek | 52 km south-east of MEP | DERM Gauging Station | 1971-1988 |
| Bee Creek | 24 km north-east of MEP | DERM Gauging Station | 1972-1988 |
| New Chum Creek | Immediately upstream of the MEP | Millennium Mine | 2003-2009 |

A comparison of the parameters that have been measured across all monitoring sites are given in **Table 10-5** over page.

Regional surface water quality results show that, when there is flow in the creeks following rainfall events, the pH is slightly alkaline (7-8) with relatively low salinity recorded as EC levels averaging between 200–500 µS/cm.

The *Queensland Water Quality Guidelines* (DERM, 2009) for upland streams in the Central Coast of Queensland are shown in **Table 10-4** below. The *QWQGs* have generally adopted the *ANZECC Guidelines*, however as noted in **Section 10.4.1.1** above, these are not directly applicable to ephemeral waterways such as those on the MEP. In the absence of any local or ephemeral system guidelines, the *QWQGs* have been adopted for assessing water quality in the Isaac River catchment.

**Table 10-4 Queensland Water Quality Guidelines for Central Coast, Upland Streams**

| Central Region Water Type | pH | | EC | | Turbidity | Dissolved Oxygen | | Total Nitrogen | Total Phosphorus |
|---|---|---|---|---|---|---|---|---|---|
| | Lower | Upper | 90th | 10th | | Lower | Upper | | |
| **Upland streams** | 6.5 | 7.5 | 1,250 | 130 | 25 | 90 | 110 | 225 | 30 |

Source: DERM QWQG (2009).

### *10.5.1.5 New Chum Creek Water Quality*

The New Chum Creek monitoring site referenced in **Table 10-3** above is the upstream monitoring site, before New Chum Creek crosses into the Millennium Mine operations. The Aluminium and Iron levels in New Chum Creek exceed the site's existing EA conditions before they come onto the site, while more extensive results show that Turbidity, Zinc, Copper, Nitrogen and Phosphorous all regularly exceed ANZECC Guideline trigger levels in New Chum Creek upstream of the Millennium Mine (GHD, 2010a).

**Table 10-5 Comparison of Regional Water Monitoring Results**

| Parameter | EA Conditions | | Burton Gorge | | Goonyella | | Deverill | | Devlin Creek | | Bee Creek | | New Chum Creek | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | End of Pipe Limit | Receiving water trigger | Median | 90th Percentile | Median | 90th Percentile | Median | 90th Percentile | Median | 90th Percentile | Median | 90th Percentile | Median | Maximum |
| pH | 6.5-9.0 | 6.5-8.0 | 7.8 | **8.1** | 7.7 | **8.2** | 7.6 | **8.3** | 7.2 | 7.9 | 7.6 | 8.0 | 7.2 | 7.6 |
| EC (µS/cm) | 2,500 | 1,000 | 458 | 756 | 566 | **2,363** | 241 | 585 | 155 | 235 | 245 | 448 | 150 | 250 |
| TSS (mg/L) | 5,000 | - | 230 | **5,416** | 170 | 4137 | 128 | 2,500 | 64 | 249 | 40 | 668 | NS | NS |
| Sulphate (mg/L) | 1,000 | 1,000 | 4 | 18 | 19 | 106 | 10 | 35 | BD | BD | BD | BD | 7.3 | 16 |
| Aluminium (µg/L) | - | 100 | NS | NS | 30 | 60 | BD | BD | NS | NS | NS | NS | **532** | **1500** |
| Iron (µg/L) | - | 300 | BD | BD | 40 | **2,760** | 35 | **735** | BD | BD | BD | BD | **1,880** | **3,800** |

NS = Not sampled BD = Below Detection Limits

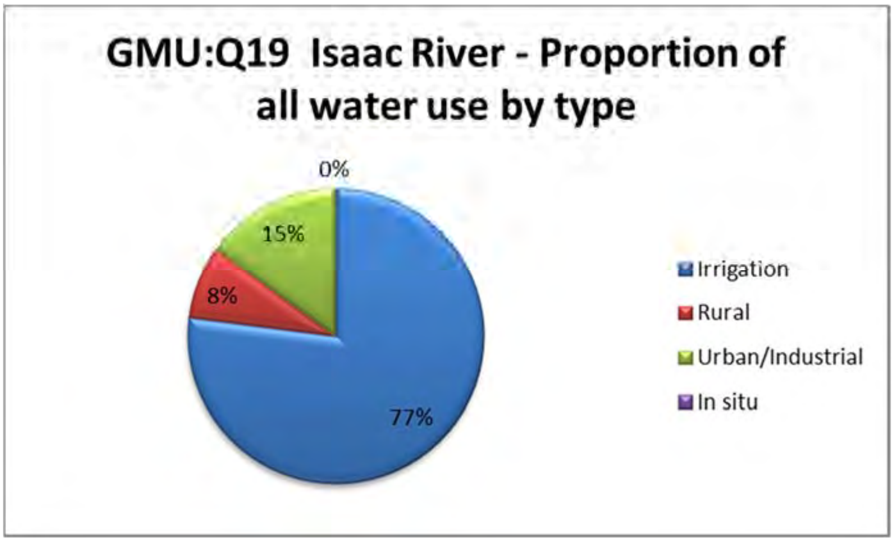
Values represented in **bold** indicates levels exceeding the corresponding ANZECC Guideline

### 10.5.1.6 Existing Land and Water Use

The Fitzroy River Basin covers a catchment area of 142,537 km$^2$ (GBRMP, undated) of which 60% has been cleared and almost 90 % is under agricultural production in the form of grazing (87.5%) or horticulture (1.95%).

Water usage in the Isaac River catchment shows a similar relationship between agricultural and industrial usage, with irrigation for agriculture accounting for over 75% of all water used in the region (including both underground and surface water resources), as shown in **Figure 10-5** below.

**Figure 10-5 Isaac River–Proportion of Water use by Type**




Adapted from: http://www.anra.gov.au/topics/water/allocation/qld/gmu-isaac-river.html

According to the DNRW database for surface water extraction licences, there are two Water Licences within a 10 km radius of the MEP, as shown in **Table 10-6**. Both licences are for the extraction of water from the Isaac River.

**Table 10-6 Existing Surface Water Extraction Licences**

| Lot / DP Details | Purpose |
|---|---|
| Lot 18 SP113322 | Water harvesting |
| Lot 18 SP113322 | Water harvesting |

The predominant land use surrounding the MEP is grazing, which has resulted in the spread of the exotic species, Buffel Grass (*Cenchrus ciliaris*) throughout large areas in the region. Areas of Buffel Grass that are grazed have the potential to increase soil erosion in two ways, firstly through overgrazing if cattle numbers are not managed in response to changing conditions, and secondly through the tussock-forming nature of the Buffel Grass which exposes more soil to erosion impacts. Increased erosion leads to higher levels of suspended solids and agricultural related nutrients into the natural water system.

*10.5.1.7 Existing Millennium Mine Operations*

The existing mine water management system is operated in accordance with the Millennium Coal Mine Water Management Plan (GHD, 2010a) and the Red Mountain Joint Venture (RMJV) Water Management Plan (GHD, 2010b), which were prepared to comply with the conditions of the Environmental Authorities (EAs) MIN100344305 and MIN100846708 respectively.

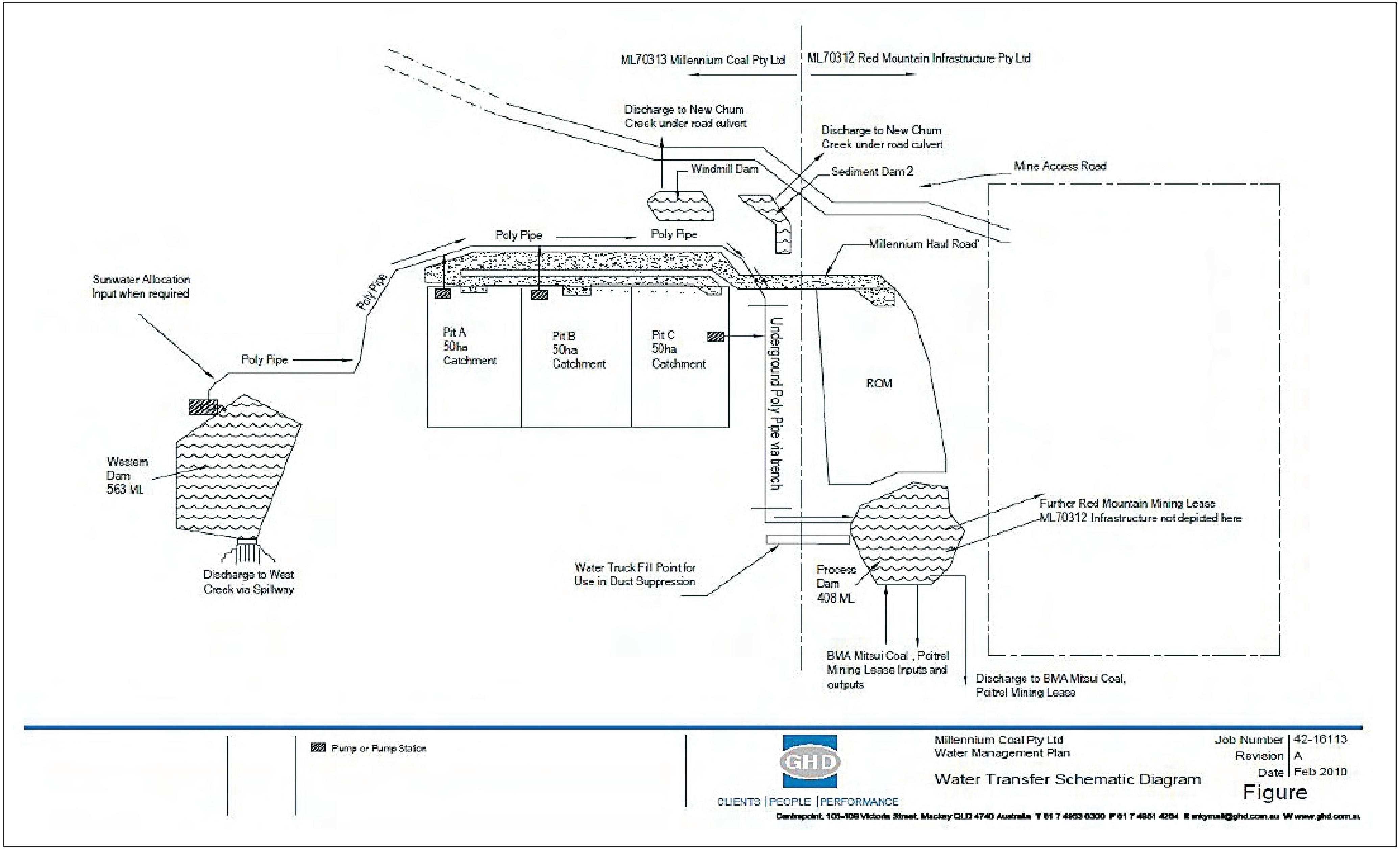
The key existing water storages at Millennium Mine are shown in **Figure 10-6**.

### Water Quality in Existing Site Water Management System

Water at the Millennium Mine is monitored on a regular basis, as required in the existing Environmental Authority. Water that is collected and stored on the mine site falls into one of five storage categories or locations, with a range of pH and EC values as shown below in **Table 10-7**.

**Table 10-7 Range of pH and EC Results for Millennium Mine Water Storages**

| Millennium Mine Stored Water | EC | | pH | | General Comments |
|---|---|---|---|---|---|
| | Average | Maximum | Average | Maximum | |
| Pit Water | 4,500 | >10,000 | 8.3 | >9 | Groundwater inflow into pits is approximately 1 L/s. Natural groundwater EC levels can exceed 14000 µS/cm. Nearby monitoring of groundwater shows some elevated levels of EC, Copper, Chromium, Manganese and Zinc. |
| Process Water | 2,500 | >5,000 | 8 | 9.1 | Monitoring has detected some elevated levels of Aluminium, Arsenic, Copper, Iron and Nickel. |
| Environmental Dam | 1,185 | >5,000 | 8.1 | 9.2 | Monitoring has detected some elevated levels of Aluminium, Copper, Chromium, Iron and Nickel. |
| Western Dam | 1,872 | 13,630 | 8.1 | 8.7 | Western Dam was temporarily used to store Coal Seam Gas water by an external operator. This process water was utilised by Millennium Mine for process water makeup. The Western Dam now collects relatively clean runoff. |
| Sediment Dams | 2,400 | >6,000 | 7.6 | 9.4 | Water volume in site sediment dams varies significantly in response to rainfall and is highly influenced by rainfall dilution and evaporation. |

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**Existing Water Storages at Millennium Coal Mine - Figure 10-6**

Water quality on the site generally shows stored water is alkaline (pH 8–9) and slightly to moderately saline (EC 1,500–5,000 µS/cm²), with higher salinity in the collected pit water due to naturally high groundwater EC levels and interaction with the overlying strata. The significantly elevated EC levels recorded early in the EEP in the Western Dam were due to the use of Coal Seam Gas water as the mine's sole water supply for the CHPP. CSG water is no longer used on-site or stored in the Western Dam and EC values have assumed a range similar to that of the Environmental Dam.

*10.5.1.8 Flood Modelling for Existing Environment*

A flood study was undertaken to estimate existing design flood levels and the flood extent along New Chum Creek.

**Methodology**

The RAFTS runoff-routing model (RAFTS, 2002) was used to estimate design flood discharges throughout the New Chum Creek catchment based on design rainfall intensity-frequency-duration data from the Institution of Engineers (IE Aust, 1998). The model parameters were chosen to match the peak 100 year ARI discharges at the upstream and downstream extents of the mine workings, as shown in **Table 10-8** below.

**Table 10-8 Model Parameters for New Chum Creek Flood Modelling**

| Location | Catchment Area (km²) | Channel Length (km) | Slope (%) | Time of Concentration, (mins) | 100 yr ARI Rainfall Intensity (mm/hr) | 50 yr ARI Runoff Coefficient | 100 yr ARI Peak Discharge (m³/s) |
|---|---|---|---|---|---|---|---|
| MEP Upstream Boundary | 10.5 | 6.5 | 0.56 | 210 | 37.3 | 0.6 | 69.4 |
| MEP Downstream Boundary | 29.9 | 14.0 | 0.39 | 435 | 23.0 | 0.6 | 121.3 |

Design rainfall intensities were derived in accordance with Institution of Engineers (1998), and probable maximum precipitation (PMP) design rainfall depths were estimated using the Generalised Short-Duration Method (GSDM) for durations up to 6 hours (BoM, 2003).

The HEC-RAS model (USACE, 2009), was used to estimate the 100 year ARI and PMF design flood levels along New Chum Creek around the existing and proposed mine lease area.

Full details of the methodology and results of the flood study are provided in **Appendix F3–Surface Water.**

**Existing Flooding characteristics**

Historic records of flood events for the Isaac River both upstream at Goonyella Gauging Station (refer to **Figure 10-7**) and downstream at Deverill Gauging Station (refer to **Figure 10-8**), of the MEP site show that flow timing and extent are extremely variable, although generally occurring during the wetter, summer months. Despite there being some extremely high flow (flood) events that occur once or twice a decade, there are also long periods of no or very low flow events.

**Figure 10-7 Historic Flood Events-Isaac River at Goonyella Gauging Station**

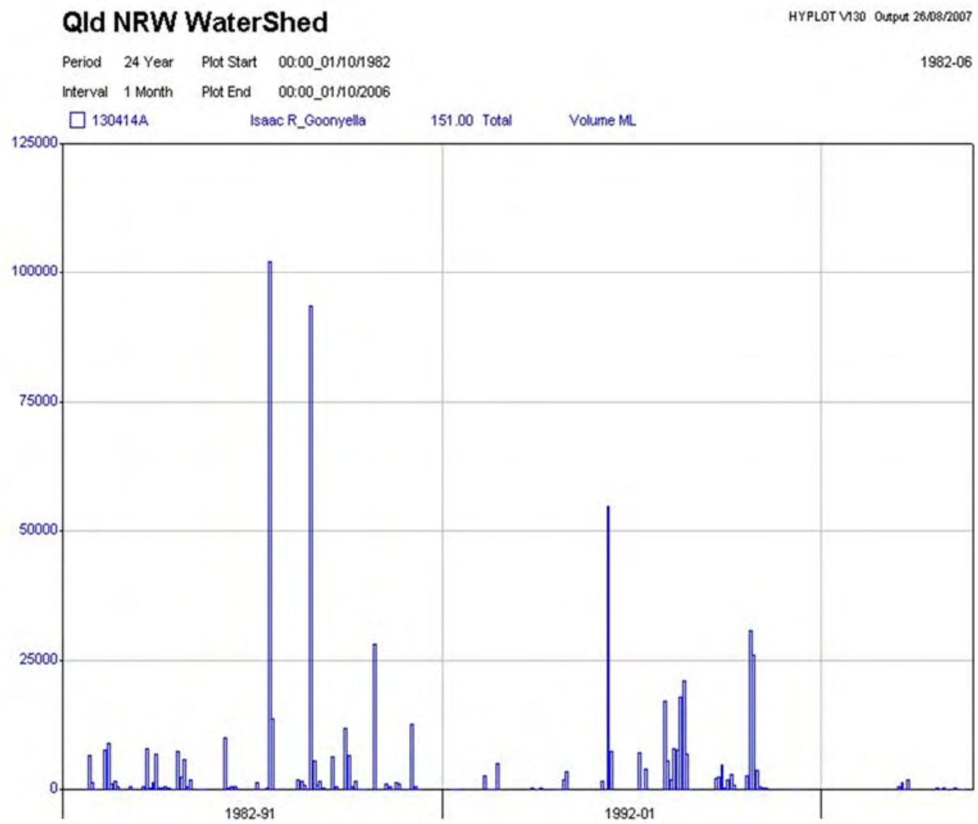
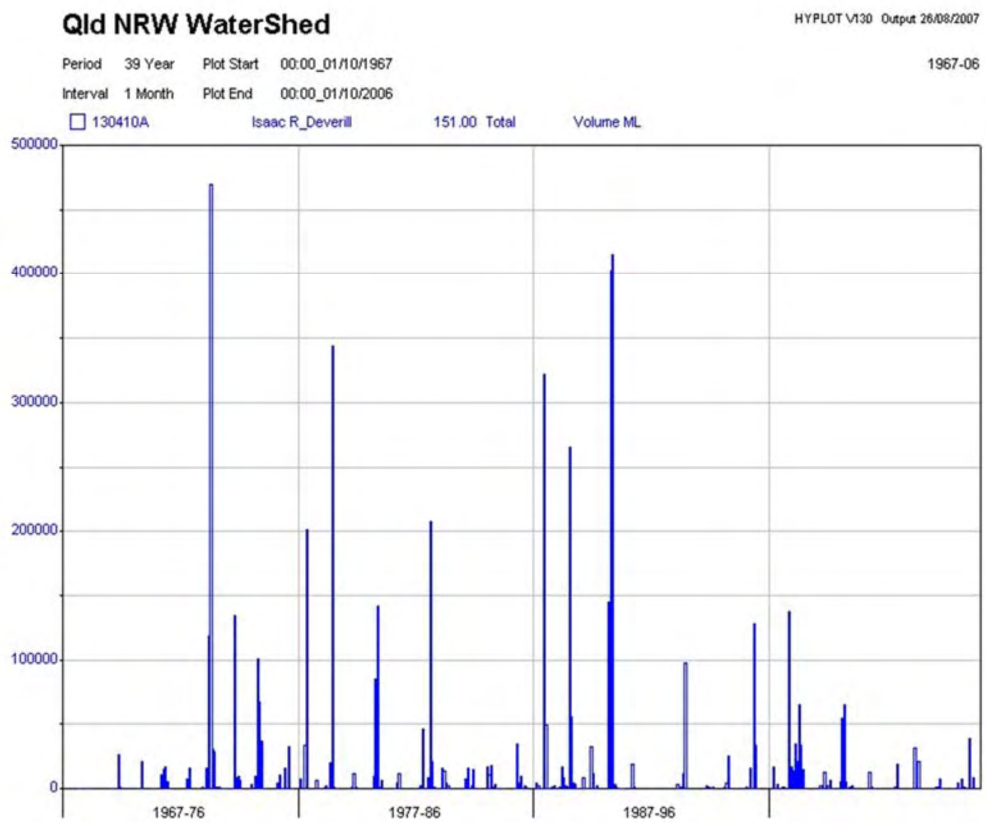
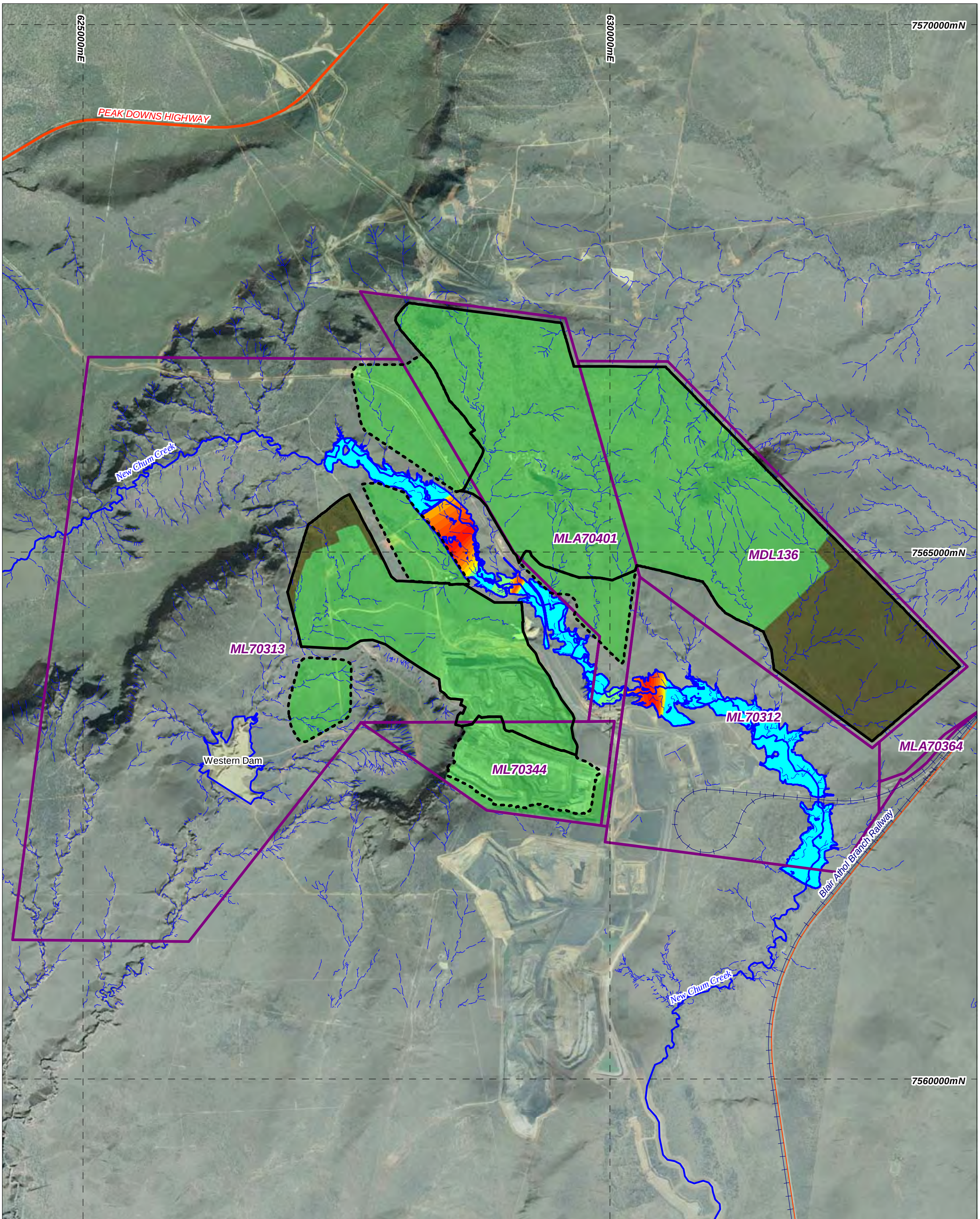



**Figure 10-8 Historic Flood Events-Isaac River at Deverill Gauging Station**



As shown in **Figure 10-9**, flood modelling undertaken by WRM Water & Environment Pty Ltd (2010), confirms that the existing Millennium Mine operations are outside the 100 year ARI flood extent from New Chum Creek.

Since the commencement of Millennium Mine operations in 2005, there have been a number of recorded high flow (flood) events, the most extreme being the January 2008 flood. The BoM report, Central and Western Queensland Floods–January 2008, estimates the 72 hr ARI rainfall intensity that was experienced through Central Queensland was approximately a 1:2,000 year event. Even during this extreme flood, Millennium Mine water storage infrastructure maintained integrity and operations commenced in a relatively short time frame once flood waters retreated.




**LEGEND**

- Peabody tenement
- Principal road
- Road (unsealed)
- Railway
- Watercourse
- 2027 pit footprint
- 2027 dump footprint
- Final void
- Completed rehabilitation

**INCREASE IN Q100 WATER LEVEL (m)**

- -0.01m < dWL < 0.01m
- 0.01m < dWL < 0.10m
- 0.10m < dWL < 0.25m
- 0.25m < dWL < 0.50m

Data Source: Topography - Geoscience Australia. Tenement - Minserve.
Surfacewater - WRM Water & Environment.

MET SERVE

Peabody

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## Peabody Energy Australia Pty Ltd

# Millennium Expansion Project

**100 Year ARI Flood Extent from New Chum Creek**

0 1 2

**Kilometres**

Scale: 1:50,000 (A4)

26/10/2010

Datum: GDA94
Projection: MGA55

FIGURE 10-9

## 10.5.2 Groundwater

### *10.5.2.1 Geology*

The MEP is located in the Bowen Basin on the western margins of the Taroom Trough within a heavily faulted and folded Permian sub-crop. The MEP geology typically comprises of Triassic sediments uncomfortably overlying Permian coal measures (Department of Mines and Energy, 2006). The target resource is contained within the Rangal Coal Measures, approximately 70 m thick. The Leichhardt, Millennium and the Vermont seams, occurring within the Rangal Coal Measures, are targeted for mining. The coal seams are interbedded with fine-grained and low-permeability sediments (e.g. siltstones, shales and mudstones) and sandstones. The average seam thickness is 3.6 m with the interburden thickness ranging between 18-36 m.

