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### DWER Submission / Approval Record

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<th>Date of Director General of DWER endorsement</th>
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<td>2.0</td>
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<td>n/a</td>
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<tr>
<td></td>
<td>Submitted with Southern Flank PER initial referral</td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td>October 2017</td>
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<td>New document.</td>
<td>March 2014</td>
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<tr>
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<td>All</td>
<td>Revised document. Submitted with Southern Flank Revised Proposal.</td>
<td>Updated to reflect latest PWRMP template, including changes to reflect Environmental Assessment Guidelines EAG 17 direction. Includes content relating to ecohydrology and hydrological processes from Mining Area C EMP Rev 6. Updated to include Southern Flank Revised Proposal and the Juna Downs Managed Aquifer Recharge Scheme.</td>
<td>October 2016</td>
</tr>
<tr>
<td>3.0</td>
<td>All</td>
<td>Revised document, updated as part of Southern Flank PER process</td>
<td>Restructured to align with Instructions. Minor edits to align with EIA assessments. Coondewanna drawdown triggers reinstated, separate schedule for Ben’s Oasis, updated commitments on cumulative impacts and mitigation strategies.</td>
<td>November 2017</td>
</tr>
</tbody>
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1. Context, Scope and Rationale

This Central Pilbara Water Resource Management Plan (CPWRMP) has been compiled by BHP Billiton Iron Ore Pty Ltd (BHP) to meet external regulatory (Department of Water and Environmental Regulation (DWER)) requirements. The requirements include the development and submission of an 'Environment Management Plan (EMP)' and relevant ‘Schedules’ in accordance with the Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans (EPA, 2017) (the ‘Instructions’). The instruction require an EMP and associated Schedules to demonstrate how a Proponent will meet the intent of various water-related implementation conditions under the relevant Ministerial Statement.

BHP has utilised these provisions to manage an identified number of regional water assets to meet its outcome-based water management objectives in the Central Pilbara water management area\(^1\) of Western Australia (WA). BHP’s outcome-based objective for water in the Central Pilbara water management area is:

*To manage the range of potential hydrological changes (groundwater, surface water and/or soil moisture) resulting from Mining Area C (Northern Flank and Southern Flank) operations impacting on receiving receptors to an acceptable level.*

The regional water assets within the Central Pilbara water management area to which a Ministerial Statement implementation condition applies are:

- Coondewanna Flats vegetation community Priority ecological Community (PEC)
- Weeli Wolli Spring riparian vegetation and groundwater system PEC
- Ben’s Oasis riparian vegetation and groundwater system PEC

This document is one of a number of ‘EMPs’, which have been, or are being, developed by BHP to address its water management requirements in water catchment areas within the Pilbara Region.

In accordance with the Instructions (EPA, 2017), the following sub-sections outline the Proposals that this CPWRMP addresses (Section 1.1), the relevant key environmental factors (Section Error! Reference source not found.), the condition requirements applicable to this Proposal (Section 1.2) and the rationale and approach underlying this CPWRMP (Section 1.4). The EMP Provisions (Section 2) are given in the form of “schedules” as described in the Instructions.

1.1. Proposal

This EMP addresses Ministerial water management conditions for BHP activities within the Coondewanna and Upper Weeli Wolli creek catchments, which BHP refers to as the ‘Central Pilbara water management area’. This includes water management relating to the existing Mining Area C development (MS491), and the activities of the expanded Mining Area C (MAC) operations that include the Southern Flank development.

The key activities include dewatering of the existing and expanded Mining Area C via borefields; and the management of the surplus water generated through dewatering via Managed Aquifer Recharge in the form of reinjection borefields and infiltrations basins. More detail on the proposal is given in Appendix 1.

\(^1\) Further explained in Section 1.1
Figure 1: Central Pilbara water management area
1.2. Key environmental factors

The Instructions require, for each key environmental factor, that a Proponent describes:

1. “the proposal activities which would affect the key environmental factor; and
2. the site-specific environmental value, existing and/or potential uses, ecosystem health condition or sensitive component of the key environmental factor which will be affected”.

(EPA, 2017, p. ii)

The Mining Area C Northern Flank Life-of-Mine Proposal was approved in December 1998 under Ministerial Statement 491 (MS 491). The Proposal was extended to include the Southern Flank deposits via the Public Environmental Review process in 2017 and was approved in XXXX 2017 under Ministerial Statement XXXX (MS XXXX).

The key environmental factors applicable to the Proposal are listed in Table 1.

Table 1: Key environmental factors for which a Schedule has been developed in this CPWRMP

<table>
<thead>
<tr>
<th>Title of proposal / operation</th>
<th>Ministerial Statement Number</th>
<th>Key Environmental Factors</th>
<th>Values</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining Area C Hub Northern Flank and Southern Flank</td>
<td>491 (Pending new MS number)</td>
<td>Riparian Vegetation</td>
<td>Coondewanna Flats vegetation community PEC</td>
<td>Reduction in abundance and diversity of vegetation at Coondewanna Flats</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Riparian Vegetation</td>
<td>Weeli Wolli Creek riparian vegetation community PEC</td>
<td>Reduction in abundance and diversity of riparian vegetation along Weeli Wolli Creek</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydrological Processes</td>
<td>Weeli Wolli spring</td>
<td>Reduction of spring flow at Weeli Wolli spring</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Riparian Vegetation</td>
<td>Ben’s Oasis</td>
<td>Reduction in abundance and diversity of riparian vegetation at Ben’s Oasis</td>
</tr>
</tbody>
</table>