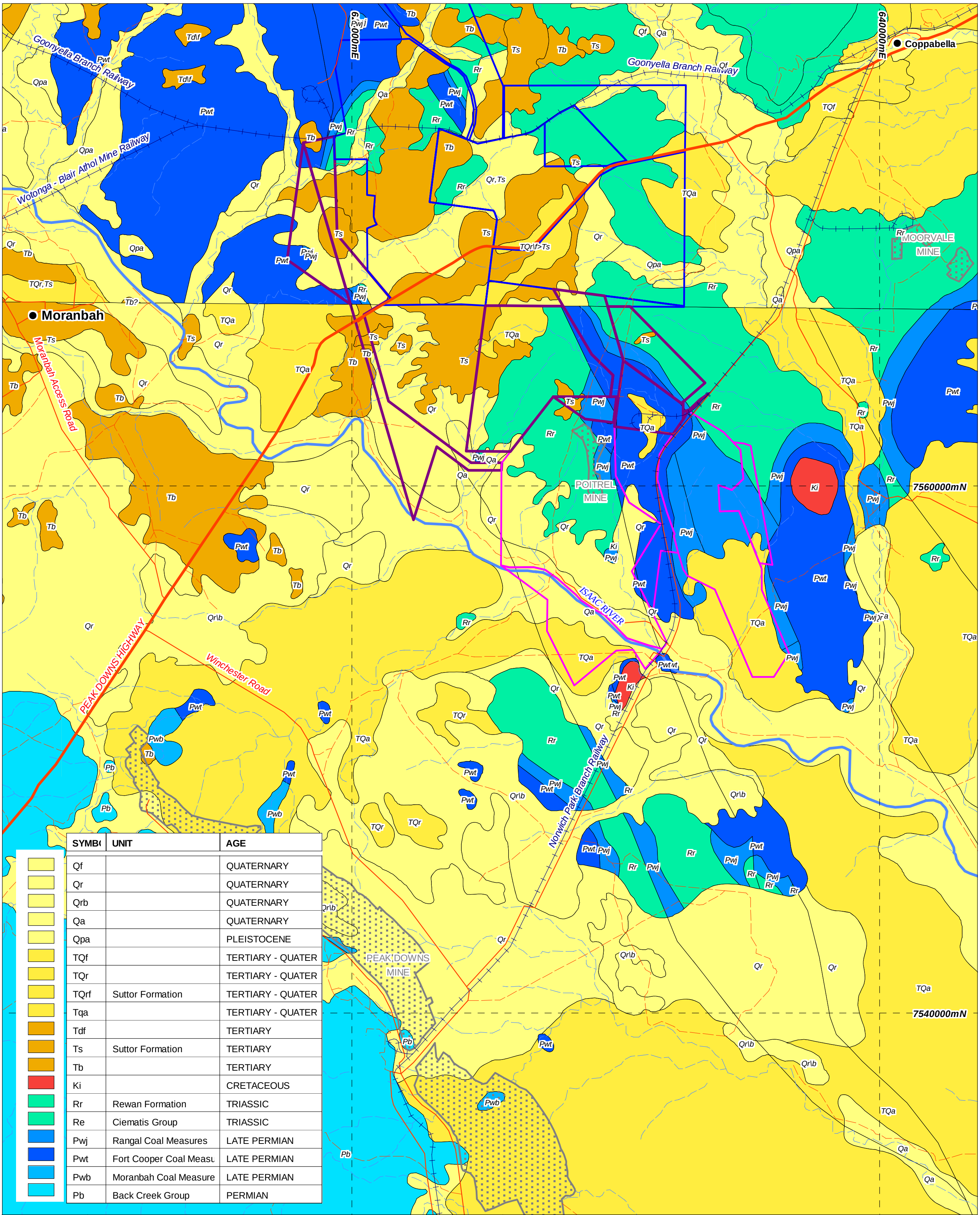
The Rangal Coal Measures are underlain by the Permian Fort Cooper Coal Measures and is overlain by the Triassic Rewan Group. A series of northwest aligned faults displaying throws of up to 80 m disjoint the assemblage, with the Fort Cooper and Rangal Coal Measures outcropping in the centre of the MEP area.

The majority of the MEP area is covered with a veneer of Triassic Rewan sediments. In the south towards BMC’s operation, Quaternary aged alluvium associated with the Isaac River overlies the Triassic - Permian sequence. Tertiary sediments are known to occur in isolation east and west of the MEP, forming topographic features.

**Table 10-9** describes a generalised stratigraphic section of the MEP area including a brief lithologic description of each unit. **Figure 10-10** illustrates the regional geology. A detailed account of the geology and geochemistry of the MEP area is presented in **Chapter 7-Land**.

**Table 10-9 Summary of Stratigraphic Sequence**

| Age | Unit | Lithology | Thickness (m) |
|---|---|---|---|
| Quaternary | Recent Alluvial | Clay, silt, sand and gravel | 0–20 |
| Tertiary | Suttor Formation | Sandstone, mudstone, conglomerate and minor basalt | 0–50 |
| | Duaringa Formation | Mudstone, sandstone, conglomerate, siltstone, oil shale, lignite and basalt | 0–50 |
| Triassic | Rewan Group | Sandstone, mudstone and minor conglomerate (at base) | 5–70 |
| Permian | Rangal Coal Measures | Sandstone, siltstone, mudstone, and coal including:<br>• Leichhardt seam (4–10 m);<br>• Millennium seam (1 m); and<br>• Vermont seam (4-10 m). | 20–70 |
| | Fort Cooper Coal Measures | Sandstone, conglomerate, mudstone, tuff and coal | 30–60 |




| SYMB( | UNIT | AGE |
|---|---|---|
| Qf | | QUATERNARY |
| Qr | | QUATERNARY |
| Qrb | | QUATERNARY |
| Qa | | QUATERNARY |
| Qpa | | PLEISTOCENE |
| TQf | | TERTIARY - QUATER |
| TQr | | TERTIARY - QUATER |
| TQrf | Suttor Formation | TERTIARY - QUATER |
| Tqa | | TERTIARY - QUATER |
| Tdf | | TERTIARY |
| Ts | Suttor Formation | TERTIARY |
| Tb | | TERTIARY |
| Ki | | CRETACEOUS |
| Rr | Rewan Formation | TRIASSIC |
| Re | Ciematis Group | TRIASSIC |
| Pwj | Rangal Coal Measures | LATE PERMIAN |
| Pwt | Fort Cooper Coal Measu | LATE PERMIAN |
| Pwb | Moranbah Coal Measure | LATE PERMIAN |
| Pb | Back Creek Group | PERMIAN |

**LEGEND**

- Principal road
- Road (sealed)
- Road (unsealed)
- Railway
- River
- Watercourse
- Town
- Peabody tenement
- BMA tenement
- Vale tenement
- Existing mine

MET SERVE

Peabody

Data Source:
Geology (100k) - EEDI. Peabody tenement - Minserve. Other tenement - EEDI.
Topography (250k) - Geoscience Australia.

**Peabody Energy Australia Pty Ltd**

# Millennium Expansion Project

**Regional Surface Geology**

0 4 8
**Kilometres**
Scale: 1:200,000 (A4)

13/10/2010

Datum: GDA94
Projection: MGA55

FIGURE 10-10

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*10.5.2.2 Existing Groundwater Monitoring Network*

The Millennium Mine does not hold any water licences, which in accordance with the provisions of the *Water Act 2000*, will require groundwater monitoring. Millennium's Environmental Authority (EA) MIN100344305 has recently been revised and stipulates that the holder must develop and implement a groundwater monitoring program which must be able to detect significant changes to groundwater levels and quality. The installation of Millennium Mine's groundwater monitoring program has been timed to coincide with the outcome of the MEP approval decision which will determine the required number and locations of groundwater monitoring bores for both operations.

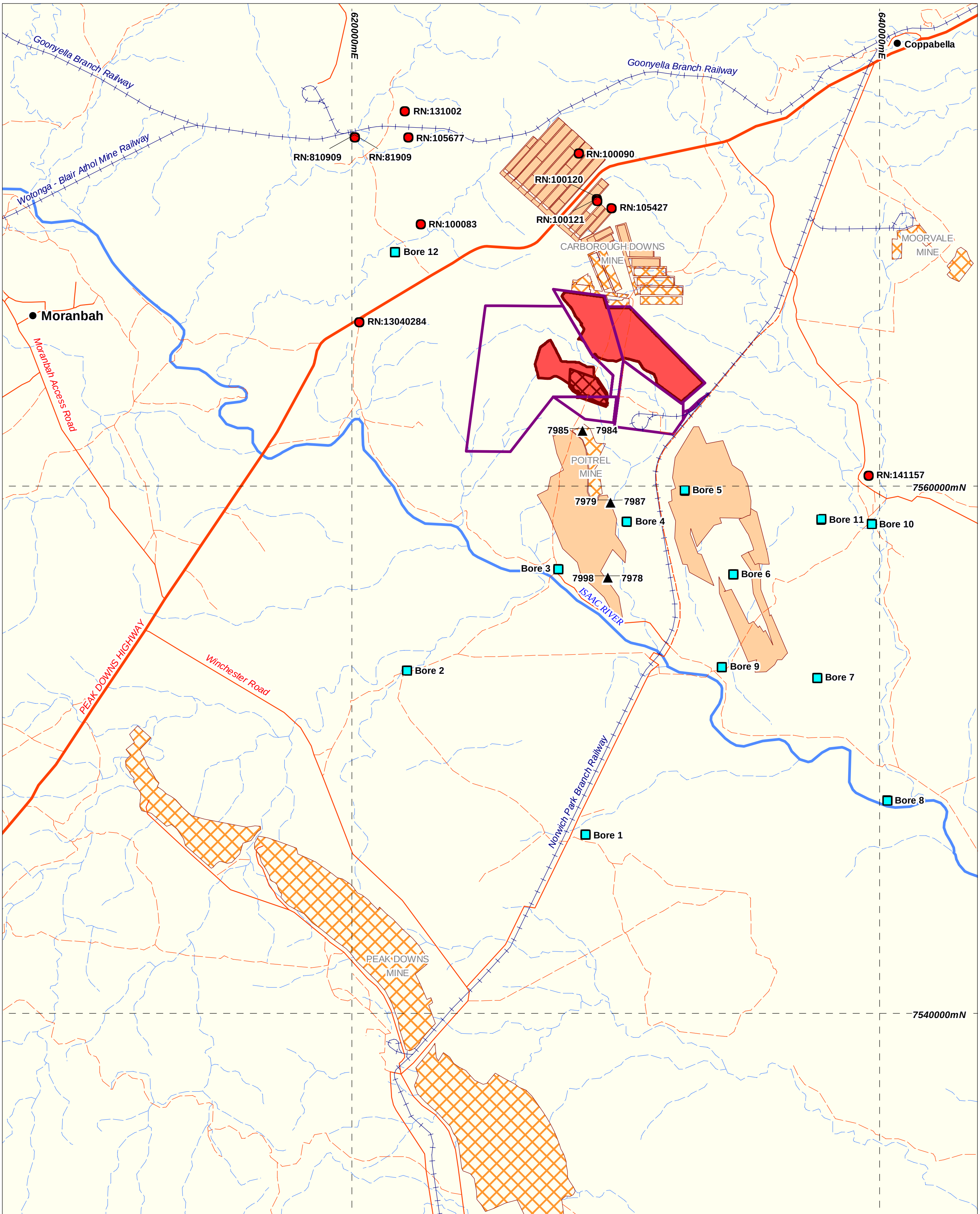
Approximately five kilometres south of the MEP, six monitoring bores surrounding BMC's Poitrel Mine are installed within the Rangal Coal Measures. Bore details are provided in **Table 10-10**, the location of these bores is shown in **Figure 10-11**.

**Table 10-10 Groundwater Levels within Surrounding Permian Registered, Landholder and Monitoring Bores**

| Bore ID | Groundwater Level (m) | Monitoring Date |
|---|---|---|
| 13040284 | 233.73 | 21/11/2007 |
| 141157 | 185.00 | 27/04/2007 |
| Bore 1 | 190.30 | 2004 |
| Bore 2 | 195.00 | 2004 |
| Bore 4 | 190.00 | 2004 |
| Bore 5 | 184.00 | 2004 |
| Bore 8 | 174.00 | 2004 |
| Bore 10 | 187.00 | 2004 |
| Bore 12 | 237.50 | 2004 |
| 7987 | 186.26 | 20/07/2004 |
| 7979 | 186.13 | 20/07/2004 |
| 7978 | 182.02 | 21/07/2004 |
| 7998 | 182.00 | 22/07/2004 |

*10.5.2.3 Groundwater Occurrence*

The published EIS for nearby Daunia mine (BMA, 2008) along with data from the recent MEP exploration drilling program and nearby landholder bores identified in the DERM database suggests that four different hydrogeological systems occur in the region; the Quaternary, Tertiary, Triassic and Permian aquifers. Lithological data collected during the MEP exploration drilling suggests that the Tertiary and Triassic aquifers are geological isolated and hydraulically disconnected, and are unlikely to be affected by proposed mining at the MEP. For the purpose of this investigation only aquifers proximal to the MEP were considered. A description of the Quaternary alluvial and Permian Rangal Coal Measures aquifers is provided below.




## LEGEND

- Principal road
- Road (sealed)
- Road (unsealed)
- Railway
- River
- Watercourse
- Town
- Peabody tenement
- Existing Millennium Mine
- Proposed MEP
- Other existing mine
- Other proposed mine
- DERM registered bore
- Landholder unregistered bore
- Poitrel Mine monitoring bore

MET SERVE

Peabody

Data Source:
Peabody tenement - Minserve. Other tenement - EEDI.
Topography (250k) - Geoscience Australia.

# Peabody Energy Australia Pty Ltd
# Millennium Expansion Project

## Surrounding Groundwater User and Monitoring Bore Locations

0 4 8
Kilometres
Scale: 1:200,000 (A4)

13/10/2010

Datum: GDA94
Projection: MGA55

FIGURE 10-11

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### Quaternary Alluvial Aquifer

The Quaternary alluvium aquifer unit consists of clay, silt, sand and gravel and occurs to the south of the MEP in association with the Isaac River. The unit is generally less than 20 m in thickness.

There is limited information on this aquifer, although it is likely that this unit represents an unconfined, perched aquifer system separated from the underlying Rangal Coal Measures by low permeable Rewan sediments. The aquifer may, however, be hydraulically connected to the underlying Permian aquifer where the Isaac River is incised into the Rangal Coal Measures and may contribute to net recharge of the Permian aquifer downstream of MEP.

Recharge to the alluvial aquifer will occur in areas of thin soil cover or along creek beds where surface water can readily permeate into the aquifer during and following rainfall events.

Available bore yield data sampled from this unit suggest flows are variable and can range as high as 4 L/sec. However prolonged groundwater extraction from this aquifer at high rates, while possible for a short duration, is not envisaged to be sustainable. Groundwater salinity is marginal to brackish, ranging from 1,500-3,000 mg/L total dissolved solids (TDS) (SKM, 2005).

### Permian Rangal Coal Measures Aquifer

The Permian Rangal Coal Measures unit consists of interbedded siltstone, sandstone, mudstone and coal. The unit occurs across the majority of the MEP as a regular sedimentary sequence, on the eastern and western blocks of a faulted anticline assemblage. In general, the formation does not yield significant volumes of groundwater. The Rangal Coal Measures aquifer unit can be classified as fractured porous media with water stored and transmitted via both primary and secondary porosity. Groundwater flows through pore spaces of interburden sandstone, cleated coal and fractured sandstone. Higher yields (1-4 L/s) are intersected within coal seams while lower yields (0.1-1 L/s) are recorded within fractured sandstone.

Background groundwater levels reveal that levels within the coal seams and the interburden sandstone units become more similar at proximal locations. This suggests that there may be a degree of interaction between the various water bearing units throughout the aquifer.

There is no specific information on the range of hydraulic properties of the aquifer proximal to the MEP and therefore parameter values have been determined from pumping tests undertaken on similar units in the region and standard textbook values.

The quality of the groundwater is poor to fair and generally suitable only for stock purposes. The groundwater salinity associated with these deposits is anticipated to range in between 1,000-10,000 mg/L TDS (SKM, 2005). The regional groundwater flow within the Rangal Coal Measures aquifer is to the south southeast.

Recharge to the Rangal Coal Measures predominantly occurs via direct rainwater infiltration in areas where the formation outcrops or sub crops. Recharge may also occur from the alluvial aquifer to the south of the MEP, where the Isaac River is incised into the Rangal Coal Measures.

*10.5.2.4 Groundwater Use*

The MEP area is located within the Highlands Declared Subartesian Area and under the *Water Act 2000* bores drilled in the area must be approved. DERM maintain a database of all registered groundwater bores in Queensland. A search of the groundwater database indicates that there are 36 registered bores within a 10 km radius of the MEP that could potentially be impacted.

A review of available construction details reveals that 26 of the registered bores were drilled for coal and gas exploration purposes and not groundwater extraction or monitoring. Exploration holes are drilled to different standards from groundwater extraction or monitoring bores and may have been incorrectly entered into the groundwater database because they were drilled by drillers without water boring licences, which has been a requirement since the *Water Act 2000*. To ensure accuracy, these holes have been excluded from background data compiled for this investigation. Hydrogeologic details for the 10 remaining registered bores is summarised in **Table 10-11**.

It is not unusual to find additional landholder bores that are not on the DERM register and to identify these bores a census is undertaken. The bore census completed as part of the Poitrel EIS (SKM, 2005) identified 12 bores within the vicinity of BMC's operations and Millennium Mine (including the MEP). The construction detail available for these bores is limited, with screened lithologies based on anecdotal evidence and geological interpretations. Bore details collected as a part of the census, along with data from the DERM database search and EC where available, are provided in **Table 10-11** and their locations are shown in **Figure 10-11.**

Compiled data suggests that groundwater usage surrounding the MEP is minimal to non-existent. Surrounding landholders source water for domestic consumption from rainfall, while stock water is predominantly supplied from surface water (i.e. dams) and in small volumes from the Quaternary alluvial and Rangal Coal Measures aquifers.

Millennium Mine and other surrounding operations currently only extract groundwater as it discharges into the open-cut pits or underground panels as a by-product of mining. This groundwater ingress creates operational problems for the mines and often requires expensive management procedures. No water licence is required for this purpose in Queensland.

**Impacts of Current Pumping**

The rate at which groundwater can be extracted from a bore is dependent upon the extraction capacity of the pump, bore construction and the hydraulic properties of the aquifer. This also determines the rate groundwater moves into the bore column. Similarly, the impact that extracting groundwater from a bore has on the surrounding groundwater resource is related to the quantity of water removed, and the aquifer parameters that govern its ability to store and transmit water.

It is likely that the majority of landholder bores are equipped with submersible pumps and set to extract groundwater rates of less than 5 L/s for a few hours each day. On the basis of the dispersed location of the bores and the low extraction rates, the impact to the regional groundwater resource by current landholder pumping is likely to be negligible, in both the Quaternary alluvium and Permian Rangal Coal Measures aquifer.

At low rates and frequency of pumping, drawdown (reduced water levels) within the aquifer is likely to be limited to the immediate vicinity of the landholder bore, and will typically vary from minimal up to 10 m depending upon the characteristics of the aquifer immediately surrounding the bore.

**Table 10-11 Surrounding Registered, Landholder and Monitoring Bore Details**

| RN | Date Drilled | mE (GDA94) | mN (GDA94) | Total Depth (m) | Screened Aquifer | Yield (L/s) | EC (µS/cm) |
|---|---|---|---|---|---|---|---|
| **DERM Registered Bores** | | | | | | | |
| 81909 | 17/12/1994 | 620090 | 7573318 | 60 | Rewan Formation | 5.3 | 5,670 |
| 100083 | 25/9/1992 | 622605 | 7570006 | - | Unknown | - | - |
| 100090 | 16/10/1992 | 628593 | 7572696 | - | Unknown | - | - |
| 100120 | 11/8/1993 | 629268 | 7570968 | - | Unknown | - | - |
| 100121 | 10/6/1994 | 629296 | 7570906 | - | Unknown | - | - |
| 105427 | 22/4/2004 | 629841 | 7570637 | 100 | Rewan Formation | 3.8 | - |
| 13040284 | 2/9/2004 | 620264 | 7566309 | 19 | Rangal Coal Measures | 3.6 | 14,310 |
| 105677 | 13/6/2005 | 622136 | 7573306 | 67.7 | Tertiary Basalt | 7.3 | 1,055 |
| 131002 | 18/11/2005 | 621997 | 7574302 | 63 | Tertiary Basalt | 6 | 1,022 |
| 141157 | 27/4/2007 | 639587 | 7560479 | 66 | Rangal Coal Measures | 1.3 | - |
| **Unregistered Landholder Bores** | | | | | | | |
| Bore 1 | Unknown | 628740 | 7546688 | - | Rangal Coal Measures | - | - |
| Bore 2 | Unknown | 621970 | 7552907 | - | Rangal Coal Measures | 0.3 | - |
| Bore 3 | Unknown | 627714 | 7556752 | - | Quaternary Alluvium | - | - |
| Bore 4 | Unknown | 630297 | 7558574 | - | Rangal Coal Measures | - | - |
| Bore 5 | Unknown | 632495 | 7559750 | - | Rangal Coal Measures | - | - |
| Bore 6 | Unknown | 634350 | 7556563 | - | Rangal Coal Measures | - | - |
| Bore 7 | Unknown | 637519 | 7552624 | - | Rangal Coal Measures | - | - |
| Bore 8 | Unknown | 640189 | 7547989 | - | Quaternary Alluvium | - | - |
| Bore 9 | Unknown | 633898 | 7553055 | - | Quaternary Alluvium | 2-4 | - |
| Bore 10 | Unknown | 639594 | 7558477 | - | Rangal Coal Measures | 2 | - |
| Bore 11 | Unknown | 637684 | 7558650 | - | Fort Cooper Coal Measures | - | - |
| Bore 12 | Unknown | 621511 | 7568791 | - | Rangal Coal Measures | - | - |
| **Poitrel Mine Monitoring Bores** | | | | | | | |
| 7984 | 2004 | 628626 | 7562006 | - | Rangal Coal Measures | - | - |
| 7985 | 2004 | 628626 | 7562006 | - | Rangal Coal Measures | - | - |

| RN | Date Drilled | mE (GDA94) | mN (GDA94) | Total Depth (m) | Screened Aquifer | Yield (L/s) | EC (µS/cm) |
|---|---|---|---|---|---|---|---|
| 7987 | 2004 | 629690 | 7559289 | - | Rangal Coal Measures | - | - |
| 7979 | 2004 | 629689 | 7559294 | - | Rangal Coal Measures | - | - |
| 7978 | 2004 | 629578 | 7556426 | - | Rangal Coal Measures | - | - |
| 7998 | 2004 | 629578 | 7556426 | - | Rangal Coal Measures | - | - |

- = No information

*10.5.2.5 Groundwater Quality*

An assessment was made of the MEP's groundwater quality in terms of the relevant ANZECC Guidelines criteria and the environmental values identified in the *Environmental Protection (Water) Policy 1997* below:

- aquatic ecosystems;
- suitability for recreational use;
- suitability for minimal treatment before supplying as drinking water;
- suitability for agricultural use; and
- suitability for industrial use.

There is limited verified groundwater quality data for the MEP, therefore to characterise the MEP groundwater quality, data was compiled from exploration drilling, DERM registered bore database and available data from surrounding mining operation's groundwater monitoring.

Rangal Coal Measures groundwater quality data, from field measurements taken during the MEP exploration drilling and measurements recorded within DERM registered bore database, are presented in **Table 10-12**.

Groundwater sample results from the neighbouring BMC Poitrel Mine's Rangal Coal Measures aquifer monitoring bores collected in July 2004 are shown and compared to the *ANZECC Guidelines* (ANZECC & ARMCANZ, 2000) and *Australian Drinking Water Guidelines* (NHMRC, 2004) in **Table 10-13**.

**Table 10-12 Rangal Coal Measures Aquifer Electrical Conductivity and pH On-site**

| Bore ID | Electrical Conductivity | pH |
|---|---|---|
| 13040284 | 14,310 | 8.10 |
| R112 | 12,370 | 6.55 |
| M018 | 14,200 | 12.72 |
| R588 | 6,861 | 7.53 |
| R596 | 17,830 | 7.30 |
| R612 | 2,074 | 7.87 |
| **Median** | **14,200** | **7.70** |

## Table 10-13 Rangal Coal Measures Aquifer Groundwater Quality Compared with Adopted Guidelines

| Parameter | Units | ANZECC Guidelines (1) | | | Drinking Water Guidelines (2,4) | Bore | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Aquatic ecosystem (3) | Irrigation | Stock Water | | 7987 | 7979 | 7978 | 7998 |
| Alkalinity | mg/L | N/a | N/a | N/a | N/a | 746 | 758 | 860 | 769 |
| TDS | mg/L | 150 | Highly dependent on crop type and soils | 4,000 (beef), 2,500 (dairy), **5,000** (sheep), 4,000 horses), 4,000 (pigs), 2,000 (poultry) | 500 | **8,190** | **8,000** | 4,880 | 4,360 |
| pH | - | N/a | N/a | N/a | **6.5 to 8.5** | 6.5 | 6.5 | 6.7 | 6.6 |
| Sulphate | mg/L | N/a | N/a | **1,000** | 250 | 174 | 201 | 89 | 122 |
| Sulphide | mg/L | N/a | N/a | N/a | N/a | <0.1 | <0.1 | <0.1 | <0.1 |
| Chloride | mg/L | N/a | >**700** (tolerant crops) | N/a | 250 | **4,020** | **3,880** | **1,730** | **1,700** |
| Calcium | mg/L | N/a | N/a | **1,000** | N/a | 237 | 208 | 116 | 128 |
| Magnesium | mg/L | N/a | N/a | **2,000** | N/a | 433 | 377 | 169 | 163 |
| Sodium | mg/L | N/a | >460 (tolerant crops) | N/a | **180** | 1,610 | 1,690 | 1,090 | 908 |
| Iron | mg/L | ID | **0.2** | Not sufficiently toxic | **0.3** | **1.35** | 0.05 | 0.02 | **1.47** |
| Arsenic | mg/L | 0.001 (As 3), 0.0008 (As 5) | 0.1 | **0.5 to 5** | 0.007 | 0.004 | 0.005 | 0.001 | <0.001 |
| Cadmium | mg/L | 0.00006 | 0.01 | **0.01** | 0.002 | 0.0002 | <0.0001 | <0.0001 | 0.0001 |
| Chromium | mg/L | 0.00001 (Cr5) | 0.1 | **1** | 0.05 | 0.006 | 0.006 | <0.001 | 0.002 |
| Copper | mg/L | 0.001 | 0.2 | **0.4 to 5** | 1 | 0.007 | 0.016 | <0.001 | 0.003 |
| Lead | mg/L | 0.001 | 2 | **0.1** | 0.01 | 0.003 | 0.003 | 0.002 | <0.001 |
| Zinc | mg/L | 0.0024 | **2** | **20** | 3 | 0.013 | 0.035 | 0.007 | 0.007 |
| Mercury | mg/L | 0.00006 | 0.002 | **0.002** | 0.001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Manganese | mg/L | 1.2 | **0.2** | Not sufficiently toxic | 0.1 | **0.901** | **0.821** | 0.163 | **0.468** |

Notes: (1) ANZECC & ARMCANZ (2000). (2) NHMRC (2004). (3) The aquatic ecosystem guideline represents 99 percent species level of protection.
(4) Both Health and Aesthetic guidelines are provided for drinking water. The value adopted was the lower of the two. ID = Insufficient data.
Values represented in **bold** indicates levels exceeding the corresponding ANZECC Guideline.

### Permian Rangal Coal Measures Aquifer

The monitoring data indicates that groundwater in the Rangal Coal Measures aquifer on-site is typically neutral to slightly alkaline with a median pH of 7.70. EC ranges between 2,074-14,310 µS/cm. This observed wide range of EC levels is likely due to the distribution of sample location across the Permian unit. Groundwater bores proximal to recharge areas will exhibit fresher characteristics while bores screened at a greater depth will show high salinity owing to reduced permeability.

Comparatively low readings for EC observed in bores R588 and R612 (2,074-6,861 µS/cm) could be explained by the location of the recharge zone where the unit sub-crops, suggesting that the water is replenished by rainfall recharge near the Millennium pit sub-crop. With an average and median EC of 10,667 and 14,200 µS/cm respectively, the Rangal Coal Measures aquifer groundwater can be classified as saline.

### Quaternary Alluvial Aquifer

Minimal data is available on groundwater quality of the alluvial aquifer along the Isaac River. Anecdotal evidence suggests that the alluvial groundwater is brackish to saline, an assessment supported by the DERM registered bore database that indicates there are few landholder bores that draw water from the alluvium surrounding the MEP. This is consistent with other rivers in the Bowen Basin, with the river alluvial systems containing little groundwater except for a few metres at the base of the alluvium that is generally brackish to saline.

*10.5.2.6 Groundwater Values*

### Groundwater Dependent Ecosystems

Groundwater Dependent Ecosystems (GDEs) are managed by the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) to ensure, whenever practical, that ecological processes of dependent ecosystems are maintained or restored.

The groundwater table in the Rangal Coal measures aquifer is >20 m below ground level at the units recharge zones. Brigalow vegetation has a reported rooting depth of 5-6 m, (above the groundwater table). There are also no springs or permanent water bodies connected to the Rangal coal measures aquifer around which groundwater dependent ecosystems may develop. Quaternary alluvial aquifer systems are of a sufficient distance away from the MEP such that mining induced impacts will not affect the hydrogeological nature of the aquifer. Therefore, it is considered that there are no GDEs evident within the MEP area. Therefore it can be concluded that groundwater potentially impacted by the MEP does not have any environmental value associated with GDEs.

### Aquatic Ecosystem

No groundwater dependent aquatic ecosystems are known to exist on or nearby the MEP. To corroborate this assumption, the aquatic ecosystem guideline levels for salinity, arsenic, chromium, copper, manganese and zinc are all elevated in the majority of the groundwater samples that were available from surrounding bores and will indicate the ecosystem is unsuitable for the majority of aquatic species.

### Stygofauna and Troglofauna

Stygofauna and troglofauna are typically present in aquifers and voids within suitable aquifer systems, i.e. porous, abundant void presence, low salinity aquifer systems such as alluvial and calcrete beds (Humphreys, 2001). Groundwater drawdown in the MEP will have zero impact on the alluvial aquifer system in the area which is the only likely aquifer in which stygofauna and troglofauna may be present. As this aquifer will not be impacted upon by the proposed MEP and other aquifers are considered too saline for stygofauna and troglofauna to be present, further monitoring for stygofauna and troglofauna was assessed as unnecessary.

Any stygofauna or troglofauna are unlikely to be within the Rangal Coal measures themselves due to its deep potentiometric surface and poor water quality.

### Recreational Use

There are no known recreational uses for groundwater in the MEP areas.

### Drinking Water

The high levels of salinity of most of the groundwater in the MEP area renders it unsuitable for human consumption and it will require substantial treatment to meet drinking water standards. The Australian salinity guideline is less than 500 mg/L TDS and values of 8,100 mg/L have been measured.

The poor groundwater quality in the EEP area and the ease of obtaining a rainwater tank for a drinking water supply are factors that have precluded the potential use of the groundwater as a drinking water source.

Drinking water in rural areas is stored in rain water tanks collected off infrastructure.

### Agricultural Use

Given the general low yield and poor quality of the groundwater in the Rangal Coal Measures, the environmental value has been classified as ‘primary industry’ with the main potential use being for stock watering. The salinity of the groundwater generally limits its use for stock watering, in some bores the groundwater is too saline for the more salt sensitive stock.

### Industrial Use

Surrounding coal operations intersect groundwater within the Rangal Coal Measures however these operations are not actively extracting water from the resource for industrial purposes.

Evaluation of the groundwater quality data and the hydrogeological regime does not indicate any obvious industrial value of the groundwater.

Based on the description of the groundwater usage surrounding the MEP and current knowledge of groundwater quality within the Rangal Coal Measures aquifer, the environmental value of the resource has been assessed against the *Environmental Protection (Water) Policy 1997*. A summary is provided in **Table 10-14**.

**Table 10-14 Environment Values of the Rangal Coal Measures Aquifer Resource**

| *Environmental Protection (Water) Policy 1997 –* Environmental Values | Interpretation |
|---|---|
| Aquatic ecosystems | Groundwater dependent aquatic ecosystems are not known to exist within the MEP and are unlikely to occur given the depth and water quality of the Rangal Coal Measures |
| Suitability for recreational use | There are no known recreational uses of groundwater in the MEP areas |
| Stygofauna and troglofauna | No stygofauna and/or troglofauna are expected to exist within the MEP areas due to lack of suitable aquifer systems |
| Suitability for minimal treatment before supplying as drinking water | The high levels of salinity of much of the groundwater in the MEP area indicates that the resource is unsuitable for human consumption and will require substantial treatment to meet drinking water standards |
| Suitability for agricultural use | Some bores surrounding the MEP area are utilised for agricultural use |
| Suitability for industrial use | While surrounding coal operations (such as Poitrel and Carborough Downs) intersect groundwater within the Rangal Coal Measures, these operations are not actively extracting water from the resource for industrial purposes |

## 10.6 POTENTIAL IMPACTS AND MITIGATION MEASURES

### 10.6.1 Surface Water

The potential impacts on surface water values from the MEP are detailed below, with the proposed management and mitigation strategies detailed as per the proposed Mine Water Management System (MWMS).

*10.6.1.1 Water Management Strategy*

The overarching operational water management strategy for the MEP is to:

- minimise the amount of surface runoff impacted by mining operations by diverting clean water flows around the mining operations;
- minimise the amount of raw water to be imported to site by maximising the recycling of stored water resources within the mine site;
- minimise, or prevent, the need for mine water to be discharged from site;
- maintain the 100 m buffer area around New Chum Creek;
- minimise impacts to water quality and quantity on existing downstream water users; and to
- ensure adequate protection of internal water management infrastructure and external surface water values during flood events.

**Mine Water Management System**

As part of the surface water management assessment undertaken for the MEP, Peabody developed a conceptual Mine Water Management System (MWMS) based upon the existing Environmental Authority conditions and regulatory requirements, Millennium Mine’s current operational water management system, WRM Water & Environment Pty Ltd’s (2010) MEP surface water management modelling results and the proposed mine plan for the MEP.

The MWMS includes:

- a site water balance;
- modelling and management of flood impacts to prevent uncontrolled discharges;
- modelling of final void water balances and appropriate flood protection requirements;
- conceptual design of water management infrastructure, including clean and dirty water drains, sediment ponds and process water dams; and
- a proposed surface water monitoring program.

The MEP MWMS surface water infrastructure layout evolves over the 16 year life of the MEP. For the purposes of design, water balance modelling and impact assessment, the following incremental stages of the mine plan development have been assumed:

- stage 2012 - applies for 2011-2012 (2 yrs)
- stage 2015 - applies for 2013-2016 (4 yrs)
- stage 2020 - applies for 2017-2021 (5 yrs)
- stage 2027 - applies for 2022-2027 (6 yrs)

Plans showing the conceptual water management layout at each of these incremental stages are provided in **Figure 10-12** to **Figure 10-15** below.

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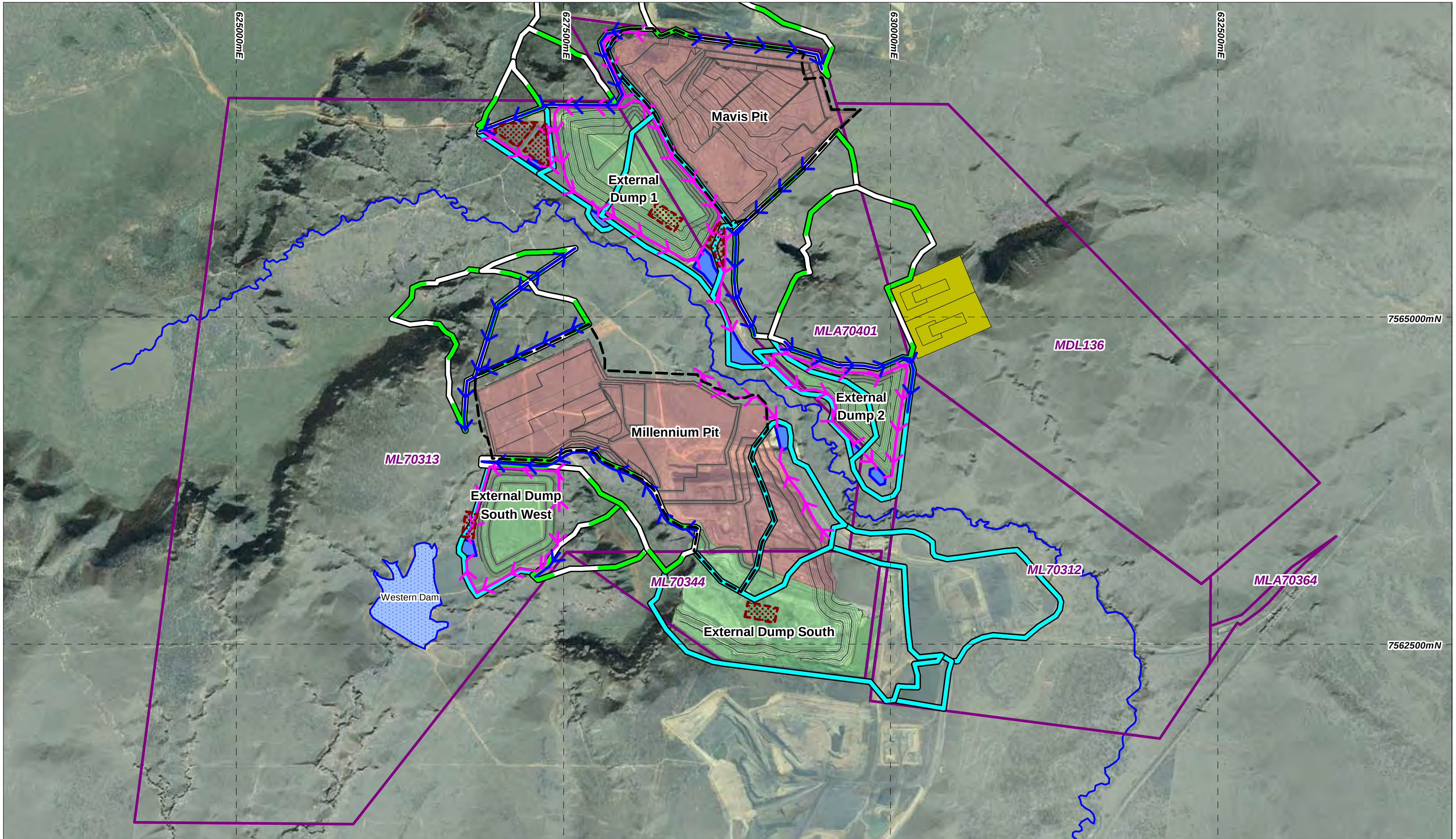


0 800
Metres
Scale: 1:40,000 (A4)

**LEGEND**

- Peabody tenement
- 2012 pit footprint
- 2012 dump footprint
- 2012 topsoil storage
- New Chum Creek
- Major contour (20m)
- Minor contour (5m)
- Proposed clean water drain
- Proposed dirty water drain
- Sediment water catchment
- Raw water catchment
- Pit catchment
- Sediment water dam (10yr 24hr)
- Temporary central dam

Data Source: Infrastructure, Tenement, Topography - Minserve. Surfacewater - WRM Water & Environment.

**Peabody Energy Australia Pty Ltd**

# Millennium Expansion Project

**2012 Water Management System Layout**

14/10/2010

Datum: GDA94
Projection: MGA54

FIGURE 10-12

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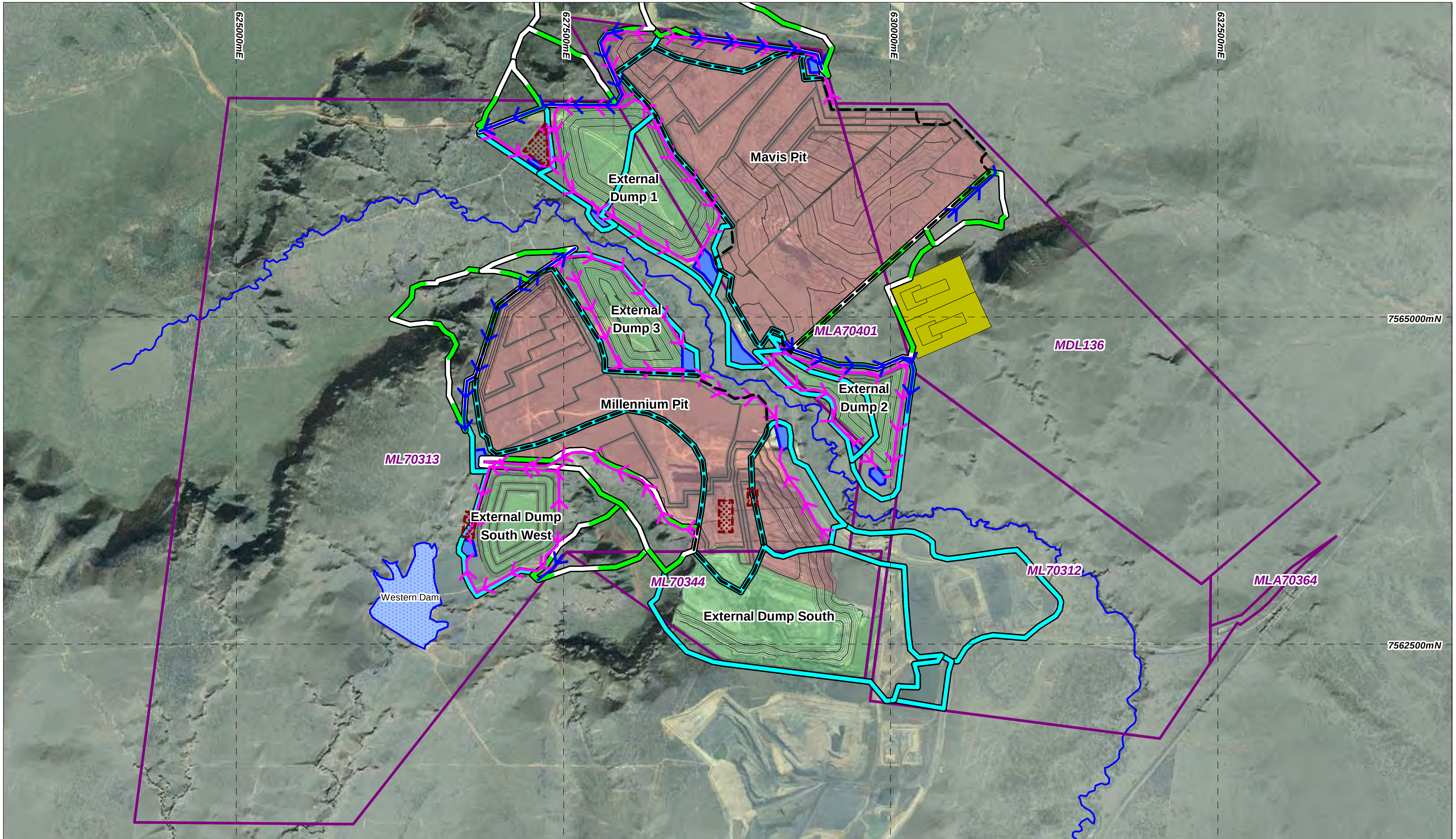


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Peabody

0 800
Metres
Scale: 1:40,000 (A4)

**LEGEND**

- Peabody tenement
- 2015 pit footprint
- 2015 dump footprint
- 2015 topsoil storage
- New Chum Creek
- Major contour (20m)
- Minor contour (5m)
- Proposed clean water drain
- Proposed dirty water drain
- Sediment water catchment
- Raw water catchment
- Pit catchment
- Sediment water dam (10yr 24hr)
- Temporary central dam

Data Source: Infrastructure, Tenement, Topography - Minserve. Surfacewater - WRM Water & Environment.

**Peabody Energy Australia Pty Ltd**

# Millennium Expansion Project

**2015 Water Management System Layout**

14/10/2010

Datum: GDA94
Projection: MGA54

FIGURE 10-13

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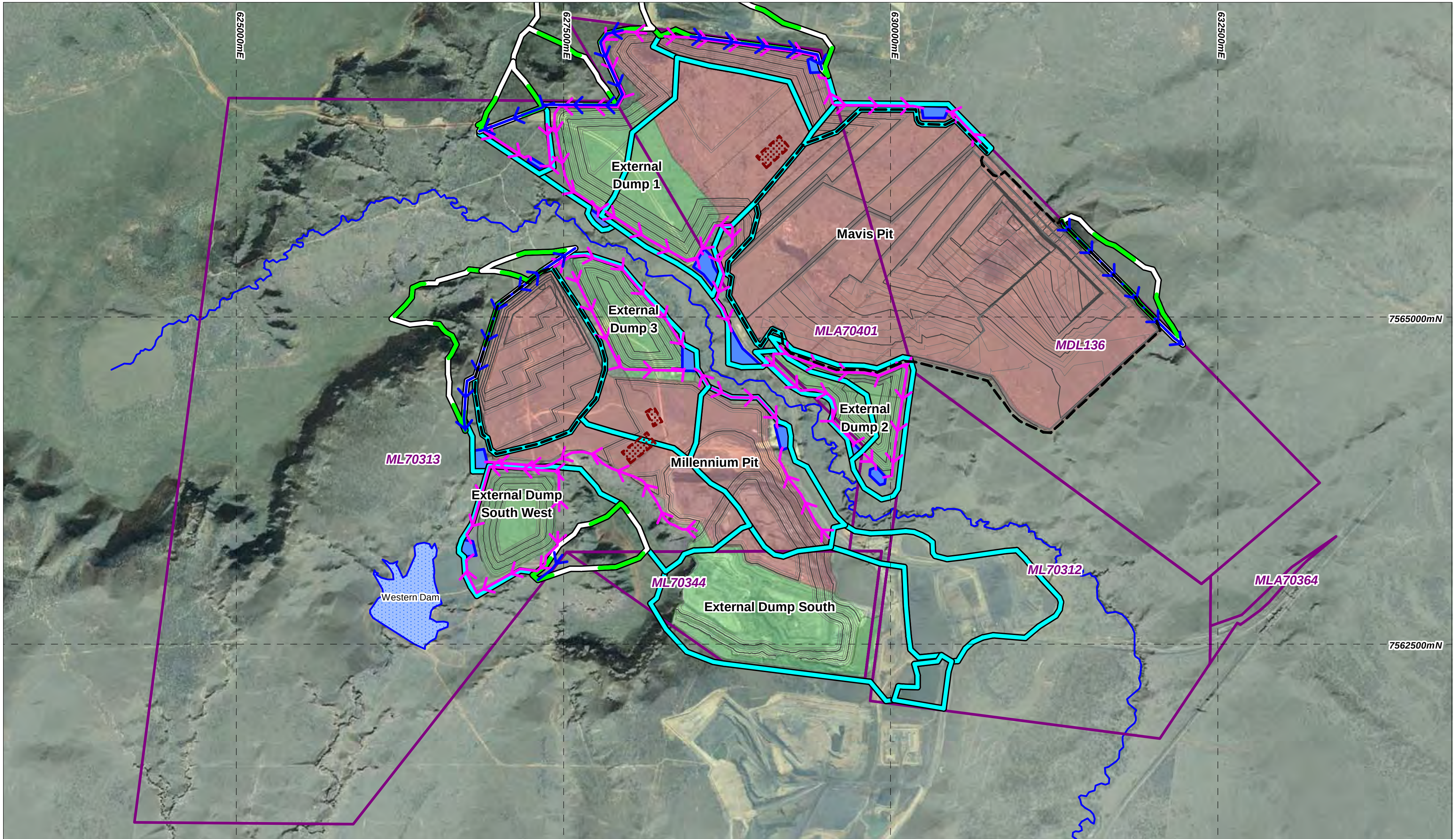


MET SERVE

Peabody

0 800
Metres
Scale: 1:40,000 (A4)

**LEGEND**

- Peabody tenement
- 2020 pit footprint
- 2020 dump footprint
- 2020 topsoil storage
- New Chum Creek
- Major contour (20m)
- Minor contour (5m)
- Proposed clean water drain
- Proposed dirty water drain
- Sediment water catchment
- Raw water catchment
- Pit catchment
- Sediment water dam (10yr 24hr)
- Temporary central dam

Data Source: Infrastructure, Tenement, Topography - Minserve. Surfacewater - WRM Water & Environment.

**Peabody Energy Australia Pty Ltd**

# Millennium Expansion Project

**2020 Water Management System Layout**

14/10/2010

Datum: GDA94
Projection: MGA54

FIGURE 10-14

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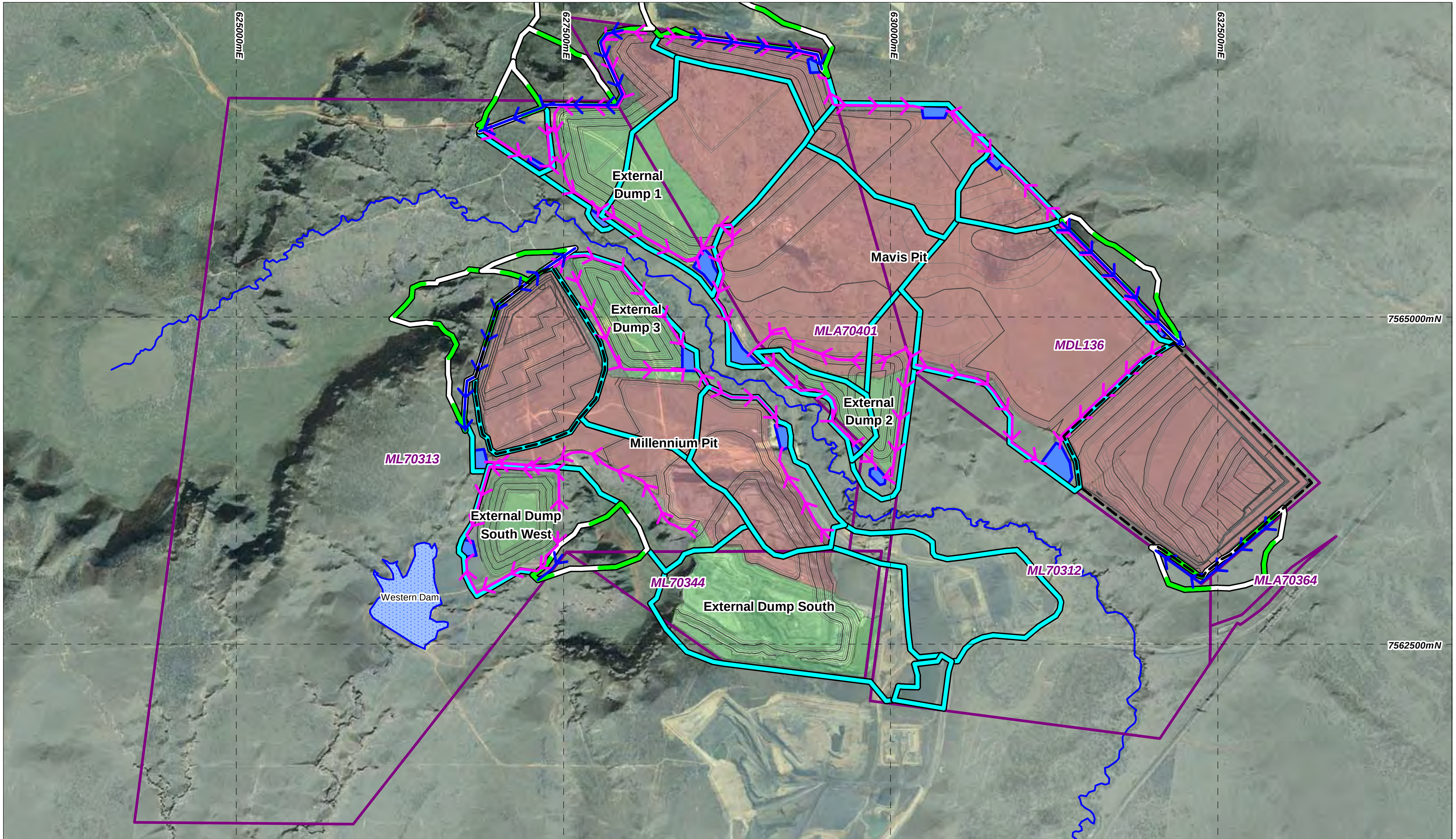



MET SERVE

Peabody

0 800
Metres
Scale: 1:40,000 (A4)

**LEGEND**

- Peabody tenement
- 2027 pit footprint
- 2027 dump footprint
- New Chum Creek
- Major contour (20m)
- Minor contour (5m)
- Proposed clean water drain
- Proposed dirty water drain
- Sediment water catchment
- Raw water catchment
- Pit catchment
- Sediment water dam (10yr 24hr)

Data Source: Infrastructure, Tenement, Topography - Minserve. Surfacewater - WRM Water & Environment.