1.3. Condition requirements

A list of those Ministerial Statement implementation conditions, for which a Schedule has been developed within this CPWRMP is provided below in Table 2. The relevant Schedule number is also included in Table 2.
<table>
<thead>
<tr>
<th>Ministerial Statement</th>
<th>Operation</th>
<th>Condition No.</th>
<th>Environmental Factor</th>
<th>Condition Requirements</th>
<th>Schedule</th>
<th>Value</th>
</tr>
</thead>
</table>
| No. 491               | Northern Flank   | Condition 5   | Hydrological Processes | 5-1 The proponent shall manage groundwater abstraction and dewatering activities to ensure minimal adverse impacts on groundwater dependent ecology at Weeli Wolli Spring and Coondewanna Flats through implementation of Section 4.5 of the “Life of Project” Environmental Management Plan (Revision 5a dated October 2014), approved by the CEO, and any subsequent approved revisions in accordance with condition 5-2.  
5-2 To verify that the requirements of condition 5-1 are met the proponent shall undertake monitoring and management as outlined in Section 4.5 of the “Life of Project” Environmental Management Plan (Revision 5a dated October 2014), approved by the CEO, and any subsequent approved revisions which include:  
   i) the specific environmental objectives, trigger and threshold criteria for each environmental factor;  
   ii) the trigger criteria, threshold criteria and management measures to be applied to avoid and minimise the environmental impact of the proposal;  
   iii) monitoring measures to measure the performance of management against trigger and threshold criteria;  
   iv) reporting exceedances of trigger and threshold criteria; and  
   v) contingency measures to mitigate impacts.  
5-3 In the event that the monitoring required by condition 5-2 indicates that the requirements of condition 5-1 are not met, the proponent shall implement contingency actions as outlined in Section 4.5 of the “Life of Project” Environmental Management Plan (Revision 5a dated October 2014), approved by the CEO, and any subsequent approved revisions.  
5-4 The proponent shall submit annually the results of monitoring against objectives, trigger and threshold criteria required by condition 5-2 to the CEO (The Chief Executive Officer of the Department of the Public Service which is responsible for the administration of section 48 of the Environmental Protection Act 1986 or as delegated) as part of the compliance reports required by condition 11. | Schedule 1 | Coondewanna Flats PEC |
| No. XXX               | Southern Flank   | Commitment 1  | Hydrological Processes | No net-loss of the biological diversity and/or ecological integrity of the Coondewanna Flats Priority Ecological Community, as a result of BHP activities.                                                                                     | Schedule 1 | Coondewanna Flats PEC |
|                       |                  | Commitment 2  | Hydrological Processes | No net-loss of the biological diversity and/or ecological integrity of the Weeli Wolli Spring Priority Ecological Community, as a result of BHP activities.                                                                 | Schedule 2 | Weeli Wolli Spring PEC   |
|                       |                  | Commitment 3  | Hydrological Processes | No net-loss of the biological diversity and/or ecological integrity of the Ben’s Oasis Priority Ecological Community, as a result of BHP activities.                                                                                     | Schedule 3 | Ben’s Oasis PEC          |
It is noted that groundwater water quality relating to discharge is managed via the Environmental Protection Act 1986 (EP Act) Licence (licence issued under Part V of the Environmental Protection Act; Licence number L7581/2002/6) and groundwater quality and abstraction is managed via the Department of Water and Environmental Regulation 5C Licence requirements. EP Act Licence allows for discharge of excess mine dewatering water to groundwater (27,541,000 gigalitres per annual period), in order to dispose of water abstracted to facilitate mining below the water table. Compliance to water quality Licence conditions are reported in the Annual Environment Report. Monitoring requirements are outlined in Appendix 1.

Groundwater abstraction is regulated through Department of Water and Environmental Regulation Licence to Take Water GWL110044(10), which allows for the annual abstraction of 15,330,000 kL of groundwater. The groundwater abstraction is carried out in accordance with the GWL Operating Strategy for Mining Area C (BHP, 2015).

1.4. Rationale and approach

This section provides a concise description of the rationale and approach for this CPWRMP overall (to meet internal requirements around managing all activities within the Central Pilbara water management area) and then discusses the environmental objectives for each of the three identified regional water assets to which implementation conditions (and Schedules) apply.

For each regional water asset, it summarises:
- survey findings;
- key assumptions and uncertainties;
- the management approach; and
- the rationale for choice of provisions,

as is required by the Instructions (EPA, 2017, p. ii).

1.4.1. Overall objective, purpose and scope of this CPWRMP

This CPWRMP has been compiled by BHP to meet regulatory (DWER) requirements to develop and submit an EMP and relevant Schedules to demonstrate how BHP meets the intent of various water-related implementation conditions.

Over 30 years of surveys, data collection and understanding of water in the Central Pilbara water management area have been considered in the development of this CPWRMP. This CPWRMP seeks to continue that work and:

… consider the hydrological changes resulting from BHP operations, the receiving receptors (water resources, environment, social and third-party operations), external influence and factors, the potential impacts and the required risk-based adaptive management to mitigate potential impacts to acceptable levels.

As part of BHP’s ongoing commitment to water stewardship this CPWRMP also seeks to:
- establish specific water resource and water-dependent ecosystem management requirements for the Central Pilbara water management area;
- provide a standardised and consistent risk-based approach to regional water management for multiple BHP operations within the same catchment area;
set out the overarching approach and incorporate technical considerations, assumptions and adaptive management approaches;

direct the consistent development and consideration of the catchment, hub and site-specific water resource management requirements for each of the hubs within this catchment area; and

incorporate adaptive management as knowledge regarding the implementation of a particular objective or management action for a specific factor changes over time.

This CPWRMP does not manage impacts on receiving receptors that are beyond BHP’s operational impact, control or responsibility, such as impacts resulting from prolonged dry periods, climate variability or third-party operations.

1.4.1.1. Key Water Sensitive Receptors

Three regional water sensitive assets have been identified that require a ‘Schedule’ to be developed. These are:

- Coondewanna Flats vegetation community PEC (Schedule 1)
- Weeli Wolli Spring riparian vegetation and groundwater system PEC (Schedule 2)
- Ben’s Oasis riparian vegetation and groundwater system PEC (Schedule 3)

For these regional water assets, triggers and thresholds and management measures, as applicable, have been developed in this CPWRMP and specifically included in the relevant Schedules for the endorsement of the Director General of the DWER. The Schedules are intended to be a stand-alone documents.

1.4.1.2. Sources of Hydrological change

There are a range of water-affecting activities in the Central Pilbara catchment which may result in changes to hydrological processes. These include:

1. Local drawdown of the groundwater levels, resulting from abstraction of water to facilitate below water table mining;
2. Regional drawdown or mounding of the groundwater levels, which is a change in groundwater levels that extends beyond the immediate vicinity of the deposit or site or re-injection of surplus water into the aquifer via managed aquifer recharge;
3. Changes in groundwater water quality resulting from mining, abstraction or re-injection; and
4. Changes in surface water flows or water quality resulting from surface water management, including discharge of surplus water, or diversion.

A high level assessment of the range of water-affecting activities, potential change in hydrological environment and controls in place for each receptor is presented in Sections 1.4.2 to 1.4.4.

1.4.1.3. Methodology for monitoring hydrological change

Adaptive management for the key receptors allows for three stages of response, including an investigation, action and mitigation stage. The approach ensures that any change and/or response observed is characterised and understood prior to implementing corrective action.

A Source-Pathway-Receptor approach to monitoring will provide the data that supports the response hierarchy:

1. **Source** – measure the change created by BHP operations. This includes the magnitude, timing and duration of the change to water.
2. **Pathway** – measure how this change propagates into the surrounding environment. This includes rate, magnitude, timing and direction of changes moving out from our operations. Pathway measurement forms the basis of regional conceptual models and impact forecasts.
3. **Receptor** – measurement of water parameters at receptors is used to confirm predictions based on Source and Pathway monitoring.