**Peabody Energy Australia Pty Ltd**

**Millennium Expansion Project**

**2027 Water Management System Layout**

14/10/2010

Datum: GDA94
Projection: MGA54

FIGURE 10-15

*10.6.1.2 Surface Water Quality*

One underlying premise for the MWMS is that clean water from undisturbed catchments will be diverted around the active mining area, thereby minimising the volume of water impacted by mining activities. Clean water diversion drains will be constructed around operational mining areas, as shown in **Figure 10-12** to **Figure 10-15.**

No diversion to any existing creek will be required for the MEP. A minor drainage diversion of clean water from the north of the MEP into New Chum Creek will be required as part of the previously mentioned clean water diversions away from mining areas.

Water that cannot be diverted around the mine and becomes impacted by mining activities is classified into two categories and managed accordingly:

- pit water – from the open-cut pits; and
- overburden runoff – from the waste rock emplacement areas.

Pit water and overburden runoff both have the potential to decrease the water quality in surrounding waterways if they are not managed appropriately. The MEP MWMS proposes the following management and mitigation measures to minimise or prevent any potential impacts.

**Pit Water Management**

Water that collects in the open-cut pits is generally a mixture of groundwater seepage and direct rainfall, as surface water runoff around the pit is directed away from the operations wherever possible. Although groundwater seepage rates are predicted to be low (maximum 1.2 L/s), the predominant groundwater quality from the intersected aquifers is characterised by high EC levels and some heavy metal levels above *ANZECC Guidelines*.

Water in the pit may also become contaminated by the coal seam and associated overburden strata that can result in an increase of EC levels and a decrease of pH, if oxidation of the pyritic material occurs. This process can also result in the release of heavy metals into the water.

This mixture of high EC groundwater seepage and impacted rainfall can deteriorate further in quality over time, so for this reason pit water will be contained in a system with the lowest risk of discharge. Water collected in the pits will be temporarily stored in small in-pit sumps and re-used for in-pit dust suppression as required. Water in excess of dust suppression requirements will be transferred to the large Central Pit Water Storage, described below, for longer-term storage and eventual reuse at the CHPP as required.

The Central Pit Water Storage will be constructed in stages:

- Stage 1-2011-2015: A temporary Central Pit water storage will be excavated ahead of the future Mavis Pit mine area and will eventually be mined through. For this Stage, the Central Pit storage will be constructed to provide 2,600 ML of storage. The size of this storage will be regularly re-evaluated so that, in the event that water inventories are high and the risk of future pit inundation becomes unacceptable, additional storage compartments will be constructed.
- Stage 2–2015-2027: Once mining at the Millennium pit is complete, the Millennium Pit Void will be utilised as the ongoing mine water storage. For this Stage, the available storage volume in the Millennium pit void is well in excess of the maximum combined pit and overburden runoff volume.

### Waste Rock Emplacement Runoff Management

Runoff from waste rock emplacements is predicted to contain both less components and significantly reduced levels of contamination then Pit Water. It is expected to have with some elevated suspended solids levels, but much lower levels of salinity or other pollutants.

The MEP proposes to capture and temporarily store waste rock emplacement runoff in sediment dams that allow the suspended solids to settle and reducing the turbidity. Sediment dams will be constructed as required to align with mine disturbance and the development of waste rock emplacements. A total of 15 sediment dams are required over the MEP to intercept runoff from waste rock emplacements around the site, as shown in **Figure 10-12** to **Figure 10-15**. Ten of these dams surround the Mavis pit, four are for the existing Millennium pit, and the final sediment dam is a combined, central runoff water storage that will be used to manipulate the storage levels in the other 14 dams.

The sediment dams will be sized to contain runoff from the 10 year ARI 24 hour rainfall event that will limit any chance of sediment dam discharge to times of high and prolonged rainfall, when natural flow in the receiving waters will be likely. In addition to this, the risk of off-site discharge will be further limited by adopting an active sediment dam management system, whereby once the water level in the sediment dam reaches 20%, water will be pumped to a Central Runoff Water Storage facility to ensure all dams have at least 80% capacity in the event of rainfall.

The sediment dams then comprise a two-staged management approach:

- a passive storage level, below which water is simply allowed to pond unless required to meet a shortfall in demand; and
- an active storage level (20%) above which pumping to the Central Runoff Water Storage will commence.

The construction and operational parameters for each of the proposed sediment dams is shown in **Table 10-15**.

### Table 10-15 Sediment Dam Characteristics

| Storage | Capacity ML | Spills to Water Sources | Pump Capacity L/s | Modelled Active Period | | Number of Modelled Years |
|---|---|---|---|---|---|---|
| | | | | Start | Finish | |
| Mavis01 | 56 | New Chum Creek | 45 | 2011 | 2027 | 17 |
| Mavis02 | 115 | New Chum Creek | 95 | 2011 | 2027 | 17 |
| Mavis03 | 146 | New Chum Creek | 123 | 2011 | 2027 | 17 |
| Mavis04a | 18 | New Chum Creek | 15 | 2011 | 2027 | 17 |
| Mavis04b | 38 | New Chum Creek | 30 | 2011 | 2027 | 17 |
| Mavis05 | 164 | New Chum Creek | 130 | 2022 | 2027 | 6 |
| Mavis06 | 30 | North Creek | 20 | 2013 | 2027 | 15 |
| Mavis07 | 63 | North Creek | 50 | 2017 | 2027 | 11 |
| Mavis08 | 24 | North Creek | 65 | 2022 | 2027 | 6 |
| Mavis09 | 11 | North Creek | 10 | 2022 | 2027 | 6 |
| Millen01 | 79 | New Chum Creek | 65 | 2013 | 2027 | 15 |
| Millen02 | 64 | New Chum Creek | 50 | 2011 | 2027 | 17 |
| Millen05 | 67 | West Creek | 55 | 2013 | 2027 | 15 |
| Millen06 | 52 | West Creek | 45 | 2011 | 2027 | 17 |
| CRWS | 12 | New Chum Creek | 10 | 2011 | 2027 | 17 |

Similar to the Central Pit Water Storage plan, the Central Runoff Water Storage will be constructed in stages:

- Stage 1 - 2011-2015: A temporary Central Runoff Water Storage will be excavated ahead of the future Mavis Pit mine area and will eventually be mined through. For this Stage, the Central Runoff Water Storage will be constructed to provide 2,600 ML of storage. The available storage volume will be re-evaluated annually to ensure that inflows from the next two years of sediment dam operation could be accommodated by constructing additional water storage cells as required.
- Stage 2 - 2015-2027: Once mining at the Millennium pit is complete, the Millennium Pit Void will be utilised as the ongoing Central Pit and Central Runoff mine water storage. For this Stage, the available storage volume in the Millennium pit void is well in excess of the maximum combined pit and overburden runoff volume.

The catchments of the proposed water management dams have been calculated and show that the MEP increases the existing water management system catchment area by 610 ha; from 1,342 ha for the existing operations to 1,952 ha over the MEP life.

The MWMS described above has been devised to provide a means of dewatering the pits and maintain runoff collection during extended wet periods, without off-site discharge. The operation of the site water management system has been simulated using the OPSIM water balance model and historical climate data. Details of the contribution of water from the pits and sediment dams to the overall MEP water balance, and the mechanisms for managing it, are provided in **Section 10.6.1.5.**

Further details of the Central Pit and Central Runoff water management storages are detailed in **Appendix F3–Surface Water.**

MEP overburden is moderately dispersive and sodic, with low to moderate salinity as detailed in **Chapter 7–Land.** Analyses of overburden (GHD, 2010) have indicated that it is alkaline, with low salinity and nil to very little acid producing potential. The coal seam partings have a higher acid-producing potential, but make up a very small proportion of overburden. Dissolved metal concentrations in the overburden are expected to be similar to background levels in the region.

**Surface Water Discharge Procedure**

The MWMS is designed to ensure that the risk of discharge of poor quality water from the MEP is minimised. If for any reason the MEP requires to release any water that has been in contact with the mine pits, ROM coal, product coal or the mine infrastructure area, or any water from the Central Pit Water Storage or the Central Runoff Water Storage, it will be undertaken in accordance with the existing approved procedure in place at the Millennium Mine, and in compliance with Environmental Authority conditions.

A release of water from the MEP could potentially occur from the sediment dams. Given the proposed two stage management approach (passive and active) for sediment dams, any water that was required to be released from these storages will:

- occur during the most severe rainfall events;
- be into a flowing creek system; and
- be predominantly ‘fresh’ rainfall runoff, as pumping of stored water to the Central Runoff Water Storage will have commenced at the designated 20% storage level.

*10.6.1.3 Surface Water Quantity*

A potential ramification from the MEP could result from complying with DERM’s ‘Model Conditions for Environmental Authorities for Coal Mines in the Fitzroy Basin’ (Model Conditions). The Model Conditions contain provisions requiring site runoff water to be contained on-site, even when its quality complies with licensed discharge water quality limits due to the need for flow to be evident in receiving streams. The proposed MWMS has therefore been designed to ensure that the potential for discharge will only occur during the most significant rainfall event. By complying with this requirement from DERM, it is likely that during mine operations the MEP will reduce the magnitude and frequency of downstream flows through the capture of runoff from catchment areas and the long-term storage of this water on-site.

Modelling of the MWMS under long-term historical climate conditions shows that any release of water from the MEP will be infrequent and small in volume. Based on these results, **Table 10-16** provides an estimation of the reduction in mean annual flow in the receiving waters.

For the North Creek and West Creek Catchments, the loss of catchment from the MEP as a proportion of the downstream catchment is small, and hence the impact is small. For New Chum Creek, the impact is more significant during mining operations, but is reduced at the end of mine life as much of the catchment loss will be reinstated over the mine life as waste rock emplacements are rehabilitated, and sedimentation dams are decommissioned.

The impacts to all of the creek systems will be significantly reduced at the end of mine life when all waste rock emplacements and mine infrastructure areas will be rehabilitated. The reduction in catchment area at the end of the mine life will therefore be small, with only a small area being contained in the Mavis and Millennium Pit final voids.

**Table 10-16 Catchment Interception and Reduction in Runoff**

| | | Stage | | | | |
|---|---|---|---|---|---|---|
| | | 2012 | 2015a | 2015b | 2020 | 2027 |
| **New Chum Creek** | | | | | | |
| Area Intercepted by MWMS | ha | 342.0 | 345.1 | 345.0 | 507.3 | 906.5 |
| Percentage reduction in 2010 catchment and flow | | 6.7% | 6.8 % | 6.8% | 9.9% | 17.8% |
| **North Creek** | | | | | | |
| Area Intercepted by MWMS | ha | 0.0 | 19.3 | 19.3 | 47.9 | 157.0 |
| Percentage reduction in 2010 catchment and flow | | 0.0% | 0.4% | 0.4% | 0.9% | 3.1% |
| **West Creek** | | | | | | |
| Area Intercepted by MWMS | ha | 70.7 | 164.7 | 164.7 | 164.7 | 164.7 |
| Percentage reduction in 2010 catchment and flow | | 1.4% | 3.2% | 3.2% | 3.2% | 3.2% |

**Table 10-17** describes the modelled magnitude, frequency and duration of sediment dam spillway discharges to the receiving waters, based on the worst case MEP footprint and water management scenario later in the mine life. During the earlier stages of mining, when the disturbed area is smaller, the magnitude of discharges will be even less.

**Table 10-17 Modelled Sediment Dam Overflow Characteristics***

| | West Creek (incl. West Creek Dam) | North Creek | New Chum Creek |
|---|---|---|---|
| Total Overflows | 173 | 26 | 26 |
| Average Overflows per Year | 1.42 | 0.21 | 0.21 |
| Average Overflow Duration (d) | 13 | 6 | 6 |
| Average Overflow Volume (ML) | 150 | 66 | 479 |
| Maximum Overflow Volume (ML) | 1,846 | 269 | 1,868 |

** Based on the 2027 MWMS arrangement as shown in **Figure 10-15.***

*10.6.1.4 Potential Flood Impacts and Mitigation*

The design and layout of the MEP operations has been developed to provide a minimum 100 m buffer strip between mine workings and the New Chum Creek channel. As a result, the proposed waste rock emplacement dumps and water management infrastructure are generally outside the 100 year ARI flood extents, however there are a number of small areas where the external waste rock emplacements and/or the mine pit encroaches onto the floodplain, as shown in **Figure 10-16**.

Where the external waste rock emplacement areas are constructed on the floodplain, they will be protected with rock mulch to reduce the risk of scouring during flood events. Where the pits temporarily cross into the floodplain, levee banks will be constructed to protect the pit from the 2,000 year ARI flood event, with an appropriate freeboard allowance, at the locations shown in **Figure 10-16.**

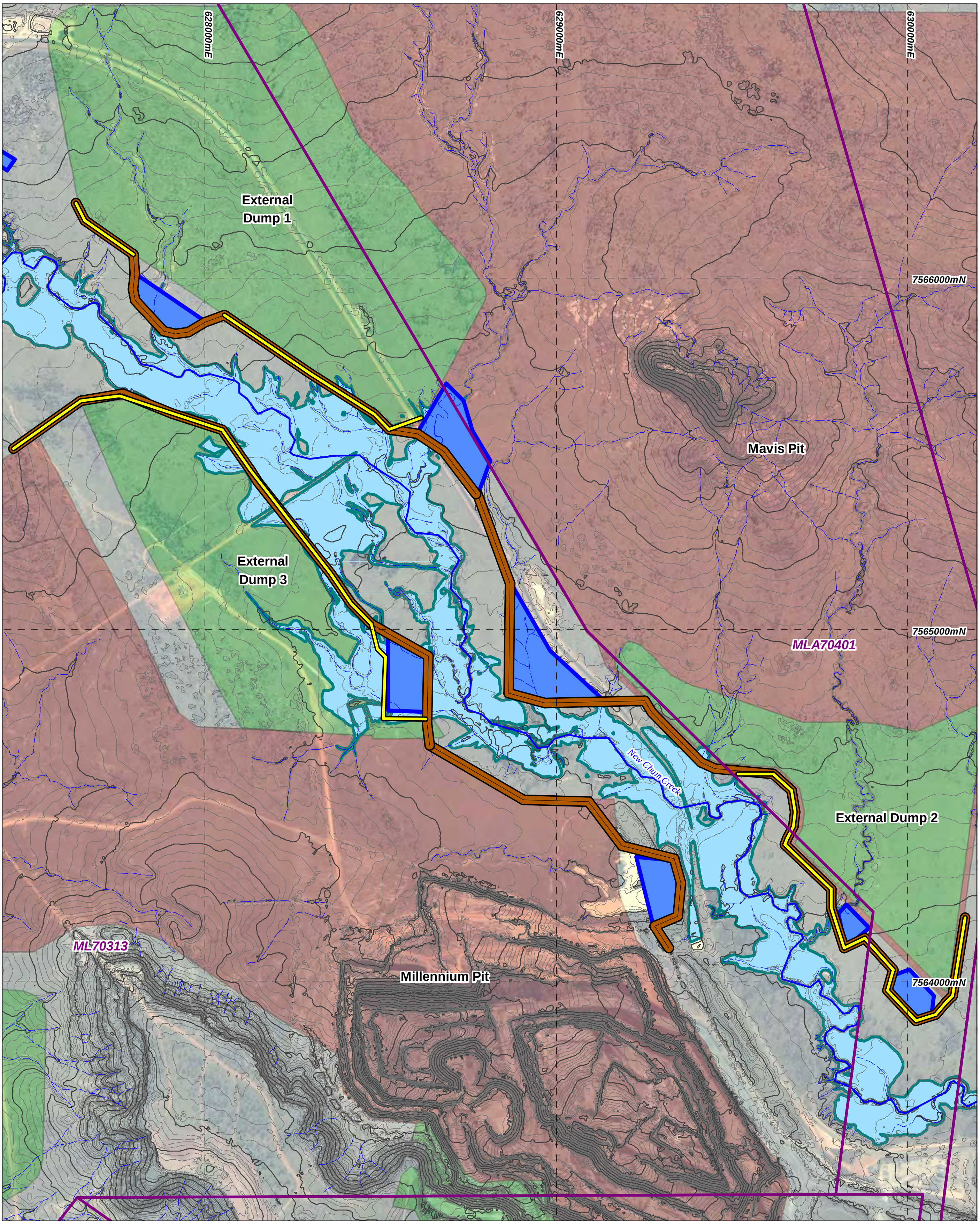
The proposed haul roads from Mavis Pit will require two new culvert crossings of New Chum Creek. The crossings are proposed to be low level floodways with low flows conveyed by dual 1,800 mm corrugated steel pipes mitred to the embankment profile, and high flows crossing over the culverts. Modelling indicates the proposed crossings will only have a localised impact on upstream flood levels as indicated by the red colouring in **Figure 10-17**.

**Figure 10-17** shows the increase in flood level in the 100 year ARI flood event, assuming that the waste rock emplacement areas and pit levees are constructed to the edge of the buffer strip, and the new haul road crossings are in place.

The hydraulic modelling shows that flood levels and flood velocities along New Chum Creek channel are virtually unchanged by the proposed MEP for events up to and including the 100 year ARI event. Localised erosion protection will be required to manage scour in the channel downstream of the culvert outlets and on the downstream haul road embankments.

Changes in flood conditions in New Chum Creek show a minor increase in flow velocity (up to a maximum increase of 2.7 L/s) immediately downstream of the proposed crossings, however that quickly dissipates to undetectable levels prior to leaving the MEP area,

Details of the flood modelling investigation are provided in **Appendix F3– Surface Water.**




**LEGEND**

- Peabody tenement
- 2027 pit footprint
- 2027 dump footprint
- New Chum Creek
- Watercourse
- Major contour (5m)
- Minor contour (1m)
- Q100 flood extent
- Sediment water dam
- Pit protection levee
- Rock mulch scour protection

MET SERVE

Peabody

Data Source:
Imagery, Tenement, Topography - Minserve. Surfacewater - WRM Water & Environment.

**Peabody Energy Australia Pty Ltd**

# Millennium Expansion Project

**Proposed Flood Protection and Scour Protection Works**

0 250 500
Meters

Scale: 1:15,000 (A4)

25/11/2010

Datum: GDA94
Projection: MGA55

FIGURE 10-16

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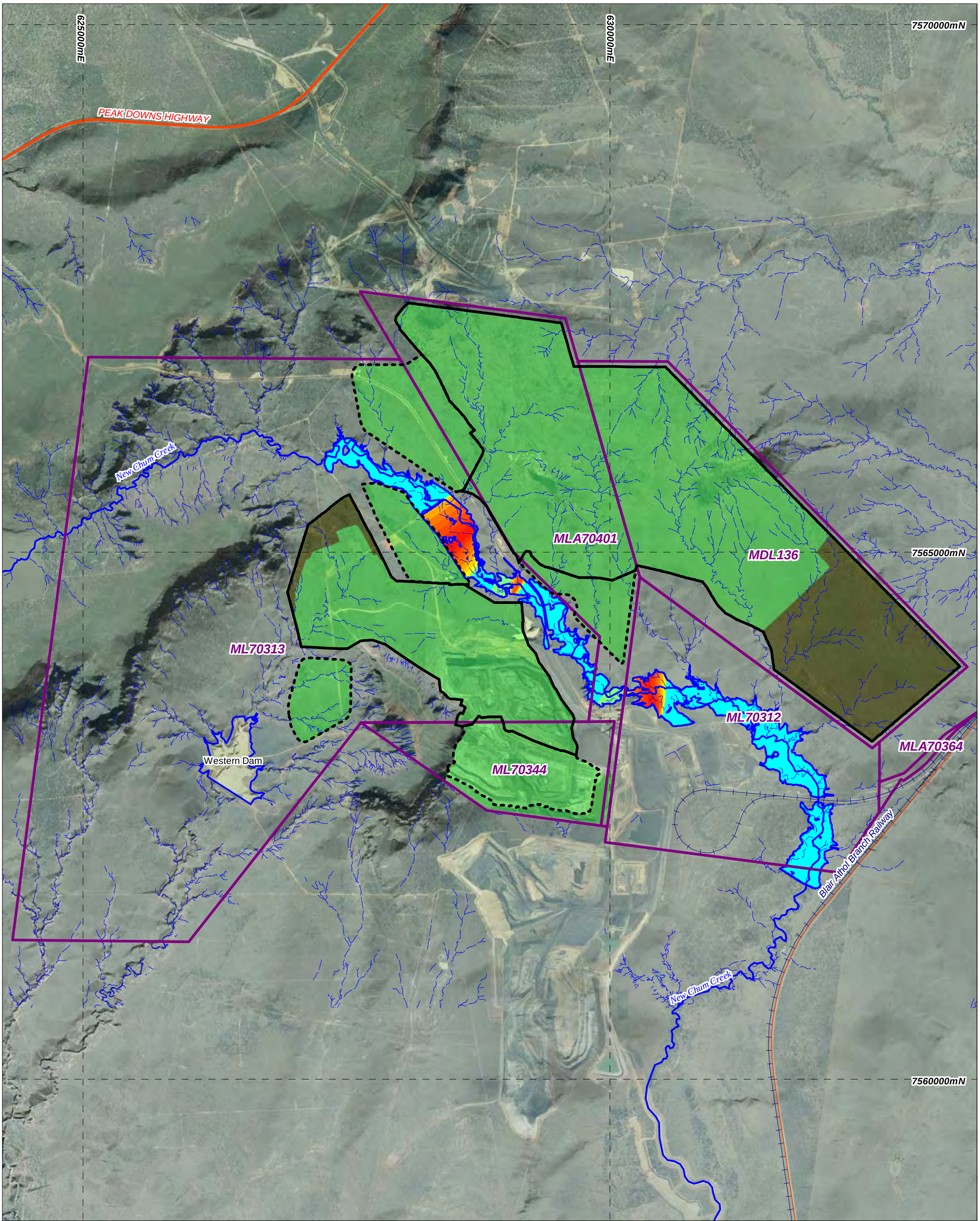


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**LEGEND**

- Peabody tenement
- Principal road
- Road (unsealed)
- Railway
- Watercourse
- 2027 pit footprint
- 2027 dump footprint
- Final void
- Completed rehabilitation

**INCREASE IN Q100 WATER LEVEL (m)**

- -0.01m < dWL < 0.01m
- 0.01m < dWL < 0.10m
- 0.10m < dWL < 0.25m
- 0.25m < dWL < 0.50m

MET SERVE

Peabody

Data Source: Topography - Geoscience Australia. Tenement - Minserve.
Surfacewater - WRM Water & Environment.

## Peabody Energy Australia Pty Ltd
# Millennium Expansion Project

**100 Year ARI Flood Extent from New Chum Creek**

0 1 2
**Kilometres**
Scale: 1:50,000 (A4)

26/10/2010

Datum: GDA94
Projection: MGA55

FIGURE 10-9

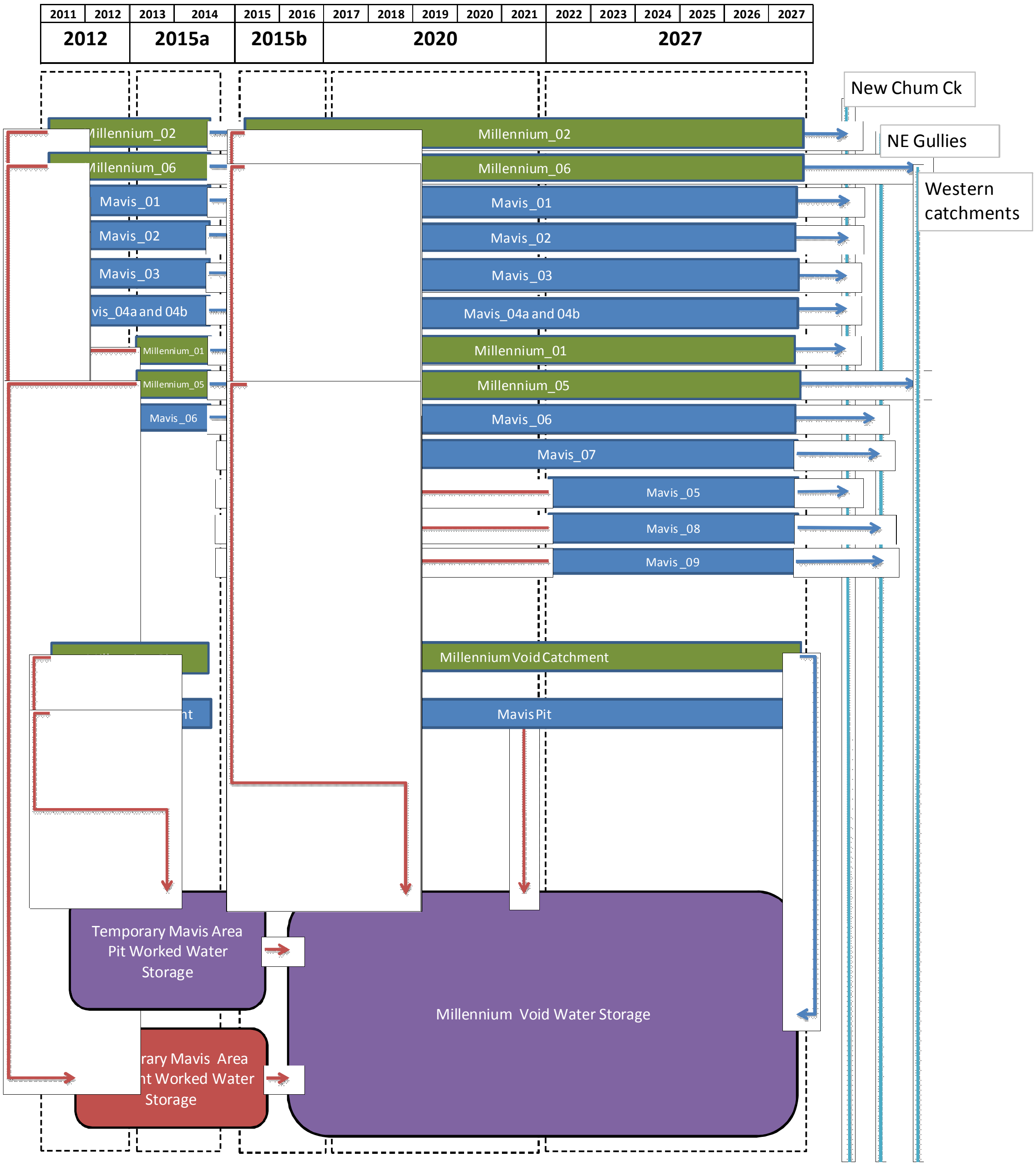
### *10.6.1.5 Site Water Balance*

A water balance model representing the proposed MWMS was prepared using the OPSIM Simulation Program. The OPSIM model simulates the operation of the major components of the MEP water management system, including:

- climatic variability – rainfall and evaporation;
- catchment runoff and collection;
- pit dewatering;
- pump transfers;
- water storage filling, spilling, evaporation and leakage;
- industrial water extraction, usage and return; and
- regional groundwater inflows.

A schematic of the water balance model is presented in **Figure 10-18**. For impact assessment purposes, it has been assumed that the proposed MEP system behaves in isolation, except where there is an additional CHPP demand on the MWMS resulting from the increase in coal production due to the MEP.

**Figure 10-18 MEP Water Management System Schematic**




Based on the modelling, a representative long-term water balance for each stage of mining is presented in **Table 10-18**. The data presented in the table has been derived from long-term simulation averages.

**Table 10-18 Summary Average Annual Water Balance (High Runoff)**

| | 2012 (2 yrs) | 2015a (2 yrs) | 2015b (2 yrs) | 2020 (5 yrs) | 2027 (6 yrs) |
|---|---|---|---|---|---|
| Inflows (ML/yr) | | | | | |
| Groundwater Millennium | 25.6 | 25.6 | 25.6 | 0.0 | 0.0 |
| Groundwater Mavis | 40.2 | 40.2 | 40.2 | 51.1 | 29.2 |
| Catchment Inflow | 1,538 | 1,860 | 1,906 | 2,242 | 2,593 |
| Burdekin Pipeline | 156.3 | 109.3 | 64.2 | 30.5 | 7.9 |
| **Sum of Inflows** | **1,760** | **2,035** | **2,036** | **2,324** | **2,630** |
| Outflow (ML/yr) | | | | | |
| CHPP | 540.0 | 540.0 | 540.0 | 540.0 | 540.0 |
| Road Dust Suppression | 350.0 | 350.0 | 350.0 | 350.0 | 350.0 |
| Vehicle Washdown | 100.1 | 100.1 | 100.1 | 100.1 | 100.1 |
| Evaporation | 298.1 | 395.4 | 438.5 | 511.8 | 610.5 |
| Releases to: | | | | | |
| New Chum Ck | 8.8 | 14.8 | 15.3 | 46.8 | 82.1 |
| North Creek | 0.0 | 0.2 | 0.2 | 3.3 | 11.2 |
| West Creek | 214.8 | 214.0 | 232.4 | 223.5 | 184.4 |
| **Sum of Outflows** | **1,512** | **1,615** | **1,677** | **1,775** | **1,878** |
| **Change in volume stored** | **248.4** | **420.3** | **359.1** | **548.2** | **751.6** |

Further details of the MEP water balance model and assumptions are contained in **Appendix F3–Surface Water.**

*10.6.1.6 Proposed Surface Water Monitoring Program*

Monitoring requirements to comply with the model EA conditions are listed in **Table 10-19** below. Surface water sampling locations are shown in **Figure 10-19.** These locations are in addition to the operational water sampling locations already sampled for the Millennium Mine.

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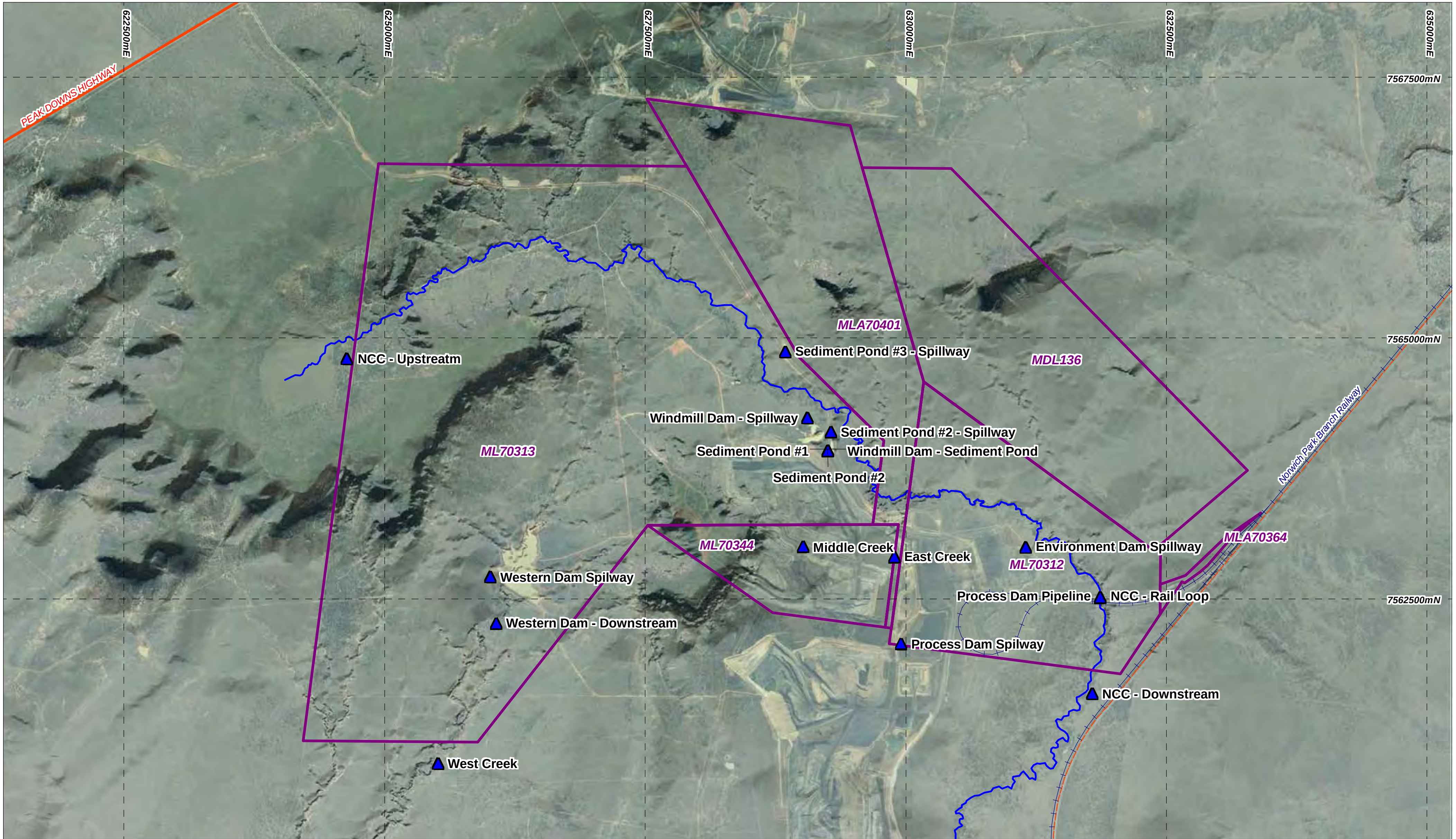


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0 1
Metres
Scale: 1:50,000 (A4)

**LEGEND**

- Peabody tenement
- Principal road
- Road (unsealed)
- Railway
- New Chum Creek
- Proposed monitoring point

Data Source: Infrastructure, Tenement, Topography - Minserve. Surfacewater - WRM Water & Environment.

**Peabody Energy Australia Pty Ltd**

**Millennium Expansion Project**

**Proposed Monitoring Points**

14/10/2010

Datum: GDA94
Projection: MGA54

FIGURE 10-19

**Table 10-19 Proposed Water Management Monitoring Points**

| Monitoring Point | Description | Water Level (Flow) | Storage Water Quality | Continuous Sampling | Full Suite as per Note Below |
|---|---|---|---|---|---|
| Upstream Monitoring Points | | | | | |
| UP MEP 1 | North Creek | X | - | - | Daily During Release |
| UP MEP 2 | West Creek | X | - | - | Daily During Release |
| UP MEP 3 | New Chum Creek (Existing Monitoring Point) | X | - | - | Daily During Release |
| Downstream Monitoring Points | | | | | |
| DN MEP 1 | North Creek | X | - | - | Daily During Release |
| DN MEP 2 | West Creek (Existing Monitoring Point) | X | - | - | Daily During Release |
| DN MEP 3 | New Chum Creek (Existing Monitoring Point) | X | - | - | Daily During Release |
| Site Water Storage Monitoring Points | | | | | |
| RP1 | Temporary Central Runoff Water Storage – Release Point | X | - | X | Daily During Release |
| RP2 | Temporary Central Pit Water Storage – Release Point | X | - | X | Daily During Release |
| GS1 | | X | - | | |
| Central Runoff Water Storage | Storage | - | X | X | Quarterly |
| Central Pit Water Storage | Storage | - | X | X | Quarterly |

Gauge boards will be provided at all dams to allow storage water levels and volumes to be monitored and inflows and outflows to be estimated. Automatic monitoring equipment may be installed at key storages.

The event-based sampling will enable quantification of any pollutant loads from the site and their corresponding impact on the water quality of receiving waters. On-site monthly sampling from the water storages allows for any potential problem areas with respect to pollutant generation on-site to be identified in advance ensuring appropriate remedial action can be taken.

*10.6.1.7 Post Mining Water Management*

**Final Void Flood Immunity**

Final voids will be left in both the Millennium and Mavis pits on the completion of mining. The final voids will be located away from New Chum Creek to reduce the risk of inundation in large flood events.

As shown in **Figure 10-16**, both the Millennium and Mavis pits are located outside the 100 year flood levels, however **Figure 10-20** shows that both mining pits may be marginally within the extent of the Probable Maximum Flood (PMF).

With regard to the PMF flood extent, it is noted that flooding in the vicinity of the Mavis Pit is significantly affected by the existing rail loop, and that in natural conditions the Mavis Pit will be well outside of even the PMF extents. Given that the rail loop has been specifically constructed to service the Millennium, Poitrel and the Daunia mines, once mining is completed in these areas the rail loop will be decommissioned as part of their Mine Closure Plans.

Once the rail loop is decommissioned, the final voids for the MEP will be outside the PMF. As an extreme, worst case scenario, the rail loop may need to service the surrounding mines for another 50 years.

To ensure flood immunity in even the most unlikely flood event (i.e. PMF), and understanding that SPP 1/03-Mitigating the Adverse Impacts of Flood, Bushfire and Landslide states in its definition of PMF that 'Generally, it is not physically or financially possible to provide general protection against this event', Peabody will construct flood levee protections to protect against a 1:2,000 yr flood event around the mining pits areas modelled to be within the PMF area. With a greater level of constructed protection than any known operation in the Bowen Basin and considering a 50 year worst case timeframe before the rail loop is rehabilitated and the MEP voids are outside the PMF, a risk assessment of final void flood immunity for the MEP shows it is well within acceptable limits.

**Final Void Water Levels**

Final void water levels in each pit have been simulated using a simplified OPSIM water balance model. The sensitivity of the model results was investigated by undertaking separate model runs with different initial water levels, as shown in **Figure 10-21** and **Figure 10-22** until the model showed the water levels stabilising when the average net contribution to the pit from rainfall, runoff and infiltration are balanced by evaporative losses from the open water void. The results are as follows:

- the Mavis Pit void water depth stabilised at a level approximately 42 m below the top of the void; and
- the Millennium Pit void water depth stabilised at a level approximately 62 m below the top of the void.

The overall general behaviour of the water stored in the void was found to be relatively robust regarding runoff parameters and evaporation and seepage rates. Results of the sensitivity analysis are provided in **Appendix F3–Surface Water**.

**Long Term Salinity**

Both the Millennium and Mavis final voids will be closed systems with no mechanism for salts to flow out of the system through flooding or discharge, therefore salinity is likely to increase over time due to evaporation. OPSIM modelling of the Mavis and Millennium voids shows that if initial water levels are low, the salinity will eventually increase beyond recommended beneficial water use levels. Salinity within the void will initially be fair (approximately 1,500 mg/L) due to the influx of rainwater and surface water, however it is expected to reach TDS levels of 4,000 mg/L after approximately 150–175 years. Even at 1,500 mg/L, salinity of the void water will negate any potential use for cattle stock water and irrigation purposes.

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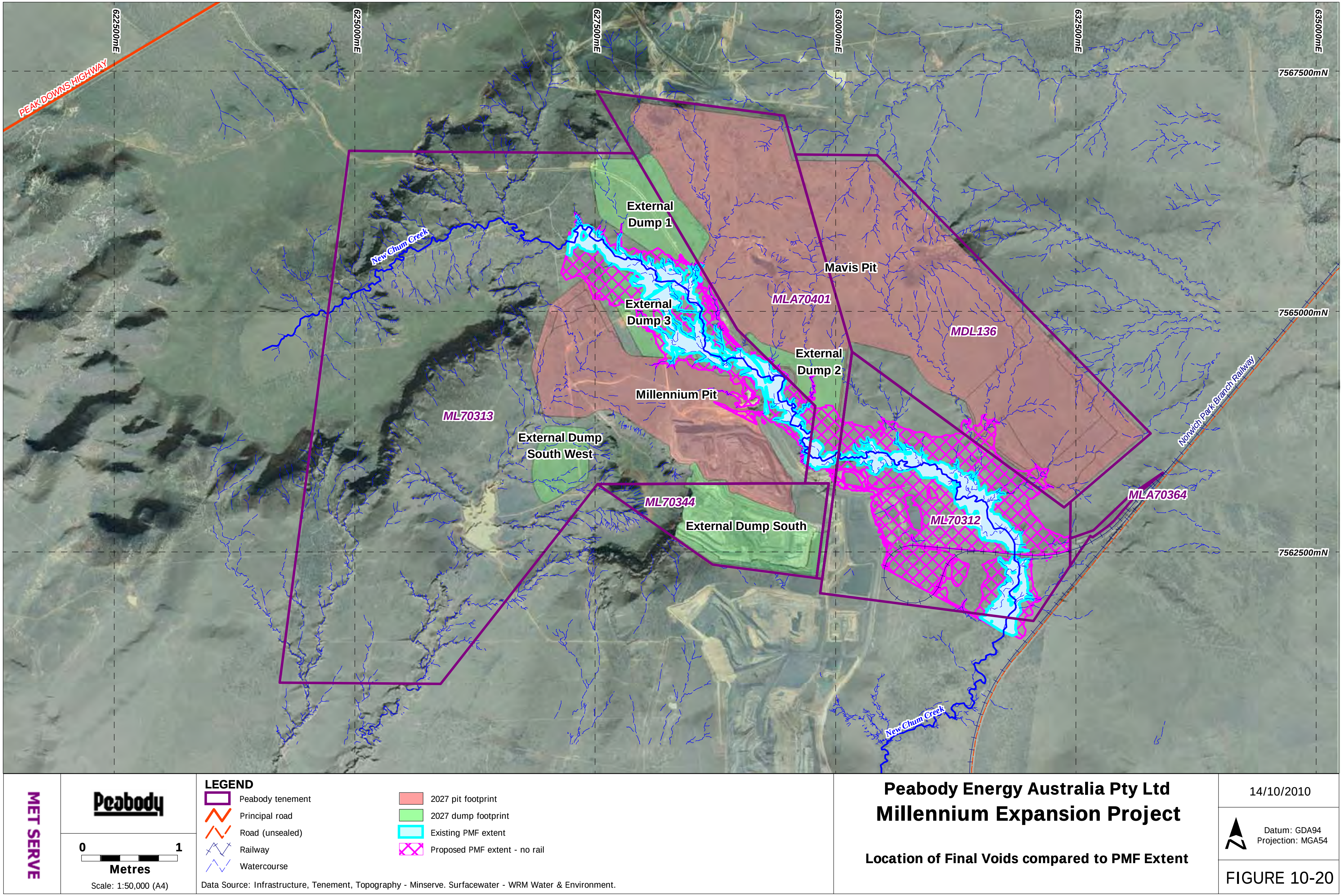


**Figure 10-21 Modelled Behaviour of Final Void–Mavis Pit**

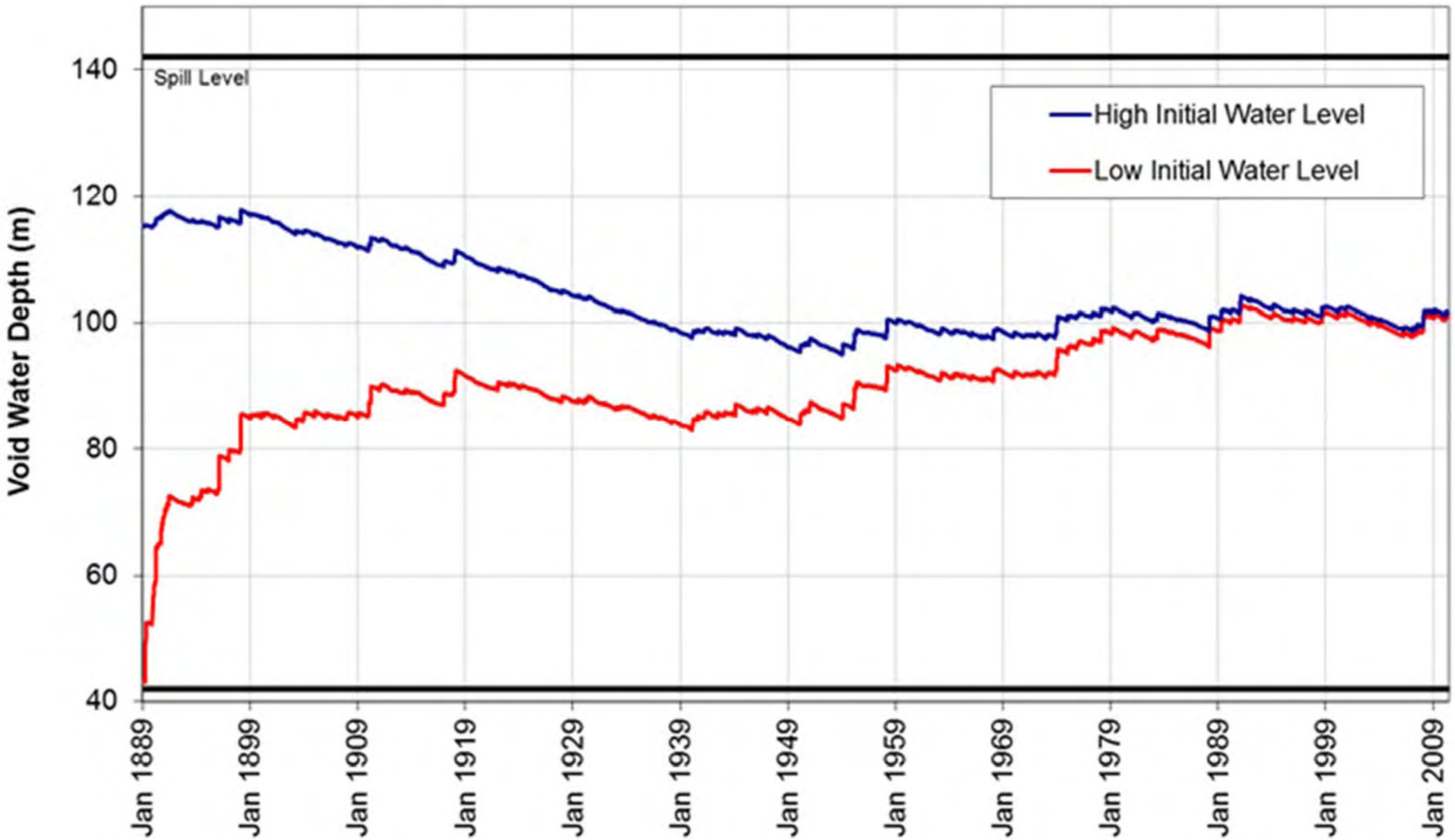
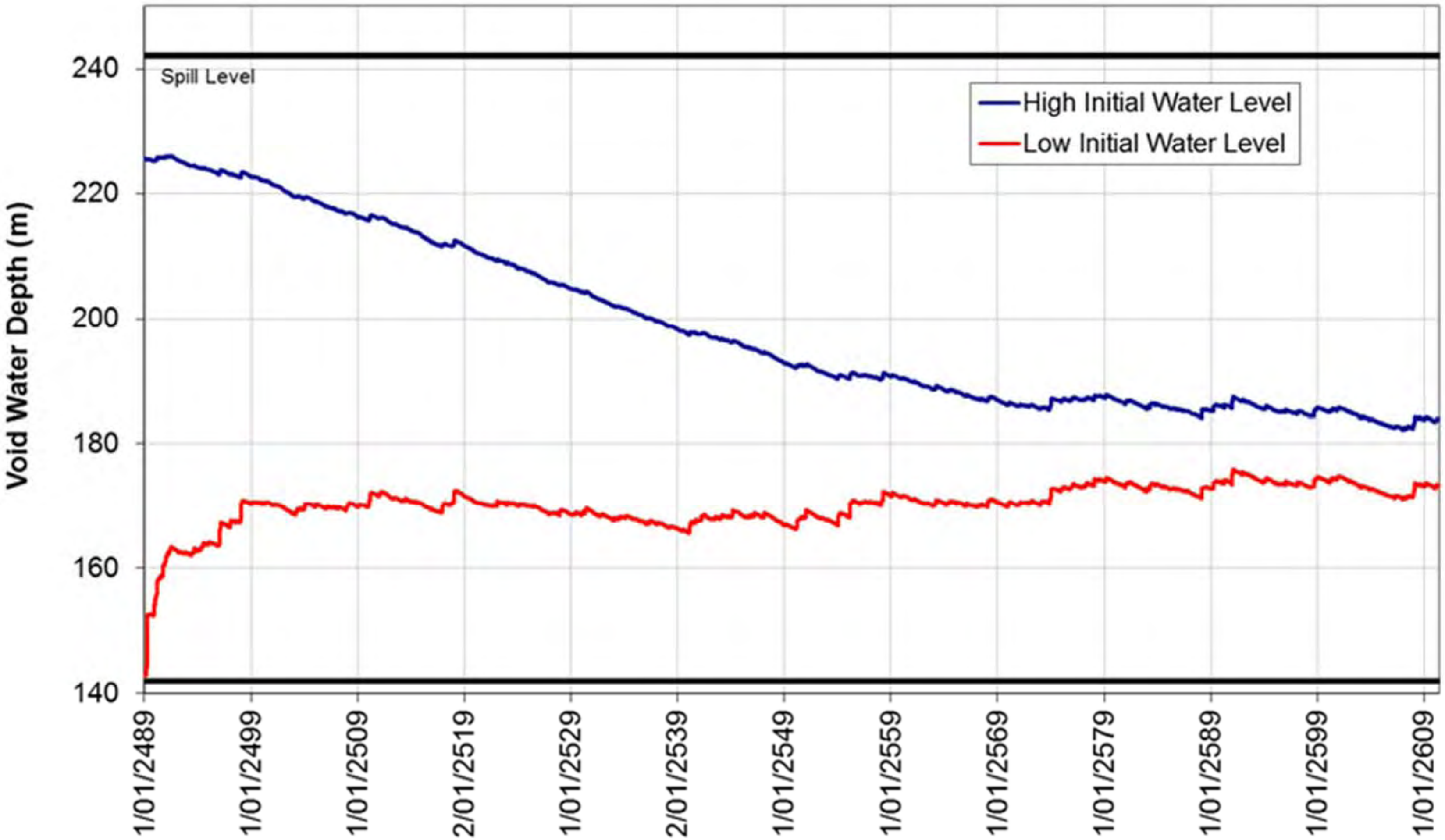


**Figure 10-22 Modelled Behaviour of Final Void–Millennium Pit**



### 10.6.2 Groundwater

The MEP will consist of an open pit mine using truck-and-shovel to remove the overburden and coal seams. This will result in the removal of the overlying strata and the localised dewatering of aquifers as mining progresses. The depth of the pit will therefore extend to the base of the deepest seam mined which is approximately 190 m below ground. Groundwater inflow to the pit void will be collected in sumps constructed on the floor of the pit. The disturbed waste rock dumped in mined out voids is uncompacted and fractured, resulting in changes in hydraulic conductivity, specific yield and bulk volume.

Potential impacts on groundwater by open-cut mining include changes to:

- water-table levels/potentiometric surface levels;
- groundwater flow patterns; and
- bore water-levels and yields.

Additionally, mining activities may also inadvertently change the chemistry of groundwater via induced groundwater mixing and/or surface water mixing. To estimate mine-induced groundwater flow and drawdown patterns, a 3-D numerical model was developed. Impacts on groundwater quality were interpreted qualitatively.