Potential impact pathways between MAC operations and these water dependent receptors have been identified using regional monitoring data and groundwater modelling. The likelihood of these pathways effecting change at receptors has been informed by measurement of catchment response to existing stresses. These measurements have also informed our numerical and conceptual models. **Error! Reference source not found.** shows the impact pathways between BHP activity and the listed receptors and the likelihood of connection.

<table>
<thead>
<tr>
<th>Source of Change</th>
<th>Receptor</th>
<th>Source of Change</th>
<th>Receptor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coondewanna Flats PEC</td>
<td></td>
<td>Weeli Wolli Spring</td>
</tr>
<tr>
<td>Northern Flank Drawdown</td>
<td>Connection to western Northern Flank deposits via regional dolomites and Marra Mamba formation. Connection likely as drawdown has been observed along pathway.</td>
<td>Connection to eastern Northern Flank deposits via regional dolomites and Marra Mamba formation. Connection unlikely as stress from Hope Downs not observed in eastern deposits.</td>
<td></td>
</tr>
<tr>
<td>Southern Flank Drawdown</td>
<td>Connection to Highway deposits via regional dolomite and Marra Mamba Formation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R Deposit Drawdown</td>
<td>No obvious impact pathway</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Likelihood: Unlikely, Possible, Likely

The monitoring strategy is to deploy sufficient monitoring along these pathways to confirm and refine predictions and to act as trigger points for minimisation or mitigation works. Trigger points and mitigation actions will be refined over time as conceptual uncertainties are resolved.

### 1.4.1.4. Setting triggers and thresholds for significant impact

Early warning triggers are defined to provide the point at which further investigation of the change in the environment is considered and management options are proposed, should the trigger values be reached. It is noted that pro-active management may result in action being taken at this stage.

Trigger values are defined to provide the point at which water management options must be considered and implemented to avoid potential impact to a receiving receptor; the trigger is intended to operate sufficiently early to allow water management options to be put in place well before the threshold value for the receiving receptor is reached.

Threshold values are defined to provide the point at which corrective actions must be implemented in order to prevent unacceptable environmental impact or reverse the negative trends.

Triggers have been set to assess whether a hydrological change has resulted in an impact to a receiving receptor as a result of BHP operations. Three receptors have been identified as having the potential to be impacted by changes in hydrological processes associated with the implementation of additional abstraction volumes, these being the Coondewanna Flats, Weeli Wolli Spring and Ben's Oasis. A
description of the receptors of value is presented in Section 1.4.2, 1.4.3 and 1.4.4, while trigger values are presented in Schedules 1 through 3.

### 1.4.1.5. Water management options

The water management options outlined in Table 4 consider feasible options and controls (preventative and mitigating) to counteract hydrological changes resulting from BHP operations and the potential impacts to receiving receptors during BHP operations and closure. This enables flexibility with regards to water management and takes into account optimising of mine dewatering, storage and use. This approach is consistent with the Department of Water (DoW) guidance (Water and Mining Guidelines, 2013) and considers prioritisation of transferring water for reuse, minimising the dewatering drawdown footprint, and offsetting the impacts to receiving receptors to an acceptable level.

**Table 4: Feasible water management options to minimise potential impacts to receiving receptors resulting from BHP operations**

<table>
<thead>
<tr>
<th>WATER RESOURCE</th>
<th>TRANSFER</th>
<th>STORAGE</th>
<th>TREATMENT</th>
<th>DISCHARGE</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proactive Dewatering</td>
<td>Short term pipeline</td>
<td>Tanks, Turkey Nests, Ponds</td>
<td>Desalination/RO</td>
<td>Managed Aquifer Recharge (MAR)</td>
<td>Community project</td>
</tr>
<tr>
<td>Aquifer Abstraction</td>
<td>Long pipeline</td>
<td>Managed Aquifer Recharge (MAR)</td>
<td>Sediment Basins</td>
<td>Infiltration Ponds</td>
<td>3rd Party Supply</td>
</tr>
<tr>
<td>Desalination/RO</td>
<td>Infiltration Dam and Ponds</td>
<td></td>
<td></td>
<td>Irrigation of Trees</td>
<td>Agriculture</td>
</tr>
<tr>
<td>Surface water capture</td>
<td>In-pit Storage</td>
<td></td>
<td></td>
<td>Creek Discharge</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>In-pit Storage Short term</td>
<td></td>
</tr>
</tbody>
</table>

Note: Options shown in bold are confirmed and currently in place. Options shown in regular are currently under evaluation or a future possible alternative under suitable water balance and sustainability scenarios.

These tools are based on capturing and moving groundwater or surface water to locations that best prevent or mitigate impacts. Depending on how water supports a particular receptor, mitigation of impacts could involve moving water into surface water systems or back into the underlying aquifers.

Ongoing evaluation and selection of appropriate mitigation tools are integral components of adaptive management. The choice of tools may change over time: for instance surface irrigation may be required during peak disturbance periods but aquifer augmentation may be more appropriate once recovery is underway.

For the receptors and high-likelihood pathways identified in Table 3, examples of potential mitigation tools are detailed in Table 5. Given the range of operational and hydrological uncertainty the selection and implementation of these tools are subject to change. Consultation with Rio Tinto Iron Ore (RTIO) may be needed to enable effective planning and implementation of some solutions.

**Table 5: Mitigation options for selected receptor and impact sources**

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Impact Source</th>
<th>Mitigation during Operations</th>
<th>Mitigation at Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coondewanna Flats</td>
<td>Northern Flank dewatering</td>
<td>Managed Aquifer Recharge (MAR) injection to offset drawdown propagation.</td>
<td>Backfill of MAC to aid groundwater recovery.</td>
</tr>
<tr>
<td>Coondewanna Flats</td>
<td>Southern Flank Highway dewatering</td>
<td>Periodic surface water irrigation following extended drought period to replenish soil moisture store.</td>
<td>Backfill of Highway pit to pre-mining water table to aid groundwater recovery. MAR and/or augmented recharge to</td>
</tr>
</tbody>
</table>
1.4.1.6. Cumulative effects

There are currently two mining operators within the Central Pilbara catchment, BHP (Mining Area C) and Rio Tinto (Hope Downs operations). BHP has taken into account third party operations and data in assessment as far as the available data allows.

Monitoring and catchment scale eco-hydrological studies are undertaken to provide baseline assessments and inform predictive models, which will be updated iteratively to inform cumulative impact assessments and inform adaptive management.

BHP will manage its share of impacts on a receptor. BHP’s proportion of impacts will be determined based on measurement and appropriate predictive techniques. Where the majority of change result from third party effects, BHP will not be responsible for final outcome at receptor.

A co-operative and collaborative approach with third parties will be sought for water management.