*10.6.2.1 Impact Assessment Methodology*

**Hydrogeological Desktop Study**

A desktop study was undertaken to obtain information on the occurrence, quality and movement of groundwater in the MEP. The study included:

- a search for registered bores and an interpretation of their results;
- regional geological analysis; and
- a study of hydrogeological assessments/groundwater models constructed for EIS requirements in proximal mines, including Carborough Downs, Poitrel and Daunia.

**Numerical Model Methodology**

A groundwater model was developed using Processing MODFLOW Professional, which is a highly advanced version of the commonly used MODFLOW code. An outline of the modelling process, including set-up and assumptions, is presented in **Appendix F4-Groundwater**.

The 3-D numerical groundwater model was developed to simulate the impact on regional groundwater flow patterns and groundwater drawdown caused by groundwater discharge/inflow into the proposed mine pit void to:

- assess the impact of open-cut mining on groundwater levels in the Rangal Coal Measures aquifer;
- assess regional impacts on groundwater levels as a result of cumulative mine dewatering; and
- predict times for the recovery of regional groundwater equilibrium conditions.

**Hydrogeological Conceptual Model**

The conceptual model was developed based on-site specific geological data, published regional geological maps, Millennium Mine's digital terrain model and adjacent mines (i.e. Carborough Downs, Poitrel and Daunia) hydrogeological data, groundwater models and reports. The conceptual model encompasses a 15 km radius surrounding the MEP and has been presented in **Figure 10-23** as cross-sectional lines north-south and east-west through the MEP area.

The following are key features of the conceptual model:

- the model includes the Quaternary alluvial and Permian Rangal Coal Measures aquifers;
- the Quaternary alluvium does not occur across the MEP, but is associated with the Isaac River to the south of the MEP. The alluvial aquifer's hydraulic connection to the underlying Permian aquifer is limited to where the Isaac River incises the Rangal Coal Measures downstream of MEP and is considered to contribute to the net recharge of the Permian aquifer;
- the alluvial aquifer is not modelled separately but is included within the Tertiary and Triassic units, this layer is modelled as the upper unit over the whole of the model area;
- a Tertiary aquifer is known to occur regionally, however the Tertiary unit will not be extensively intersected by the MEP pits and the aquifer is not known to be hydraulically connected to the Rangal Coal Measures. As such the inclusion of the Tertiary aquifer within the model is not warranted;
- while the Rewan Formation directly overlies the Rangal Coal Measures the unit is unlikely to be impacted by mining as the Rewan Formation is considered to be an aquitard;
- the Permian unit outcrops in several regions of the MEP and surrounds due to faulting;
- the underlying Fort Cooper Coal Measures outcrop in the centre of the MEP, but as it is hydraulically disconnected from the Rangal Coal Measures it has been excluded from the groundwater simulation;
- recharge of the Rangal Coal Measures will occur only where the unit subcrops, due to the impermeable characteristics the overlying Rewan sediments, primarily as a result of rainfall, and to a lesser extent from seepage loss from the base of creeks where they cross the seams;
- regional groundwater flow within the Rangal Coal Measures aquifer is to the south southeast;
- the hydraulic conductivity of the Rangal Coal Measures is considered to decline with depth; and
- significant groundwater usage surrounding the MEP is minimal to non-existent with the exception of dewatering associated with proximal coal mines (i.e. Carborough Downs, Poitrel and Daunia).

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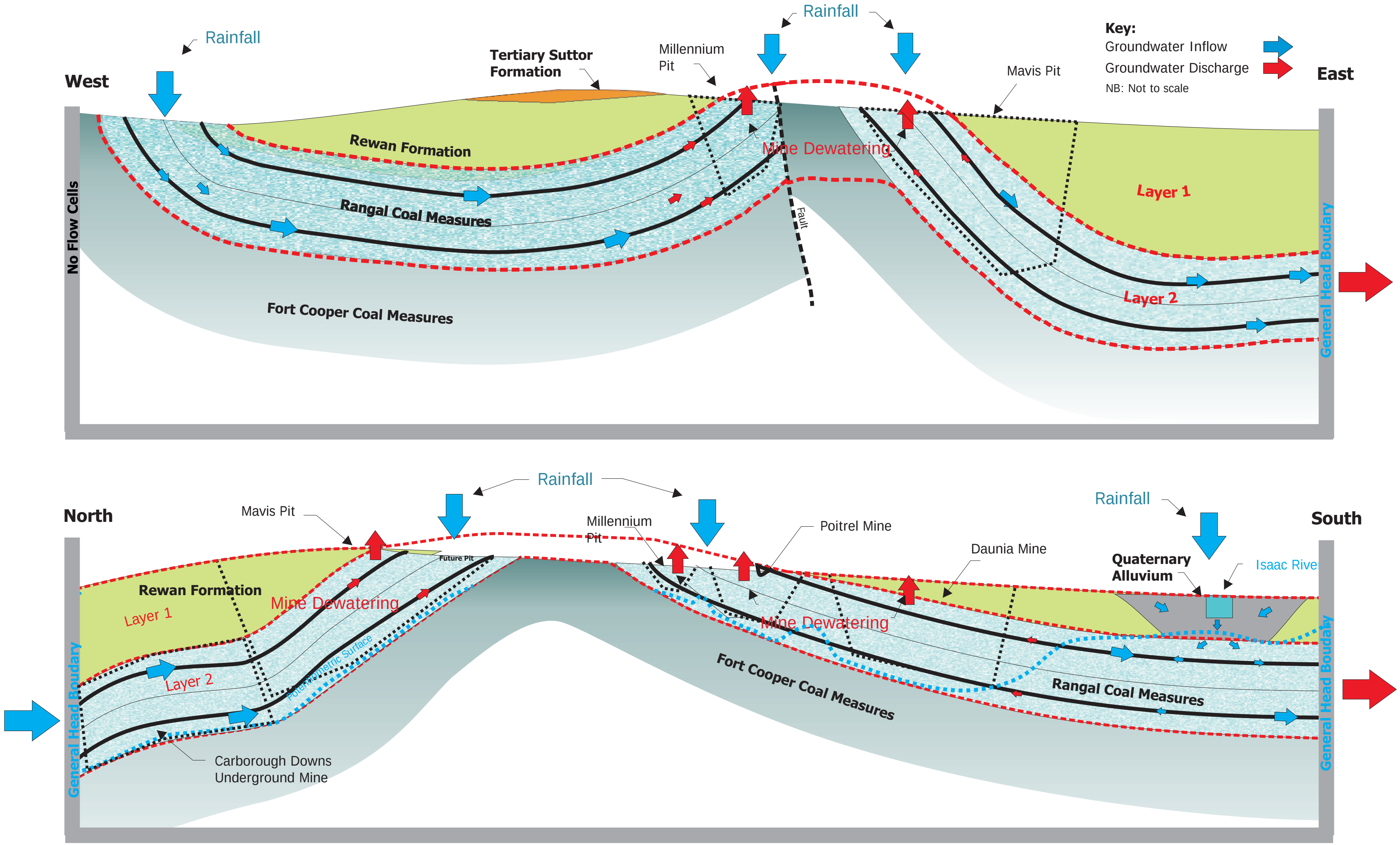


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**Groundwater Impact Assessment**

**Conceptual Groundwater Model - Figure 10-23**

### Numerical Model Geometry & Development

A numerical groundwater model was constructed, concordant with the conceptual model, using Processing MODLFOW Professional (PMWIN) software. The groundwater model is termed an 'Impact Assessment Model' and is suitable for predicting the impacts of proposed developments or management policies, as defined by the *Groundwater Flow Modelling Guideline* (Aquaterra Consulting Pty Ltd, 2000). Hydrogeological parameters including hydraulic conductivity, storativity, recharge, river leakage, vertical leakance and regional through-flow were assessed and entered into the model. The model was then calibrated to simulate site conditions. An outline of the modelling process, including set-up and assumptions, is presented in **Appendix F4-Groundwater**.

The geometry of the 3-D numerical model has been presented as **Figure 10-24**. The model included the Quaternary Alluvium & Triassic sediments (Layer 1) and the Rangal Coal Measures (Layer 2).

Inactive cells have been used to model the disconnection of aquifers where the unit out crops and sub-crops across the MEP area. The Isaac River is simulated using 'River' cells and vertical leakage to simulate possible connections with the MEP and the Quaternary Alluvium/Riparian vegetation.

Pre-mining groundwater levels are available from 2004 and therefore a start date of January 2004 was selected for the model in order to inversely calibrate aquifer parameters to match observed and simulated hydraulic heads. The predictive model progressed from 2004, with yearly stress periods, for a total of 25 years. This incorporated cumulative mining operations (2006-2028), with the predictive period extended beyond 2028, to investigate post-mining groundwater recovery.

### Calculation of Groundwater Inflow to Pit Voids

The estimation of pit inflow rates and groundwater drawdown is based on 3-D numerical groundwater modelling, experience and qualitative assessment. In terms of numerical modelling, the mine plan was notionally defined as a progressive excavation from west-to-east with 26 evenly-paced stages over 26 years.

Due to the lack of time-varient groundwater levels in the MEP area, transient model calibration was not possible. Steady state calibration was attempted with successful results, but cannot be used to assess the time varient accuracy of natural throughflow fluctuations across the model domain.

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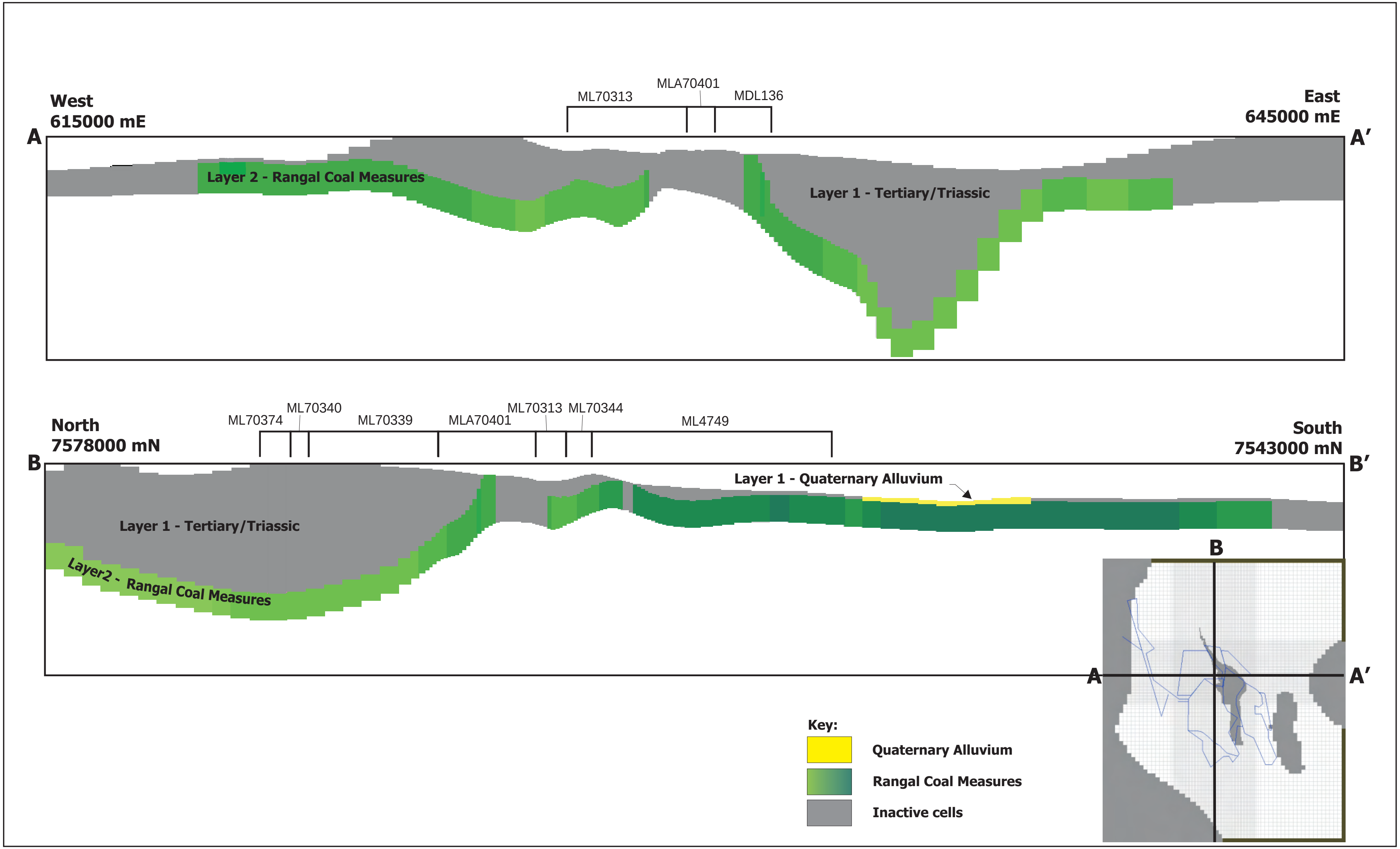


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**Model Geometry - Figure 10-24**

A uniform groundwater recharge rate of 0.01 mm/day and 0.003 mm/day was assumed for the respected aquifers, a generalised value used to represent precipitation minus the effects of evaporation. The aquifer parameters, including hydraulic conductivity and storativity, are presented in **Appendix F-4-Groundwater**.

*10.6.2.2 Groundwater Inflow and Dewatering Requirements*

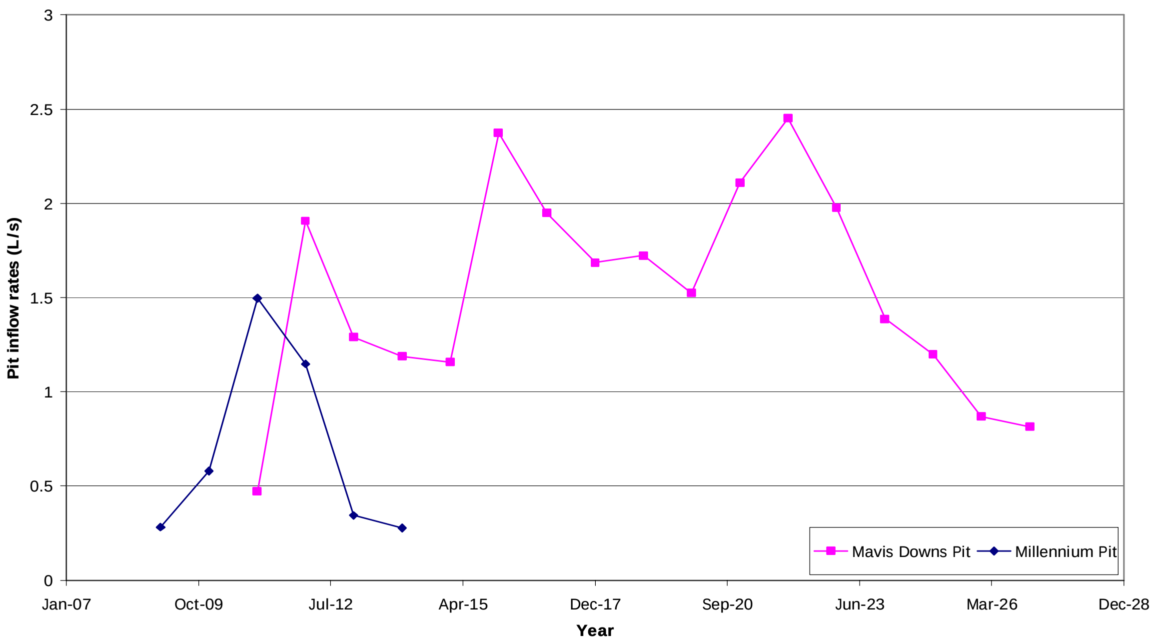
Using the water budget extractor in PMWIN, pit inflow rates for the MEP pits were simulated. Predicted inflows to the pits over the mining period are presented in **Table 10-20** and **Figure 10-25**.

**Table 10-20 Groundwater Inflow Rates into the MEP Pits**

| Pit | Units | Estimated Groundwater Inflow Rates | | | |
|---|---|---|---|---|---|
| | | Year 5 | Year 10 | Year 15 | Year 19 |
| Millennium Pit | ML/day | 0.07 | 0.02 | NA | NA |
| | ML/Year | 24.28 | 8.83 | NA | NA |
| | L/s | 0.77 | 0.28 | NA | NA |
| Mavis Downs Pit | ML/day | 0.11 | 0.14 | 0.17 | 0.09 |
| | ML/Year | 38.54 | 52.69 | 62.44 | 33.43 |
| | L/s | 1.22 | 1.67 | 1.98 | 1.06 |

NA – Inflow rates not applicable to an in-filled system

**Figure 10-25 Simulated Millennium Mine and the MEP Pit Inflows**




The MEP Mavis pit is expected to encounter higher inflow rates due to the greater depth and larger circumference of the pit compared to the Millennium pit.

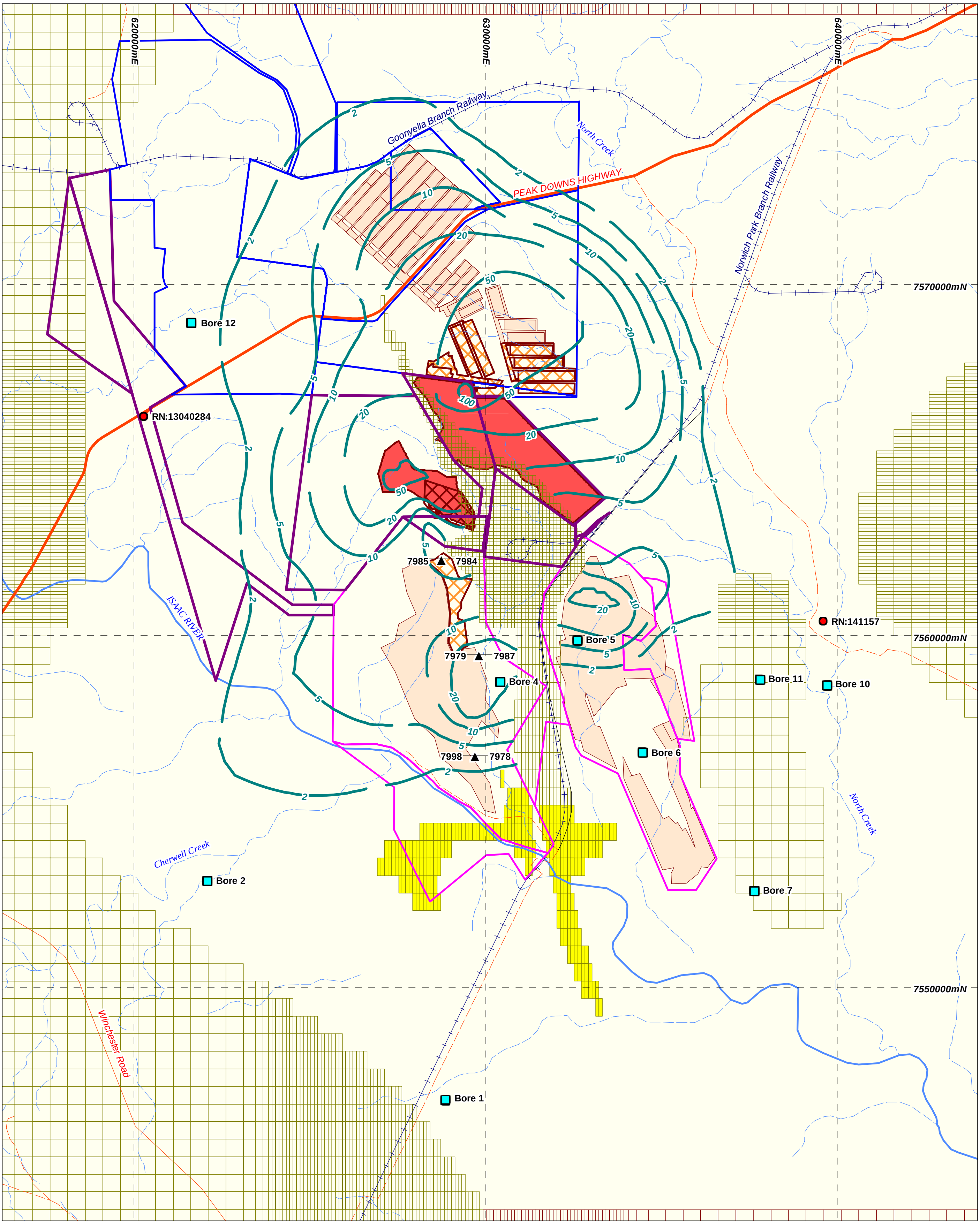
**Figure 10-25** indicates that groundwater inflow rates from the walls of the exposed Rangal Coal Measures are predicted to be relatively low, averaging between 0.28-1.98 L/s. This inflow will be distributed across the area of active mining, a portion of this inflow will be expected to evaporate with the remainder removed via dewatering sumps. It is also likely that groundwater flow through the Rangal coal measures waste rock makes up a significant proportion of this inflow.

Modelling results indicate initial flows into the MEP Mavis Pit reduced from 1.2-0.5 L/s with the inclusion of dewatering of Carborough Downs, which indicates that Carborough Downs does significantly impact the rate of inflow into the initial MEP operations. Following this initial significant difference, comparative inflows using the inclusion/exclusion of Carborough Downs are relatively minor, suggesting that dewatering activities associated with the Carborough Downs Mine have a minimal ongoing impact on MEP Mavis Pit inflows.

#### *10.6.2.3 Potential Impacts on Regional Groundwater Levels during Mining Operations*

During the life of the MEP, the rate of groundwater extraction from the mine workings will exceed the rate that the Rangal Coal Measures can recharge. This will lead to drawdown of the potentiometric surface (i.e. groundwater levels) in the vicinity of the MEP when compared to pre-mining levels at this location.

The impact of mining related groundwater extraction on the Rangal Coal Measures aquifer has been simulated within the 3-D numerical groundwater flow model. The potential impact is illustrated via a series of groundwater drawdown contour maps at various stages through the MEP mine life (refer to **Figure 10-26** to **Figure 10-29)**. The two metre contours represent the maximum radius of influence, groundwater level changes less than two metre are not considered to be significant as this is within expected seasonal fluctuations experienced within the region.

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**LEGEND**

- Principal road
- Road (sealed)
- Road (unsealed)
- Railway
- River
- Watercourse
- Drawdown contour (m)
- Permian DERM registered bore
- Permian landholder unregistered bore
- Peabody tenement
- BMA tenement
- Vale tenement
- Existing Millennium Pit
- Proposed MEP mine
- Other existing mine
- Other proposed mine
- Model boundary
- No flow zone
- Vertical leakance

Data Source:
Infrastructure, Tenement - Minserve. Topography (250k) - Geoscience Australia.

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# Millennium Expansion Project

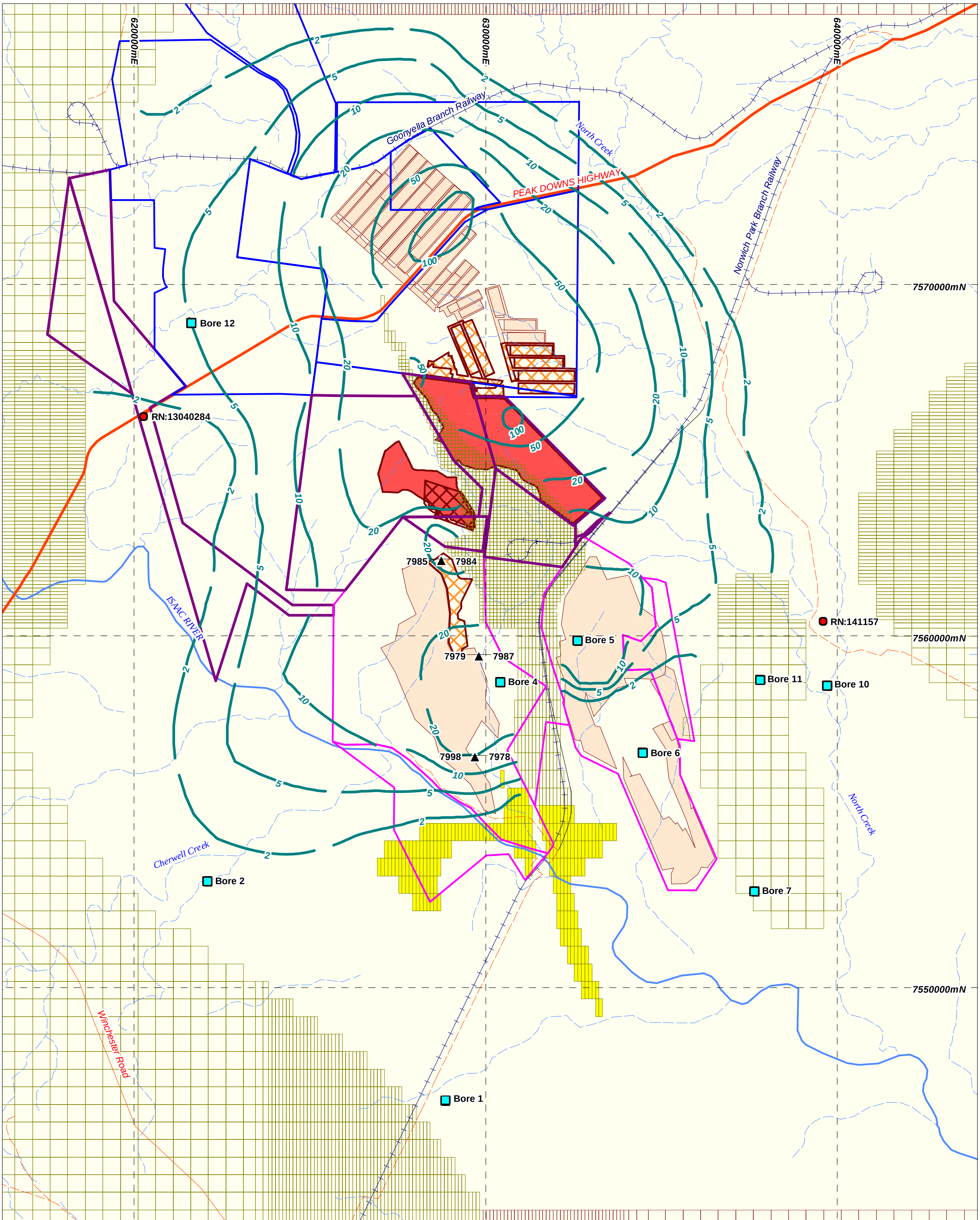
## Groundwater Drawdown Year 5
## Rangal Coal Measures

0 3 6
Kilometres
Scale: 1:150,000 (A4)

15/10/2010

Datum: GDA94
Projection: MGA55

FIGURE 10-26

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**LEGEND**

- Principal road
- Road (sealed)
- Road (unsealed)
- Railway
- River
- Watercourse
- Drawdown contour (m)
- Permian DERM registered bore
- Permian landholder unregistered bore
- Peabody tenement
- BMA tenement
- Vale tenement
- Existing Millennium Pit
- Proposed MEP mine
- Other existing mine
- Other proposed mine
- Model boundary
- No flow zone
- Vertical leakance

Data Source:
Infrastructure, Tenement - Minserve. Topography (250k) - Geoscience Australia.