1.4.2. Coondewanna Flats

1.4.2.1. Survey and Study Findings

Location
Coondewanna Flats is a PEC located about 18 km south west of BHPs MAC operations. The flats occur within an intermontane area bound by hills of Mt Robinson and The Governor to the east and south, and Packsaddle and Mt Meharry to the north and west. The Great Northern Highway passes to the east of the Coondewanna Flats boundary and Rio Tinto’s West Angelas to Cape Lambert rail line passes to the west.

Values
Coondewanna Flats (including Lake Robinson) includes several vegetation communities with two being classified as priority ecological communities (DPaW, 2014):

- Coolibah woodlands over lignum over swamp wandiree (Priority 1). Lake Robinson has the only known occurrence of this community.
- Coolibah and Mulga woodland over lignum and tussock grass on clay plains (Priority 3). This community has only been identified at Coondewanna Flats and Wanna Munna, which is about 40 km to the southeast. It is extensive on the flats to the south of Lake Robinson.

Hydrology
Lake Robinson forms within Coondewanna Flats during the wet season as a shallow ephemeral lake. The lake may persist for several months following periods of heavy rainfall.

Surface water flows towards the flats from the north, west and south draining a catchment area of approximately 866 km². Lake Robinson occurs within a topographic low at the north-eastern extent of the flats and is ultimate terminus for catchment runoff. Water in the lake is either lost to evaporation or infiltrates into the underlying Tertiary detritals, where it replenishes soil water in the unsaturated zone and potentially contributes to groundwater recharge.
Hydrological dependencies

An ecohydrological conceptualisation of Coondewanna Flats is provided in Figure 2. Figure 2 makes use of the Pilbara landscape Ecohydrological Units (EHU) developed as part of BHP’s Stratengical Environmental Approval project (BHP, 2015b). The Lake Robinson area of Coondewanna Flats (EHU 9 in Figure 2) supports distinct Coolibah (Eucalyptus victrix) woodland vegetation communities. The surrounding flats (EHU 6 in Figure 2) are characterised by poorly-defined drainages with Coolibah and mulga (Acacia aptaneura) woodland vegetation. The key hydrological aspects of the system are:

- Surface water flow into Coondewanna Flats is likely to occur every three in four years and is an important process for replenishing soil moisture in the unsaturated profile.
- Beneath the flats, an unconfined calcrite aquifer is present at a depth of 20 to 30 mbgl. It is overlain by largely unsaturated Tertiary dterials and underlain by low to high permeability dolomite of the Wittenoom Formation. This dolomite forms part of a regional groundwater flow system that ultimately reaches Weeli Wolli Spring.
- Groundwater recharge is associated with the infiltration of ponded surface water runoff. Recharge events are estimated to occur once in every four years. RPS (2014a) estimated that annual average recharge rates are about 2.4 GL at Lake Robinson and 4 GL over the broader Coondewanna Flats area. The Coondewanna Flats has been identified as a potential groundwater recharge area for Weeli Wolli Spring.
- Groundwater discharge occurs as outflow to the Southern Flank and Northern Flank Valleys, which hydraulically connect the Coondewanna and Weeli Wolli Spring catchments from a groundwater perspective however a southwest-northeast trending dyke cutting across the south east corner of Coondewanna Flats may act as a partial barrier for groundwater flow into the Southern Flank valley.

Long-term investigations into the eco-hydrology of the Coondewanna Flats priority communities indicate that the vegetation assemblage is highly unlikely to rely on groundwater to meet water requirements. The ecological studies were collectively reviewed in AQ2, 2016. For the key species in the PEC communities:

- *E. victrix* on Coondewanna Flats rely on stored soil moisture to meet their water requirements, which is replenished by surface water inflow. Studies indicate these trees are able to obtain soil moisture for prolonged periods from horizons within the unsaturated zone above the watertable (Astron, 2014). The *E. victrix* woodlands at Coondewanna Flats are considered unlikely to rely on groundwater.
- The surface water dynamics of Coondewanna Flats are likely to influence bud-set, flowering, seed production and seedling recruitment of the *E. victrix*. However, further investigations are necessary to understand the relationship between flooding regimes and the reproductive cycle of the woodland trees.
- Mulga (Acacia aptaneura) is a shallow-rooted species with xerophytic adaptations to drought stress. Water use requirements of the Mulga communities on the flats are most likely met by soil water in surface layers (up to 5 mbgl), which is replenished by rainfall and runoff.
- Muehlenbeckia are vadophytic and may not rely on groundwater to meet plant water requirements owing to the depth to water (>15 m) and seasonal surface water inundation (AQ2, 2016).

For *E. victrix*, the species with the highest likelihood of groundwater dependency, the key findings that support dependency on soil moisture rather than groundwater derived from studies undertaken within the PEC are as follows:

- Basal stem area per hectare is indicative of a water limited community. Equivalent densities of *E. victrix* have been observed in the Pilbara in areas with no available groundwater;
- Symptoms of drought stress during dry season have been observed in leaf water potential measurements, indicating groundwater is not being used;
- Matric potential indicates water is accessed to a maximum depth of 18m below ground surface.
- Size of soil moisture reservoir and surface water replenishment regime is sufficient to meet transpiration calculations based on basal stem area;
- Depth to groundwater (>20m) is at the upper end of the accessible depth for *E. victrix*.

In summary, *E. victrix* are considered to rely on the soil water reservoir to meet plant water needs with a low likelihood of facultative dependence on groundwater. It is likely that the surface water regime at Coondewanna Flats supports these vegetation communities via soil moisture replenishment by periodic infiltration. While none of these indicators are conclusive in isolation, taken together, and in the absence of any contraindicative data, they show a low likelihood that groundwater drawdown will impact this community.
Figure 2: Coondewanna Flats Ecohydrological conceptual model.
Source: MWH (2015) Development of Pilbara Landscape Ecohydrological Units. Published in Appendix 7 of the BHP Strategic Environmental Assessment
1.4.2.2. Key Assumptions and uncertainties

Improving understanding
The following work is required to improve understanding at Coondewanna Flats:

- Ongoing studies investigating the groundwater dependency of Coondewanna Flats vegetation communities and key tree species, i.e. *Eucalyptus victrix*
- Monitoring of groundwater drawdown extent and groundwater levels during operations
- Ongoing studies investigating sensitivity of vegetation fringing the PEC to seasonal variation in rainfall, runoff and surface water regime.
- Ongoing studies investigating surface water catchment response to spatial variation in rainfall distribution.
- Update of conceptual ecohydrological model, based on study findings.