## Peabody Energy Australia Pty Ltd
# Millennium Expansion Project

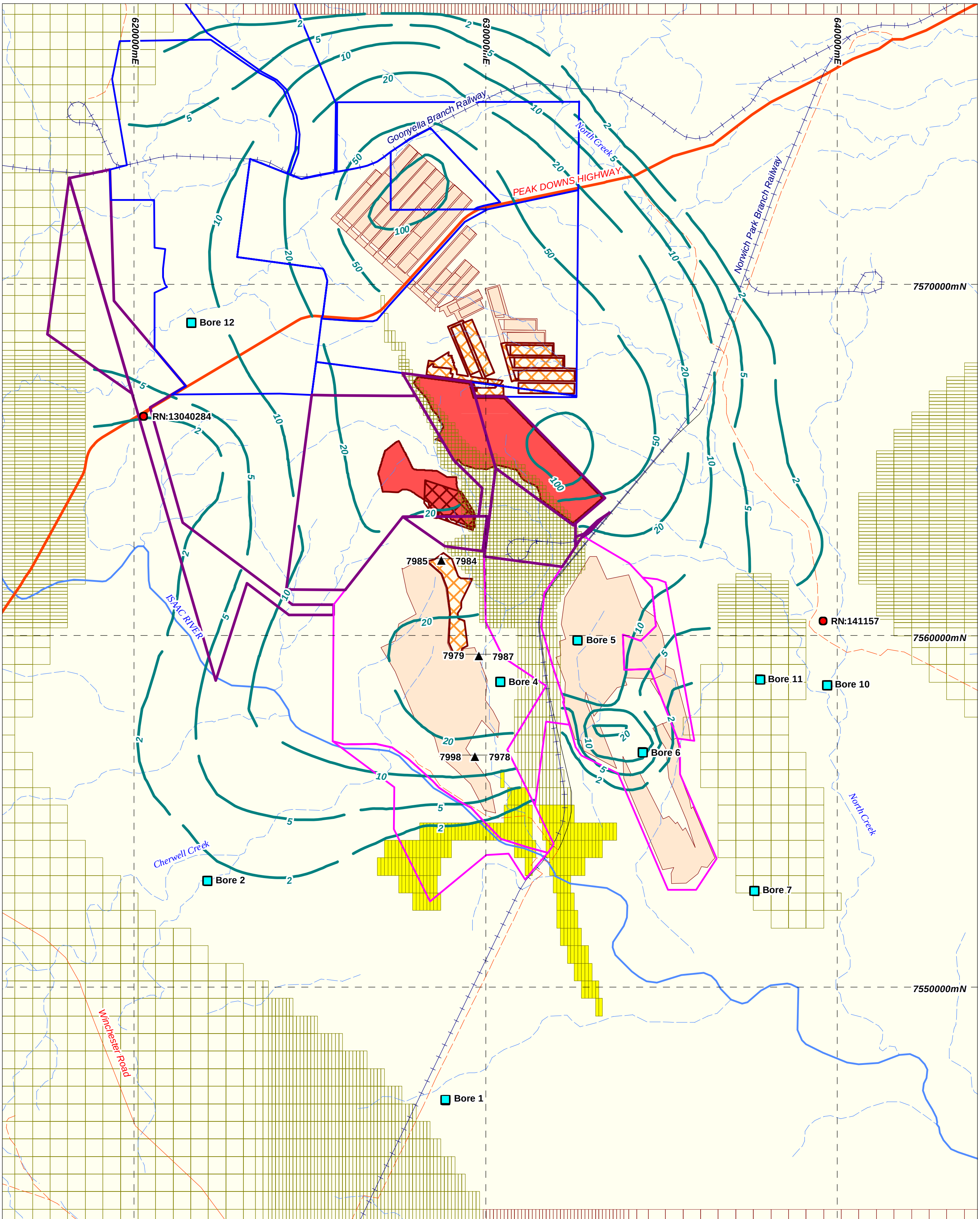
## Groundwater Drawdown Year 10
## Rangal Coal Measures

0 3 6
Kilometres
Scale: 1:150,000 (A4)

15/10/2010

N
Datum: GDA94
Projection: MGA55

FIGURE 10-27




## LEGEND

- Principal road
- Road (sealed)
- Road (unsealed)
- Railway
- River
- Watercourse
- Drawdown contour (m)
- Permian DERM registered bore
- Permian landholder unregistered bore
- Peabody tenement
- BMA tenement
- Vale tenement
- Existing Millennium Pit
- Proposed MEP mine
- Other existing mine
- Other proposed mine
- Model boundary
- No flow zone
- Vertical leakance

Data Source:
Infrastructure, Tenement - Minserve. Topography (250k) - Geoscience Australia.

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# Peabody Energy Australia Pty Ltd

# Millennium Expansion Project

## Groundwater Drawdown Year 15
## Rangal Coal Measures

0 3 6

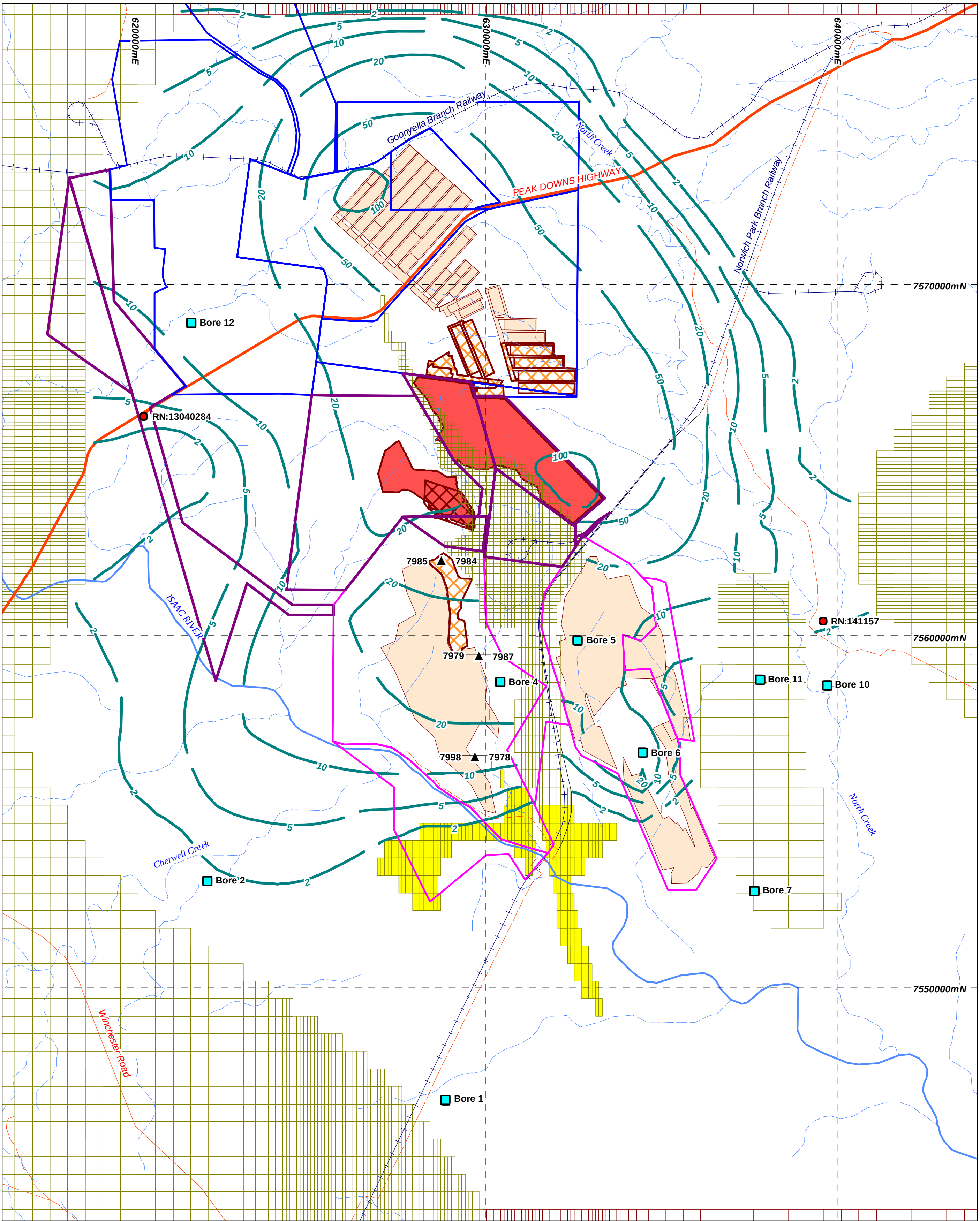
Kilometres

Scale: 1:150,000 (A4)

15/10/2010

Datum: GDA94
Projection: MGA55

FIGURE 10-28




LEGEND

- Principal road
- Road (sealed)
- Road (unsealed)
- Railway
- River
- Watercourse
- Drawdown contour (m)
- Permian DERM registered bore
- Permian landholder unregistered bore
- Peabody tenement
- BMA tenement
- Vale tenement
- Existing Millennium Pit
- Proposed MEP mine
- Other existing mine
- Other proposed mine
- Model boundary
- No flow zone
- Vertical leakance

Data Source:
Infrastructure, Tenement - Minserve. Topography (250k) - Geoscience Australia.

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# Millennium Expansion Project

## Groundwater Drawdown End of Mine
## Rangal Coal Measures

0 3 6
Kilometres
Scale: 1:150,000 (A4)

15/10/2010

Datum: GDA94
Projection: MGA55

FIGURE 10-29

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Dewatering by the MEP and the neighbouring mines is predicted to create an amalgamated drawdown cone in the Rangal Coal Measures to the north, east and west of the MEP. The largest drawdowns are immediately surrounding the MEP pits, with large radial drawdowns observed propagating north of the MEP, a cumulative response to dewatering of both the Mavis Downs Pit and the Carborough Downs Underground Mine. Drawdowns to the southwest are constricted owing to the unit outcropping and continued recharge to the Rangal Coal Measures via the Isaac River. Predicted groundwater drawdown of two metres within the Permian aquifer will reach approximately nine kilometres to the north and six kilometres west of the MEP at the end of mining at the MEP. Due to the cumulative impacts from Carborough Downs, drawdowns of up to ten metres will reach the eastern termination of the Rangal Coal Measures.

**Figure 10-30** shows hydrographs of the predicted decline of groundwater levels in bores surrounding the MEP for the period of mining. The grey cells on the map represent areas where the Rangal Coal Measures outcrops and terminates. The largest drawdown predicted in the Rangal Coal Measures aquifer is 29.96 m in bore 7987. This is to be expected as this bore is located on the edge of the Poitrel Mine pit. Modelling indicates that the MEP will have minimal additional impact on this bore as the major impact will have already occurred by that mine’s activities.

Drawdown impacts within the Quaternary alluvial aquifer have not been simulated as dewatering associated with the MEP is expected to have a minimal impact on groundwater levels within the aquifer. This is due to the hydraulic disconnection between the Quaternary and Permian aquifers.

*10.6.2.4 Potential Impacts on Groundwater Quality during Mining Operations*

The impact from dewatering during mining on the Rangal Coal Measures aquifer will be volumetric, i.e. groundwater discharge into pits will reduce water levels but have no impact on water quality within the surrounding aquifer.

Based on analysis of exploration lithological samples, it is concluded that the stockpiled overburden excavated from the open-cut pits is not expected to present an Acid Rock Drainage (ARD) or salinity risk and there are no restrictions for the proposed uses for this material in regard to ARD or salinity. Therefore runoff and/or recharge from overburden stockpiles is not expected to impact on groundwater pH or salinity through leaching.

The fine rejects or tailings will be dewatered in purpose designed cells before being disposed of within waste rock emplacements. As the tailings are dewatered before encapsulation in the waste rock emplacements, seepage impacts are predicted to be minimal and significant impacts on groundwater quality are not considered likely.

There is potential for spills and contamination by hydrocarbons from mine workshop, waste storage and fuel storage areas. However adequate bunding and clean-up of spills as described in **Chapter 9–Waste** and **Chapter 18–Hazards and Risks** will prevent contamination of shallow strata and subsequent leakage to the groundwater system.

In summary, as groundwater in Rangal Coal Measures aquifer is of poor quality, and there is no potential for it to be degraded further due to the MEP, the available information indicates the assigned environmental values will be maintained.

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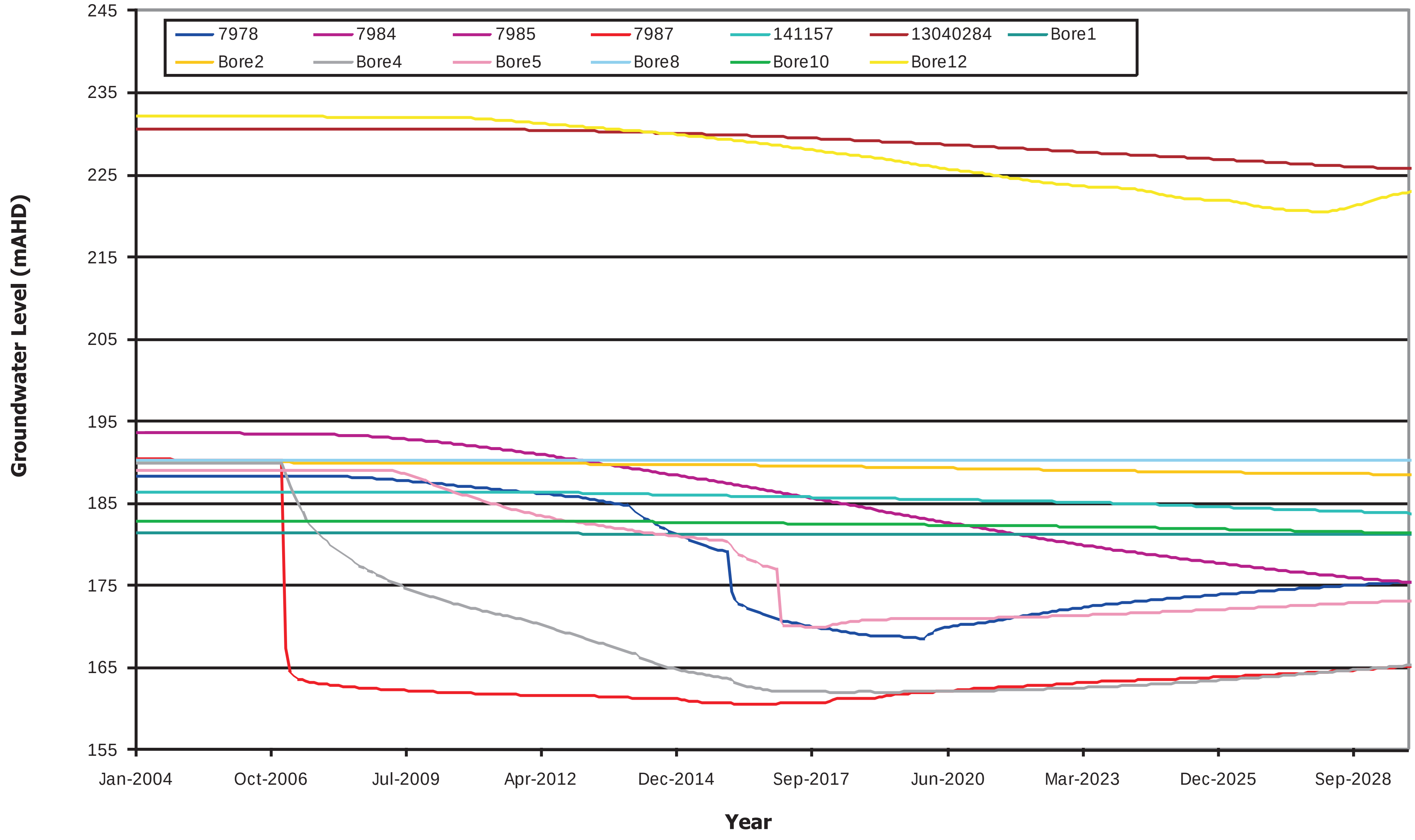


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**Groundwater Impact Assessment**

**Hydrograph of Predicted Groundwater Drawdown in Surrounding Bores - Figure 10-30**

*10.6.2.5 Potential Impacts on Groundwater Users during Mining Operations*

A review of surrounding bores has identified nine production bores that screen the Rangal Coal Measures aquifer. Predictive modelling indicates that the majority of bores screened within the Rangal Coal Measures immediately surrounding the MEP will be impacted to some degree by dewatering throughout the life of the mine. The predicted maximum drawdown on surrounding groundwater user bores are summarised in **Table 10-21**.

The largest predicted drawdowns occur close to the pits with bores exhibiting water level reductions ranging from 19.10 - 27.91 m. Groundwater level changes of this magnitude will impede the use of these bores. However it is assumed that these bores (four and five), located within the Poitrel and Daunia mining leases, will not be utilised as production bores to extract groundwater and therefore no mitigation measures are necessary.

Predicted drawdowns within surrounding landholder bores outside of mine leases are varied. Bore numbers 12, 13040284 and 141157 exhibit groundwater reductions greater than two metres, greater than the range of natural seasonal groundwater fluctuation (i.e. ±2 m). Bore 12 has the greatest drawdown of the regionally located bores, experiencing an estimated drawdown of up to 11.58 m, could potentially affect bore yields. Based on modelling results showing both MEP operations alone and in combination with neighbouring mining operations, this extensive drawdown cone is largely the result of dewatering caused by the nearby existing mining operations to the east of the bore. Modelling indicates that the cumulative impact of existing mining operations on this bore will result in the majority of impact occurring prior to any potential impact from the MEP.

**Table 10-21 Predicted Groundwater Drawdown in the Rangal Coal Measures**

| Bore ID | Bore Type | Distance from MEP Pits (km) | Maximum Predicted Groundwater Drawdown (m) |
|---|---|---|---|
| Bore 1 | Unregistered landholder | 16.2 | 0.05 |
| Bore 2 | Unregistered landholder | 12.3 | 1.50 |
| Bore 4 | Unregistered landholder | 4.4 | **27.91** |
| Bore 5 | Unregistered landholder | 3.3 | **19.07** |
| Bore 8 | Unregistered landholder | 12.6 | 0.00 |
| Bore 10 | Unregistered landholder | 8.4 | 1.52 |
| Bore 12 | Unregistered landholder | 6.6 | **11.58** |
| 141157 | DERM registered | 7.2 | **2.67** |
| 13040284 | DERM registered | 6.6 | **4.81** |

The potential impact on the groundwater users of bores numbered 4, 5, 12 and 141157 include:

- lowering of groundwater potentiometric heads and therefore lowering of pump; and
- reduction in bore pumping rate due to lower groundwater levels.

#### 10.6.2.6 Potential Impact on Riparian Vegetation during Mining Operations

All streams within the study area are ephemeral and there are no perennial water holes present. Under natural conditions, groundwater does not contribute to surface water flow within the Isaac River and local creeks.

Quaternary alluvium does not occur across the MEP, but is associated with the Isaac River to the south of the MEP. The alluvial aquifer's hydraulic connection to the underlying Permian aquifer is limited to where the Isaac River incises the Rangal Coal Measures and is considered to contribute to the net recharge of the Permian aquifer.

The alluvial aquifer is an unconfined system and is therefore directly influenced by both rainfall and river recharge mechanisms associated with the Isaac River. Existing groundwater levels indicate the hydraulic gradient decreases south towards the Isaac River, which suggests that there is likely to be seepage to the Quaternary alluvium from the Isaac River and ultimately to the Rangal Coal Measures through sub-cropping contacts beneath the Quaternary alluvium. Modelling suggests that recharge to the Rangal coal measures sub-crop is greater than the level of drawdown, resulting in a zero impact on the quaternary alluvial aquifer associated with the Isaac River.

#### 10.6.2.7 Operational Impact Mitigation

Any impact to groundwater supplies for surrounding landholders from the MEP is predicted to be minimal, however the cumulative impacts from surrounding operations may potentially have a detrimental effect on two existing bores identified as Bore 12 and Bore 13040284. Bore 141157 has also shown a potential drawdown of up to 2.67 m; however this is not significantly different from the two metre seasonal fluctuations that already occur and is not expected to require specific mitigation measures.

Should a detrimental impact on landholder groundwater supplies be detected, and shown to be related to the MEP operations, Peabody will seek to reach mutually agreeable arrangements with affected neighbouring groundwater users for the provision of alternate supplies throughout the mine life, and after mine closure while the aquifer recovers.

Regular groundwater monitoring will be undertaken to enable groundwater level drawdown to be identified prior to any impacts being experienced in surrounding landholder bores. On the basis of monitoring trends, short-term alternative water supplies can be put in place before supplies from relevant existing landholder bores are adversely affected.

To maintain existing water usage rates, the following mitigation measures will be assessed as required:

- inlet valves within bores may be lowered in order to maintain sufficient head of water above the pump. This may increase the cost of extracting groundwater from bores;
- new pumps may be required if existing pumps are not powerful enough to lift groundwater from the increased depth beneath the surface;
- in some situations, bores may need to be deepened or relocated in order to ensure sufficient long-term water supply; and
- provision of piped water sourced from the mine (i.e. surplus water from the mine pit void dewatering program, depending on quality) may be available.

The specific arrangements for affected properties will be discussed with relevant landholders if and when they occur, with a view to reaching a mutually acceptable agreement.

The actual impact on groundwater users of these two existing bores is likely to be negligible given the minimal use of the aquifer due to marginal water quality and generally low inflow rates.

### 10.6.3 Potential Impacts on Groundwater – Post-Mining

Following cessation of mining at the MEP and surrounding mines, dewatering will cease and groundwater will continue to discharge into the Mavis pit, which will be left as final void at the southern extent of the mine footprint. As the final void fills with groundwater seepage, direct rainfall and surface runoff water levels within the Rangal Coal Measures will begin to recover.

The high evaporation rates in the region will slow the rate of recovery of groundwater levels by constantly removing water from the final void water surface. Groundwater simulation results suggest that regional groundwater levels will recover progressively, reaching equilibrium conditions after approximately 200 years. While this recovery time is quite lengthy from an operational timeframe, given the existing limited use of groundwater in the area it is not predicted that this recovery time will necessitate any additional management controls above what have already been described in this section.

*10.6.3.1 Final Void Water Balance Modelling*

Groundwater recovery post mining was also assessed by 3-D numerical modelling. The majority of the pits will be filled with mine waste rock, which will act as a transmissive medium for groundwater levels to recover through. The southern section of Mavis Pit will remain open.

The recovery of groundwater levels in the Rangal Coal Measures within pits and surrounding bores at the end of mine life is shown in **Figure 10-31**. Levels for the Millennium Pit and for the Mavis Pit were simulated using MODFLOWs recharge package to simulate evaporation, precipitation and through-flow on the final pit lake body.

*10.6.3.2 Potential Impacts on Groundwater Quality Post-Mining*

Predominantly as a consequence of evaporation, the salinity level of the water in the final voids is expected to rise over time. However deteriorating water quality in the final void is not expected to impact upon the groundwater quality within the Rangal Coal Measures aquifer as the water in the void is unlikely to discharge or seep to the surrounding aquifer. This is due to:

- high evaporation rates that will result in the final void water level being lower than the potentiometric level within the surrounding aquifer;
- groundwater will flow under pressure towards the final void along a hydraulic gradient, from areas of high pressure head to areas of low pressure head (i.e. the final void). Accordingly, the depression of the potentiometric surface within the vicinity of the void means it is always down-gradient and will not permit potentially poorer water within the final void to flow outwards into the Rangal Coal Measures aquifer; and
- the Rangal Coal Measures aquifer outside the mining lease areas will continue to receive recharge via the same processes that occurred pre-mining and are not expected to change in quality from pre-mining levels.

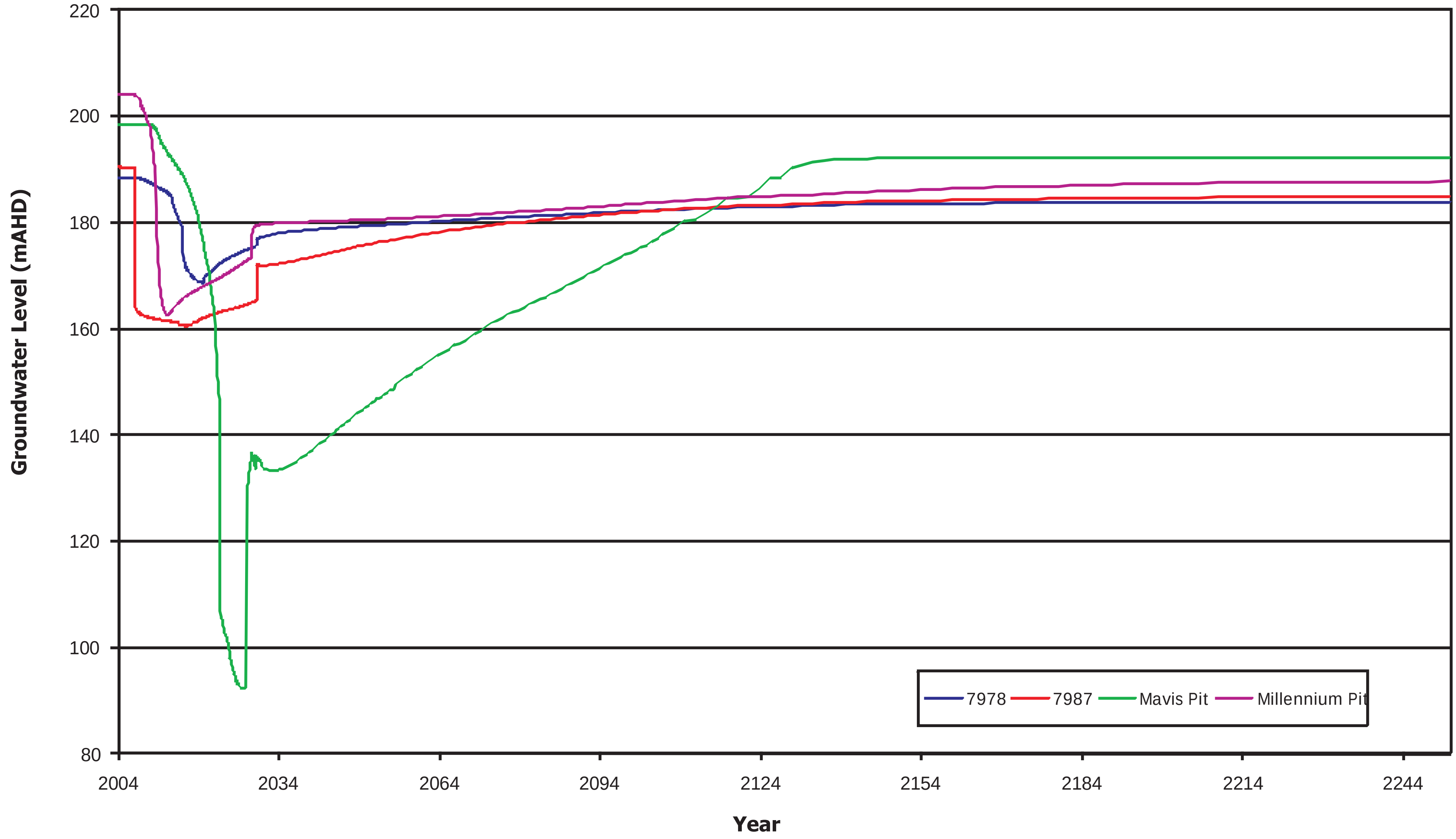
The mining and dewatering operations are not expected to have a detrimental impact on the groundwater quality in the vicinity of the MEP. Hence, the post mining groundwater quality within the Rangal Coal Measures aquifer surrounding the MEP is expected to remain the same as pre-mining groundwater quality.

*10.6.3.3 Potential Impacts on Groundwater Levels Post-Mining*

Recovery rates within the Millennium and Mavis pit voids may vary from approximately 100-200 years, this variability is a result of varying flow gradients and altered recovery conditions presented by different mining and dewatering activities, as shown in **Figure 10-31**.

Groundwater levels immediately surrounding the Millennium pit and Mavis pit will recover relatively quickly. This is due to the increased recharge through pit waste rock, resulting in elevated equilibrium groundwater levels in these areas, relative to surrounding areas i.e. groundwater will flow more easily to these areas with lower internal density.

Groundwater simulation results suggest that regional groundwater levels will reach equilibrium conditions after approximately 200 years.

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**Peabody Energy Australia Pty Ltd**
**Groundwater Impact Assessment**

**Groundwater Level Recovery Post-Mining Activities - Figure 10-31**

*10.6.3.4 Potential Impacts on Groundwater Users Post-Mining*

The two significantly impacted groundwater bores will likely remain affected by dewatering activities associated with the MEP and Carborough Downs for some time after the completion of mining. Groundwater yields will commence recovering soon after mining is finalised, but will not fully return to pre mining levels until the end of the recovery period.

*10.6.3.5 Groundwater Monitoring Program*

Regular groundwater level monitoring should be undertaken to enable groundwater level drawdowns to be identified prior to any impacts being experienced in surrounding bores. A comprehensive groundwater monitoring bore installation and monitoring program will be in place prior to commencement of MEP operations. The proposed program is summarised in **Table 10-22** and proposed bore locations are illustrated in **Figure 10-32**. It should be noted that bore locations are indicative only and will be finalised once the MEP has been approved and Environmental Authority conditions have been granted.

Construction of any bores will be in accordance with Minimum Construction Requirements for Water Bores in Australia (Land and Water Biodiversity Committee, 2003) and the *Water Act 2000* and undertaken by a licensed water bore driller.

**Groundwater Monitoring Program during Mining Operations**

Groundwater level monitoring will be conducted at regular intervals. As the MEP is relatively long-term (i.e. approximately 20 years), water level data loggers may be installed which will be more cost effective than manual measurements. Full groundwater quality analysis for bores will be sampled initially during construction, followed by biannual analysis using low flow sampling techniques. A proposed list of parameters to be sampled is shown in **Table 10-22**. Sampling frequency and parameters should be reviewed annually to assess if the program requires alterations.

All groundwater monitoring, water level measurements and sample collection, storage and transportation will be undertaken in accordance with the procedures outlined by the Murray Darling Basin Commission (1997).

The monitoring network will be installed as soon as practicable to allow collection of baseline data before the commencement of mining at the MEP. The groundwater level and quality data will be analysed annually to assess the impact of the MEP.

The proposed bores will provide groundwater levels in both local and regional extents, providing information on changes in groundwater levels. Two regional bores have been placed to provide impacts in known locations where dewatering associated with dewatering activities associated with the MEP alone. This was determined from the study of the expected groundwater impact areas presented in the respective EIS groundwater report chapters.

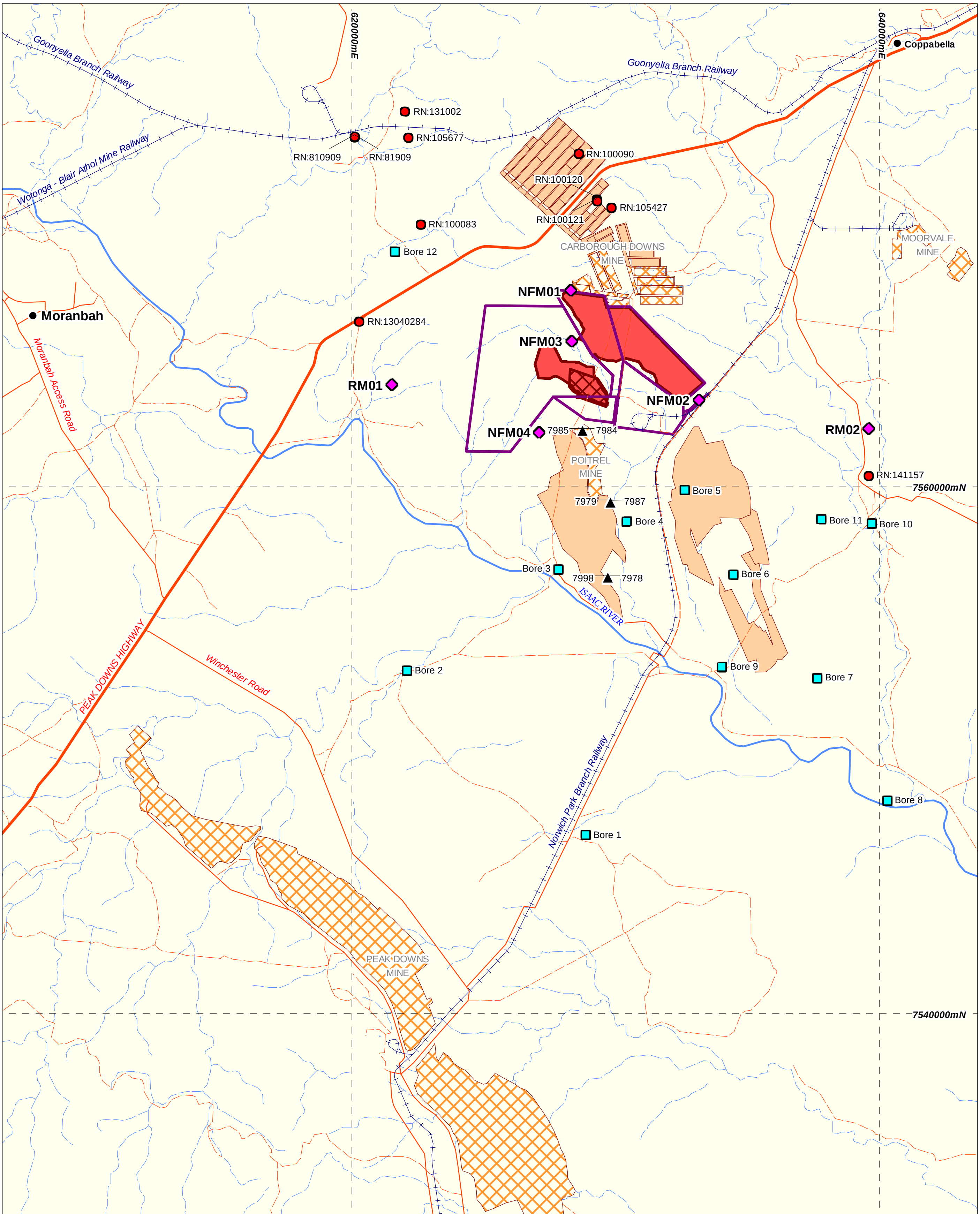
### Table 10-22 Proposed Groundwater Monitoring Program

| Bore ID | Parameter | Frequency |
|---|---|---|
| NFM01 | Groundwater level | Quarterly |
| | Groundwater quality | Biannual – ph, EC, TDS, °C, major cations & anions |
| NFM02 | Groundwater level | Quarterly |
| | Groundwater quality | Biannual – ph, EC, TDS, °C, major cations & anions |
| NFM03 | Groundwater level | Quarterly |
| | Groundwater quality | Biannual – ph, EC, TDS, °C, major cations & anions |
| NFM04 | Groundwater level | Quarterly |
| | Groundwater quality | Biannual – ph, EC, TDS, °C, major cations & anions |
| NFM05 | Groundwater level | Quarterly |
| | Groundwater quality | Biannual – ph, EC, TDS, °C, major cations & anions |
| NFM06 | Groundwater level | Quarterly |
| | Groundwater quality | Biannual – ph, EC, TDS, °C, major cations & anions |
| RM01 | Groundwater level | Quarterly |
| | Groundwater quality | Biannual – ph, EC, TDS, °C, major cations & anions |
| RM02 | Groundwater level | Quarterly |
| | Groundwater quality | Biannual – ph, EC, TDS, °C, major cations & anions |

### Groundwater Monitoring Program Post-Closure Monitoring

After mining has ceased and decommissioning and rehabilitation works are complete, Peabody will seek to relinquish the MEP Leases. Prior to relinquishment, Peabody will discuss the nature, scope and resourcing of an on-going groundwater monitoring program with any parties with whom it has had alternate water supply agreements. This program may be a continuation of that outlined for operational mining, or an agreed variation, depending on the circumstances at the time.

Post-mining groundwater monitoring will be undertaken within monitoring bores that were installed during the operational phase of the MEP.

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Peabody

**LEGEND**

- Principal road
- Road (sealed)
- Road (unsealed)
- Railway
- River
- Watercourse
- Town
- Peabody tenement
- Existing Millennium Mine
- Proposed MEP
- Other existing mine
- Other proposed mine
- DERM registered bore
- Landholder unregistered bore
- Poitrel Mine monitoring bore
- Proposed monitoring bore

Data Source:
Peabody tenement - Minserve. Other tenement - EEDI.
Topography (250k) - Geoscience Australia.

**Peabody Energy Australia Pty Ltd**

# Millennium Expansion Project

**Proposed Groundwater Monitoring Bore Locations**

0 4 8
**Kilometres**
Scale: 1:200,000 (A4)

15/10/2010

N
Datum: GDA94
Projection: MGA55

FIGURE 10-32

## 10.7 CUMULATIVE IMPACTS

### 10.7.1 Surface Water

Land use within the regional catchments is predominantly low intensity grazing, however a number of other mines operate in the vicinity as shown in **Figure 10-33**. The Poitrel Mine operates within the New Chum Creek catchment immediately downstream of the proposed mining lease area. The North Creek catchment contains a number of existing and proposed coal mine operations, including Moorvale, Carborough Downs, and Daunia. Mining operations in the upstream reaches of the Isaac River include Eaglefield, Goonyella/Riverside, Moranbah North and Isaac Plains.

The extent to which previous activities in the catchment have affected receiving water quality is difficult to ascertain. One of the findings of the Environmental Protection Agency (2009) cumulative impacts report is that, in relation to the Fitzroy River catchment 'there is insufficient data to quantify the cumulative impacts of mining water discharges'.

Coal mines have historically discharged mine-affected water immediately following significant rainfall events, but few records are publicly available of the timing and quality of these releases. Typically, under normal conditions, water is conserved on-site to provide water supplies. It is likely that during most of the historical record, streamflow and water quality records are not significantly affected by mine releases.

### 10.7.2 Groundwater

Dewatering activities from the various mining areas proximal to the MEP area will have varying impacts on regional groundwater levels in the region. Due to the low conductive nature of the Rangal coal measure aquifer, major impacts are relativity restricted proximal to mining activities.

*10.7.2.1 Carborough Downs Mine*

Based on modelling results, Carborough Downs has the greatest impact on groundwater levels in the region, due to the nature of the longwall mining activities and the associated deep dewatering requirements. Dewatering activities are predicted to result in the drawdown of groundwater levels by greater than 250 m, resulting in notable impacts on Bore 12 and 13040284. This impact will be exacerbated by the dewatering activities associated with the Millennium Pit, but only to a minor extent due to the relatively shallow nature of dewatering requirements at this location.

Carborough Downs has varying impacts on pit inflow rates into the Mavis pit due the mines close proximity to the north. Initially, impacts are substantial, reducing initial yields by approximately 50% of initial flows. However, inflows from recharge sources from the waste rock aquifer appears to have dominating pit inflow control as rates are consistent to yield predictions using a non-cumulative modelling scenario.

*10.7.2.2 Poitrel Mine*

Dewatering activities associated with the Poitrel Mine will have varied impacts on several existing bores in the area. Dewatering impacts to the east will be restricted by the sub-cropping nature of the aquifer system.

Cumulative dewatering impacts of the Millennium pit and the Poitrel mine will be minimal, due to the relatively shallow dewatering requirements of both pits.

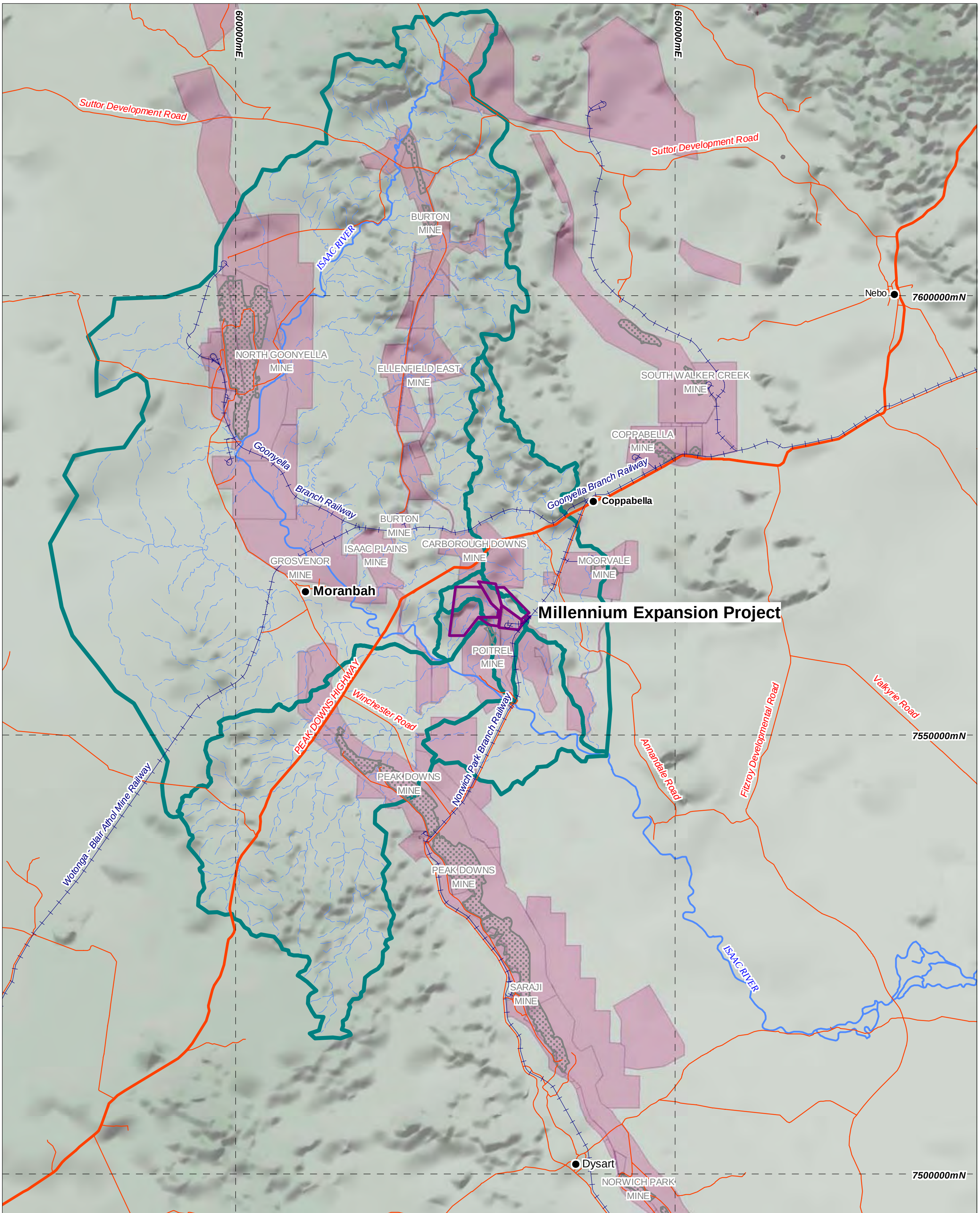
The alluvial aquifer will not be excavated until late in the mine life. Dewatering activities for this aquifer will have minor impacts proximal to the pit, but will have no impact on existing users.

*10.7.2.3 Daunia Mine*

Dewatering activities associated with the Daunia Mine will have varied impacts on several existing bores in the area. Dewatering impacts to the east will be restricted by the sub-cropping nature of the aquifer system.

Cumulative dewatering impacts of the Mavis pit and the Daunia mine will be minimal, due to the distance between the active mining areas and their mine dewatering scheduling.

The alluvial aquifer is not planned to be excavated until late in the mine life. Dewatering activities again, will have minor impacts proximal to the pit, but will have no impact on existing users.

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MET SERVE

Peabody

**LEGEND**

- Principal road
- Road (sealed)
- Railway
- River
- Watercourse
- Town
- Nearby water catchment
- Peabody tenement
- Other tenement
- Existing mine

Data Source:
Peabody tenement - Minserve. Other tenement - EEDI.
Topography (250k) - Geoscience Australia.

**Peabody Energy Australia Pty Ltd**

# Millennium Expansion Project

**Neighbouring Mining Activities**

**0 12 24**

**Kilometres**

Scale: 1:600,000 (A4)

18/10/2010

Datum: GDA94
Projection: MGA55

FIGURE 10-33

## 10.8 REFERENCES

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## ANNEXURE A – LEGISLATION AND REGULATORY GUIDELINES

The Terms of Reference (TOR) for the MEP indicate a number of legislated Acts, regulatory guidelines and other water management documents that should be addressed as part of this EIS. A summary of the relevant documents are detailed below. Requirements from these documents have been reviewed and incorporated into this section as necessary. The Water Resources (Great Artesian Basin) Plan 2006 and associated Resource Operational Plan are not relevant for the MEP which falls outside the Great Artesian Basin.

### *Environmental Protection (Water) Policy 2009*

The *Environmental Protection (Water) Policy 2009 (EPP Water)* seeks to achieve the objective identified by the *Environmental Protection Act 1994 (EP Act)* - to protect Queensland's waters while allowing for development that is ecologically sustainable.

This purpose is achieved within a framework that includes:

- identifying environmental values (EVs) for Queensland waters (aquatic ecosystems, water for drinking, water supply, water for agriculture, industry and recreational use); and
- deciding and stating water quality guidelines and water quality objectives (WQOs) to enhance or protect the environmental values.

EVs and WQOs can be included in Schedule 1 of the EPP Water. The scheduling process is set out in the EPP Water. This process is based on the approach in the *National Water Quality Management Strategy (NWQMS, 2000), Implementation Guidelines* (1998) and further outlined in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (*ANZECC & ARMCANZ*, 2000).

The definition of waters in the *EPP Water* includes the bed and banks of waters, so this section addresses benthic sediments as well as the water column.

### *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000)*

The primary objective of the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* guidelines, developed by *ANZECC*, is:

'To provide an authoritative guide for setting water quality objectives required to sustain current, or likely future, environmental values [uses] for natural and semi-natural water resources in Australia and New Zealand.'

These guidelines play a vital role in the management of water quality in both New Zealand and Australia. They provide methods for setting limits on pollutant concentrations in freshwater, coastal and marine environments.

### *National Water Quality Management Strategy*

*The National Water Quality Management Strategy* (*NWQMS*) provides a national approach to improving water quality in Australia's waterways. Through the application of the *NWQMS* the Australian Government is working in collaboration with States and Territories to reduce pollution being released into aquatic ecosystems with high ecological, social and/or recreational values across the country.

Participants in *NWQMS* are working to protect the nation's water resources by improving their quality, reducing pollutants and at the same time supporting the businesses, industry and communities that depend on water for their continued development.

***DERM Guideline: Establishing draft environmental values and water quality objectives***

This guideline sets out the processes for establishing draft environmental values (EVs) and draft water quality objectives (WQOs) for specific waterways in line with the *National Water Quality Guidelines* (*ANZECC & ARMCANZ 2000*) and the *EPP Water*.

***Queensland Water Quality Guidelines 2006***

The *Queensland Water Quality Guidelines (QWQG)* are intended to address the need identified in the *ANZECC 2000 Guidelines* by:

- providing guideline values (numbers) that are tailored to Queensland regions and water types; and
- providing a process/framework for deriving and applying more locally specific guidelines for waters in Queensland.

***Water Resources (Fitzroy Basin) Plan 1999* and *Resource Operations Plan***

The following are the purposes of this plan:

- to provide a framework for sustainably managing water and the taking of water;
- to provide a framework for establishing water allocations; and
- to regulate the taking of overland flow water.

The *WRP 1999* expires on 1st September 2010. During December 2008, the Minister for DERM advertised the intention to prepare a new *Fitzroy Basin Draft Water Resource Plan (WRP)* to replace the expiring *WRP*. The new plan will now include the management of groundwater across the whole basin, which includes the groundwater resources of the Isaac-Connors catchment.

The new *WRP* (once released) will provide for the sustainable use of the groundwater resource, effective water sharing arrangements, improved definition and security of water entitlements, a framework for tradable water entitlements, water for the environment, salinity management and monitoring and reporting.

***Water Act 2000***

The *Water Act 2000* provides a legislative basis for the sustainable planning and management of Queensland's water resources. It establishes the relevant Water Authorities and their responsibilities, including regulation of water allocations and water usage criteria, and particularly relevant for this section, it also sets the standards for water bore drilling and water bore licensing requirements.

The MEP is also located within the declared Highlands Subartesian Area. The taking of water from an aquifer under land within the area is regulated by the *Water Act* and Queensland *Water Regulation 2002*. Where operations such as coal mining activities intersect aquifers, DERM assesses the need for licensing of groundwater inflow to coal mine pit voids. In cases where groundwater inflow to a mine pit void is sourced from an identified aquifer, and/or where this resource is utilised by others, a licence to take water may be required.

The Water Licence is required to facilitate the management of the resource in terms of monitoring and mitigation requirements. In addition, the Water Licence will also provide security, via make good clauses, to other parties potentially affected by the removal of groundwater from the specified aquifers by mining activities.

A moratorium on the allocation of additional entitlements currently exists for the Isaac River and Connors River Catchment. The existing moratoria intend to ensure the water entitlement status quo remains while the draft *Water Resource (Fitzroy Basin) Plan (WRP)* is being developed. This moratorium is expected to apply until the new *WRP* for the Fitzroy Basin has been finalised. The moratorium applies to all subartesian water in the alluvial aquifers in the unconsolidated Quaternary deposits in the area associated with the Isaac River, the Connors River and all tributaries of those Rivers.

Under the *Water Act*, DERM is planning to advance the sustainable management and allocation of groundwater within the Fitzroy Basin to provide secure supplies for both water users and the environment. When the *WRP* was finalised in 1999, no provision was made for management of the basin's groundwater resources.

***Environmental Protection (Water) Policy 2009***

The *EPP Water* seeks to achieve the objective, identified by the *EP Act*, to protect Queensland's waters while allowing for development that is ecologically sustainable.

This purpose is achieved within a framework that includes:

- identifying environmental values (EVs) for Queensland waters (aquatic ecosystems, water for drinking, water supply, water for agriculture, industry and recreational use).
- deciding and stating water quality guidelines and water quality objectives (WQOs) to enhance or protect the environmental values.

***Fisheries Act 1994***

The main purpose of the *Fisheries Act 1994* is to provide for the use, conservation and enhancement of the community's fisheries resources and fish habitats in a way that seeks to:

- apply and balance the principles of ecologically sustainable development; and
- promote ecologically sustainable development.

The *Fisheries Act 1994* is relevant to the MEP in relation to any impediments or crossings of recognised creeks and waterways as a result of the MEP.

***Australian Drinking Water Guidelines* (NHMRC, 2004)**

These guidelines aim to provide information on acceptable water quality for human consumption and to offer information on measures to ensure their safety. It provides a framework for identifying acceptable water quality and is intended for use by the Australian community and all agencies with responsibilities associated with the supply of drinking water.

***Groundwater Flow Modelling Guideline* (MDBC, 2000)**

These guidelines have been developed for application to groundwater flow modelling projects in the Murray-Darling Basin, although the approaches are suitable for application to modelling projects generally. They are designed to reduce the level of uncertainty for model study clientele, including resource management decision makers and the community, by promoting transparency in modelling methodologies and encouraging consistency and best practice.