1.4.2.3. Management Approach

Monitoring
Groundwater monitoring for Coondewanna Flats follows the Source-Pathway-Receptor approach outlined in section 1.4.1.3 and is presented in Table 6 below:

<table>
<thead>
<tr>
<th>Site</th>
<th>Source</th>
<th>Pathway</th>
<th>Receptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Flank</td>
<td>Western edge of dewatered pits at E deposit</td>
<td>Northern flank valley dolomites</td>
<td>Aquifer beneath Coondewanna Flats</td>
</tr>
<tr>
<td>Northern Flank</td>
<td>Juna Downs MAR borefield</td>
<td>Aquifer beneath Coondewanna Flats</td>
<td>Aquifer beneath Coondewanna Flats</td>
</tr>
<tr>
<td>Southern Flank</td>
<td>Western edge of dewatered pits at Highway Deposit</td>
<td>Southern Flank valley dolomites west of dyke</td>
<td>Aquifer beneath Coondewanna Flats</td>
</tr>
</tbody>
</table>

Vegetation health monitoring will also be carried out at the Coondewanna Flats PEC.

Adaptive Management
Management options to reduce or mitigate detrimental changes to the groundwater regime at Coondewanna Flats involve injection of water into the aquifer to offset drawdown and ceasing injection or abstraction of water to avoid potential impacts from groundwater mounding. Implementation of these actions will occur according to the triggers and thresholds in Schedule 1.

1.4.2.4. Rationale for choice of provisions

Assessment of potential impacts
Hydrological change
The changes to hydrological conditions at Coondewanna Flats are primarily expected to be associated with falling groundwater levels as a result of dewatering the eastern deposits at both Southern Flank and Northern Flank, and to a lesser extent through the cumulative effects of dewatering the remaining Mining Area C and Hope Downs deposits. The effects of surplus water management through managed aquifer recharge are also considered.
The range of numerical groundwater modelling results predict that water levels could fall by between 10 and 22 m in the central area of Coondewanna Flats by 2047 (unmitigated) at which point water levels begin to recover. The rate of change is estimated to be up to 3 m/year. The rate and extent of drawdown is dependent upon the hydraulic connection between the Highway deposits at Southern Flank and aquifer storage in the local area. Timing of maximum drawdown at Coondewanna is associated with two deep pits at Highway and principally with Pushback 5 which extends approximately 160m below water table. There remains uncertainty about the hydraulic behaviour of a dolerite dyke which passes through the Highway deposits and shows around 30m head drop across and there is potential for this structure to limit drawdown beneath Coondewanna from the Southern Flank dewatering to the east.

Planned injection of surplus water at the Juna Downs MAR scheme will reduce the extent of drawdown at Coondewanna Flats. MAR has advantages over other surplus water disposal options, such as direct discharge to surface drainages, by virtue of having a small surface disturbance footprint. However, as MAR effectively replenishes groundwater systems at much higher rates than natural recharge processes, it has the potential to elevate groundwater levels (i.e. create a groundwater ‘mound’) in a zone proximal to the injection bores for a period of time. Modelling undertaken predicts the progression and extent of the MAR groundwater mound over the nominal 18-year operating life of the MAR scheme (2016-2034).

The development of the Northern Flank and Southern Flank mining operations are expected to reduce the size of the surface water catchment that drains into Coondewanna Flats. The surface water impact assessment undertaken for Southern Flank (MWH, 2016) determined that 6.9% of the catchment will be disturbed by the combined Mining Area C operation. This value is considered conservative as surface water will be returned to the catchment via small diversions and pumping out of pits during operations.

**Assessment of potential impacts on the Coondewanna Flats ecological communities**

Coondewanna ecological communities are unlikely to be dependent upon groundwater and therefore the magnitude and rate of change in hydrological conditions outlined above are unlikely to result in an impact to the PEC. Nonetheless triggers for groundwater level will remain in place.

Planned injection of surplus water at the Juna Downs MAR scheme has potential that groundwater draw-up may impact PEC community composition and water access strategies. The MAR scheme is predicted to progressively increase groundwater levels underlying stands of *E. victrix* trees on Coondewanna Flats. Based on the predicted maximum extent of groundwater mounding, the lower portion of the root systems of some mature *E. victrix* trees may become exposed to groundwater for a period of time. In such cases tree water status (as measured by leaf water potential) may increase relative to unaffected trees, particularly during prolonged dry conditions, when water levels are elevated. Where trees have sustained access to groundwater tree water use and growth rates may increase.

Once injection ceases trees with root systems that were brought into connection with the groundwater system will become disconnected from groundwater. In such cases tree water status may decline during prolonged dry conditions; potentially with associated decreases in leaf area, tree water use and growth rates. More extreme adjustments including canopy die back are unlikely but possible. The trees will gradually re-adjust to the surface driven hydrological regime.

The majority of the tree root systems will remain unaffected. However, pruning of the deeper roots may occur if they are exposed to frequently saturated soils. The trees may reconfigure their root systems to some extent to exploit the groundwater resource.

Due to their shallow roots systems mulga and understorey species are not expected to be affected by the predicted increase in groundwater levels associated with the MAR scheme.

Schedule 1 establishes upper water level targets and thresholds along with ecological indicators to prevent detrimental changes at the PEC. This precautionary approach will be maintained for the monitoring, investigation and management of groundwater and vegetation.

Changes in surface water volume resulting from ground disturbance are not considered likely to impact the PEC values (Onshore, 2016). Reduction in surface water flow volume is not expected to be material in the context of the wide range of seasonal variation which the historical record shows is up to 50%
over any given 5 year period (BHP, 2015b). However, further work is planned to which will improve understanding of the hydrological dependency at Coondewanna Flats.

Table 7 summarises the threats from current operations and controls in place under existing approvals to manage the potential impacts to Coondewanna Flats from BHP existing operations.

Table 7: Summary of Coondewanna Flats Threats and Controls

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Site/s</th>
<th>Operations / Activities</th>
<th>Threat</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawdown (regional)</td>
<td>Mining Area C – Northern Flank and Southern Flank</td>
<td>Mining below water table within the Coondewanna Flats catchment</td>
<td>Mining Area C is mining below water table, dewatering is required to undertake these operations, which may result in impacts to regional groundwater levels and impact the Coondewanna Flats PECs.</td>
<td>Managed under Ministerial Statements XXX (Mining Area C Revised Proposal pending) – monitoring required under this plan. Abstraction volumes and rates are controlled via 5C Licence GWL110044(10)</td>
</tr>
<tr>
<td>Surplus water management</td>
<td>Water Discharge – Juna Downs Managed Aquifer Recharge</td>
<td>Potential threat to the receiving environment of Coondewanna Flats priority ecological communities</td>
<td>Planned injection of surplus water at the Juna Downs MAR scheme has potential that groundwater draw-up may impact PEC community composition and water access strategies.</td>
<td>Managed under Ministerial Statements XXX (Mining Area C Revised Proposal pending) – monitoring and management required under this plan. Discharge locations, volumes and quality are controlled under DER Licence L7851/2062/6.</td>
</tr>
</tbody>
</table>

External Considerations – weather

The ecological assessment has identified that seasonal rainfall and resulting runoff and ponding is likely to be the most significant hydrological factor in maintaining the vegetation community at Coondewanna Flats (AQ2, 2016). Analysis of historic rainfall suggests that Lake Robinson receives some quantity of runoff every year and receives enough water to initiate groundwater recharge every 4 years on average (AQ2, 2016). The smaller annual events are likely to replenish soil moisture in the vicinity of Lake Robinson which then becomes the main source of water for the herbs and understory vegetation and that comprise the PEC. Long term variability in rainfall is expected to result in periods of reduced rainfall although the presence of the current vegetation assemblage suggests resilient strategies for dealing with these changes.

1.4.3. Weeli Wolli Spring

1.4.3.1. Survey and Study Findings

Weeli Wolli Spring is located approximately 14 km east of Mining Area C and is an area where surface water and groundwater flows converge and discharge from the Upper Weeli Wolli Creek catchment. The spring occurs where groundwater flow is constrained through a gorge in the Wildflower Range. The creek and surrounding floodplain area support permanent pools and riparian woodlands.

A shallow groundwater system with extensive areas of calcrete is present up-gradient of the spring. Downstream of the gorge, the creek flows via a narrow channel past the confluence with Marillana Creek and ultimately into the Fortescue River Valley.

The spring’s natural function is currently being impacted from Hope Downs operations and is maintained through artificial discharge through a series of spigots.
Hydrological baseline conditions
An ecohydrological conceptualisation of Weeli Wolli Spring is provided in Figure 3 with the key features being:

- Surface flow at Weeli Wolli Spring is a combination of spring baseflow supported by groundwater discharge, as well as seasonal surface water inflows.
- On average, the area experiences two surface water flow events each year. Local infiltration of the surface water results in recharge to the shallow groundwater system.
- The groundwater system comprises an unconfined aquifer sequence including calcrete and detritals. Groundwater is shallow being less than 10 mbgl and becoming shallower towards the spring. As the aquifer thins and narrows towards Weeli Wolli Spring, groundwater flow is concentrated and discharged over near-surface basement as baseflow.
- The water balance suggests that groundwater throughflow from the upstream catchment is about 11 ML/day. Discharge occurs as spring baseflow (7 ML/day), evapotranspiration (2.6 ML/day) and groundwater throughflow in the shallow aquifer (4 ML/day).
- There is no evidence for outflow associated with a fractured-rock aquifer through the gorge in Wildflower Range. There may be a zone of slightly enhanced permeability; otherwise, the basement at the spring is of low permeability.
Figure 3: Weeli Wolli Spring Ecohydrological Conceptualisation
Source: BHP (2015) SEA Hydrology – Ecohydrological Change Assessment, Appendix 7 of the BHP Strategic Environmental Assessment

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1.4.3.2. Key Assumptions and uncertainties

Ecological understanding
The Weeli Wolli Spring area is recognised as having multiple ecological values that collectively contribute to its status as a Priority 1 Ecological Community (DPaW, 2014). These include:

- Riparian woodland and forest associations with unusual understory species composition including an assortment of wattles (Acacia spp.), and sedges and herbs that fringe many of the pools and associated water bodies along the main channel. There are several species of conservation interest including one named after the spring \( (Stylidiurn weeliwollo)\). The woodland trees include the obligate phreatophyte \( Melaleuca argentea \), and facultative phreatophytes \( Eucalyptus camaldulensis \) and \( E. victirix \).

- An unusual and diverse aquatic fauna assemblage occurs in a series of permanent pools upgradient of the spring associated with the shallow groundwater system. The permanent discharge from Weeli Wolli Spring is an uncommon habitat for the Pilbara and may function as a refuge for mesic-adapted fauna. A relatively high diversity of stygofauna is associated with the calccrete and alluvial aquifer system.

- The creek valley at Weeli Wolli Spring supports a diverse bird assemblage (over 60 species) and very rich microbat assemblage including the Ghost bat \( (Macroderma gigas) \), a State and Commonwealth listed species. The permanent pools provide a water source and foraging habitat for microbats.

- The creek valley of Weeli Wolli Spring is known to support a very rich microbat assemblage including the Ghost Bat \( (Macroderma gigas); EPBC Act - Vulnerable, WC Act - Schedule 4)\), the Chocolate Bat \( (Chalinolobus morio) \) occurring at the most northern extent of its natural range, and the White-striped Free-tailed Bat \( (Tadarida australis) \).

The Weeli Wolli Spring PEC includes a second location at Ben’s Oasis, located about 20 km upstream to the south of Weeli Wolli Spring. At this location, the vegetation is concentrated along a relatively narrow creek channel adjacent to some surface water pools. Ben’s Oasis has been identified as a separate receptor and is discussed further in Section 1.4.4.

Hydrological dependency
The Weeli Wolli Spring area hosts a PEC comprising groundwater-dependent vegetation, permanent pools supporting a range of fauna, and a diverse stygofauna community.

- There is up to 30 m of saturated calcrete that provides the main stygofauna habitat.

- A number of permanent pools upgradient from Weeli Wolli Spring (sustained by the shallow groundwater regime) provide aquatic habitat, and a permanent water source for terrestrial fauna and avifauna.

Improving understanding
There are a number of uncertainties relating to regional groundwater flow across the Central Pilbara catchment. The current conceptualisation considers Weeli Wolli a terminal outflow location for groundwater that has accumulated across the Central Pilbara catchment. However recent investigations have suggested local flow pathways appear to be absent or restricted in key locations. Consequently opportunity exists to test and improve understanding of key groundwater transmission pathways that may influence hydrologic function at Weeli Wolli including:

- connectivity east of A deposit at Northern Flank;
- connectivity across the dolerite dyke south east of Coondewanna;
- connectivity of regional dolomite within Pebble Mouse valley across structures east of Southern Flank
- R deposit dewatering and drawdown estimates;
Improved understanding of the regional groundwater system may also come from third party operations in the catchment, in particular RTIO’s Hope Downs and Baby Hope deposits. In addition, post-closure remediation and mitigation plans at these operations have potential to influence BHP’s approach to long term management at Weeli Wolli Spring.

1.4.3.3. Management Approach

Monitoring

Groundwater monitoring for Weeli Wolli Spring follows the Source-Pathway-Receptor approach outlined in section 1.4.1.3 and is presented in Table 8 below.

**Table 8: Potential source and pathway of hydrologic change at Weeli Wolli Springs**

<table>
<thead>
<tr>
<th>Site</th>
<th>Source</th>
<th>Pathway</th>
<th>Receptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Flank</td>
<td>Eastern edge of dewatered pits at A Deposit</td>
<td>Northern Flank valley dolomites</td>
<td>Aquifer beneath Weeli Wolli Spring</td>
</tr>
<tr>
<td>Northern Flank</td>
<td>North Eastern edge of dewatered pits at R Deposit</td>
<td>Detrital valley deposits within Weeli Wolli Creek Valley</td>
<td>Aquifer beneath Weeli Wolli Spring</td>
</tr>
<tr>
<td>Southern Flank</td>
<td>Eastern edge of dewatered pits at Vista</td>
<td>Southern Flank valley dolomites</td>
<td>Aquifer beneath Weeli Wolli Spring</td>
</tr>
</tbody>
</table>

It should be noted that dewatering at R deposit has not started and monitoring in this area is currently to gather baseline data and to measure aquifer response to Hope Downs dewatering.

Adaptive Management

Adaptive management at Weeli Wolli Spring will be complex due to the presence of significant dewatering operation at Hope Downs. BHP’s response to mitigate the effects of drawdown from the MAC deposits will necessarily be designed in the context of Hope Down’s current and planned activity at the time.

A number of options have been identified to avoid or mitigate detrimental change to the groundwater regime at Weeli Wolli Spring. Recharge of the aquifer could be carried out by injection of dewatering surplus or enhanced recharge using dedicated basins, small dams or open pits to capture, impound and infiltrate surface water. Local irrigation has been demonstrated to be effective at Weeli Wolli spring to maintain groundwater levels and ecosystem health.

Due to the ongoing influence of Hope Downs, triggers and thresholds at Weeli Wolli Spring will be developed for the BHP operations:

- on notification of pre-closure of the Hope Downs Operation and;
- prior to commencement of dewatering at R deposit.

These arrangements are summarised in Schedule 2.

1.4.3.4. Rationale for choice of provisions

Assessment of potential impacts

Hydrological Change

The regional groundwater drawdown response to Mining Area C pumping is predicted to propagate out from the Marra Mamba orebodies in an east-west direction following the higher transmissivity Wittenoom dolomite and detrital aquifers. The extent of drawdown associated with Brockman
dewatering is considered to be less significant owing to low permeability rocks (shale and banded iron formation (BIF)) constraining the drawdown extent.

The predicted groundwater drawdown resulting from Mining Area C only abstraction activities until 2054 extends to the east and reduces water levels in the lower catchment aquifer (alluvials, dolomite and calcrete aquifers) by 2 to 4 m.

The predicted maximum groundwater drawdown at Weeli Wolli Spring from proposed Northern Flank and Southern Flank activities is around 1.75m and occurs in 2054 following cessation of aquifer recovery activities at Hope Downs. This magnitude of water level change may impact the vegetation community at Weeli Wolli Spring. Further work is required to determine the likelihood and extent of impacts however should there be a clear risk of vegetation impacts, BHP will take steps to avoid or mitigate this outcome.

The maximum predicted cumulative groundwater drawdown (from Mining Area C and Hope Downs operations) occurs prior to Hope Downs closure in 2025 and is between 3 m and 14 m at Weeli Wolli Spring. This drawdown is associated predominantly with abstraction from Hope Downs. This cumulative impact could result in decline of groundwater dependent vegetation at both sites (Onshore Environmental 2015). The timing and success of Hope Downs closure plans to recover groundwater levels will influence the final water level and potential for a continued impact at Weeli Wolli Spring.

Surface water flow interception which contributes to Weeli Wolli creek flow will be around 4.2% and considered to be within predictive error and insignificant in terms of change or impact.

Table 9 summarises the threats from current operations and controls in place under existing approvals to manage the potential impacts to Weeli Wolli Spring from BHP existing operations.

Table 9: Summary of Weeli Wolli Spring Threats and Controls

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Site/s</th>
<th>Operations / Activities</th>
<th>Threat</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawdown (local)</td>
<td>Mining Area C – Northern Flank</td>
<td>Mining below water table within the Weeli Wolli Creek catchment</td>
<td>Mining Area C is mining below water table, dewatering is required to undertake these operations, which may result in localised groundwater drawdown.</td>
<td>Managed under Ministerial Statements XXX (Mining Area C Revised Proposal pending) - monitoring required under this plan.</td>
</tr>
<tr>
<td>Drawdown (regional)</td>
<td>Mining Area C – Northern Flank</td>
<td>Mining below water table within the Weeli Wolli Creek catchment Hope Downs will predominantly continue to impact the spring and any long term effects from Mining Area C are considered to be comparatively small</td>
<td>Mining Area C is mining below water table, dewatering is required to undertake these operations, which may result in impacts to regional groundwater levels.</td>
<td>Managed under Ministerial Statements XXX (Mining Area C Revised Proposal pending) - monitoring required under this plan.</td>
</tr>
<tr>
<td>Water Discharge – Managed Aquifer Recharge</td>
<td>Mining Area C – Northern Flank</td>
<td>Water re-injected into local aquifer within the Weeli Wolli Creek catchment</td>
<td>Potential threat to the receiving environment of Weeli Wolli Spring community</td>
<td>Discharge locations, volumes, quality and groundwater levels are controlled under DER Licence L7851/2002/6.</td>
</tr>
</tbody>
</table>

Assessment of potential impacts on the Weeli Wolli Spring

Over the next 20 years Hope Downs will predominantly continue to impact and manage the spring and any long term effects from Mining Area C are considered to be comparatively small and ultimately will depend upon the success of Hope Downs closure. However, the potential impacts will be reviewed and where necessary controls implemented as more monitoring data is made available.
External Considerations

As discussed previously RTIO’s Hope Downs operations will continue to dominate groundwater drawdown in the vicinity of Weeli Wolli Spring. This will continue into closure with the extent and duration of impacts being determined by the selected remediation strategy. BHP’s catchment management activities will be planned and undertaken in the context of RTIO’s planned actions. A co-operative approach with RTIO with the purpose of optimising water management activities in the catchment to meet the environmental outcome described in Schedule 2.

1.4.4. Ben’s Oasis

1.4.4.1. Survey and Study Findings

Ben’s Oasis is located in the upper reaches of Weeli Wolli Creek about 15 km south of Weeli Wolli Spring and 15 km east of the Southern Flank Vista Oriental deposit. Ben’s Oasis consists of several small perennial pools with fringing vegetation, and appears to be similar in occurrence to the pools seen downstream at Weeli Wolli Spring, albeit at a smaller scale.

BHP has had limited opportunity to assess and catalogue the vegetation community at Ben’s Oasis. An initial field inspection was carried out by BHP staff in 2011 as part of work to support the 2011 BHP Jinidi Mine submission. That inspection showed a phreatophytic vegetation community with a similar composition to Weeli Wolli Spring.

Ben’s Oasis was recognised as a PEC in 2011 on advice from members of the Threatened Ecological Communities Scientific Committee. It is considered to have similar environmental values and faces the same threats as Weeli Wolli Spring.

The geology beneath the spring comprises Wittenoom Formation (including the Paraburdoo Member) bedrock (Figure 4). This is bounded to the north by unmineralised Brockman Iron Formation which forms a prominent ridge to the south of the Southern Flank Valley. The bedrock is overlain in places by a thin detrital and alluvial cover. A NW-SE trending regional dyke also extends through the area, to the northeast of Ben’s Oasis. The regional dyke is believed to form a barrier to groundwater flow within the Paraburdoo Member and may lead to ‘backing up’ of groundwater to the southwest of the dyke and hence groundwater levels being expressed at surface as a spring. However, this conceptualisation carries a significant degree of uncertainty due to the lack of data (Ben’s Oasis is located on RTIO tenure).

Preliminary observations from recent drilling suggests that the water level south of the dyke is about 17 m higher than to the north (600 mRL and 583 mRL respectively). If this dyke does impede groundwater flow, it could also potentially isolate Ben’s Oasis from the effects of groundwater drawdown from mining operations in the North and Southern Flank Valleys.

The surface water catchment supporting Ben’s Oasis is outside of the MAC development footprint and impact to surface water quality or quantity in this catchment and at the spring is unlikely.

1.4.4.2. Key Assumptions and uncertainties

Ecological understanding

Based on brief field inspection in 2011 BHP observed a riparian woodland and forest associations fringing the pools at Ben’s Oasis. The woodland contains a similar composition to Weeli Wolli spring with unusual understory species composition including sedges and herbs that fringe many of the pools along the main channel. Species of conservation value observed in the understory included *Fimbristylis sieberiana* (Priority 3) and *Stylidium weeliwolli* (Priority 3). The woodland trees include the obligate phreatophyte *Melaleuca argentea*, and facultative phreatophytes *Eucalyptus camaldulensis* and *E. victrix*. 
A detailed survey has not been undertaken by BHP to date due to lack of access as the spring itself is on RTIO tenure.

**Hydrological dependency**

The presence of obligate phreatophytes and an extensive understory indicates long term water availability at Ben’s Oasis. The pools at Ben’s Oasis are likely to be fed surface runoff as well as from the underlying aquifers comprised of Wittenoom Dolomite. Recharge to the dolomites is likely to come the upstream catchment west of the spring from surface water infiltration via the stream bed and the extensive calcrete deposits upstream.

However, at areas were current mining operations (MAC and Hope Downs Mine) and the proposed Project are on the down-stream side of the water table off-set (i.e. Ben’s Oasis), it is interpreted the geological barrier may limit progression of drawdown impacts on the spring itself.
Figure 4: Ben’s Oasis Catchment

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Improving understanding

The hydrogeological understanding both at Ben’s Oasis and along the hydraulic pathway north towards Hope Downs is very limited. At present, there is no observed evidence of adverse impacts on Ben’s Oasis ecology due to groundwater abstraction from either MAC or Hope Downs Mine.

In 2016 4 monitoring bores were installed on BHP tenure east of Ben’s Oasis on either side of the dyke thought to generate the spring. It is expected that long term data at these points will provide insight on the extent of groundwater connection downstream of the dyke towards Hope Downs.

There is currently a limited understanding of potential hydraulic pathways between the valley upstream of Ben’s Oasis and Pebble Mouse creek valley to the north. Based on differences in groundwater elevation, the current conceptual model considers that the geology between the two valleys acts as a barrier to groundwater and that hydraulic connection between Southern Flank and Ben’s Oasis is unlikely. Installation of additional monitoring points outside of BHP tenure will be required to confirm the conceptual model in this area.

BHP’s current understanding of the vegetation community is based on brief field inspections and a thorough survey is yet to be undertaken. A survey will be carried out once land access has been secured with RTIO.

1.4.4.3. Management Approach

Monitoring

Groundwater monitoring for Ben’s Oasis follows the Source-Pathway-Receptor approach outlined in section 1.4.1.3 and is presented in Table 10 below:

<table>
<thead>
<tr>
<th>Site</th>
<th>Source</th>
<th>Pathway</th>
<th>Receptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Flank</td>
<td>North Eastern edge of dewatered pits at R Deposit</td>
<td>Detrital valley deposits within Weeli Wolli Creek Valley</td>
<td>Aquifer beneath Ben’s Oasis</td>
</tr>
<tr>
<td>Southern Flank</td>
<td>South-eastern edge of dewatered pits at Vista Southern Flank valley dolomites and overlying detritals</td>
<td>Aquifer beneath Ben’s Oasis</td>
<td></td>
</tr>
</tbody>
</table>

Monitoring of the recently installed bores adjacent to Ben’s Oasis will continue both to establish baseline data and to understand response to current catchment stresses. Work will be undertaken to install additional monitoring points, off-tenure, along the potential impact pathway across the Southern Flank Valley.

BHP will review whether alternate vegetation monitoring techniques such as remote imagery can be used to evaluate change in vegetation condition prior to gaining ground access.

Adaptive Management

Impacts at Ben’s Oasis are most likely to result from propagation of drawdown along the Weeli Wolli Creek valley south of Hope Downs. A preliminary assessment has identified a number of options that could avoid or mitigate detrimental change to the groundwater regime at Ben’s Oasis Spring. These include:

- Aquifer recharge along the impact pathway south of Hope Downs to prevent drawdown extending to Ben’s Oasis.
- Discharge of water into the catchment upstream of Ben’s Oasis to increase groundwater levels and fill pools
- Use of enhanced recharge by diverting surface water to infiltration ponds or basins.
Due to the current lack of access to Ben’s Oasis, a management-based outcome has been selected and is detailed in Schedule 3.

1.4.4.4. Rationale for choice of provisions

Assessment of potential impacts

Ben’s Oasis is understood to be separated from BHP’s activities by a hydrogeological barrier and therefore is outside the domain of the groundwater model (BHP, 2017). To estimate the amount of drawdown at Ben’s Oasis, a proxy location was selected about 1km inside the model domain to the north along Weeli Wolli Creek, considered the most likely pathway for drawdown propagation. The predicted groundwater drawdown at the proxy location from Northern Flank and Southern Flank activities is less than 1m and occurs in 2054 following cessation of aquifer recovery activities at Hope Downs. The maximum predicted cumulative groundwater drawdown (from Mining Area C and Hope Downs operations) occurs prior to Hope Downs closure in 2025 and is between 2m to 5m at this location. The impacts reported for the proxy location are considered conservative and changes of this magnitude are unlikely to be seen at Ben’s Oasis itself. Under the current conceptualisation, drawdown is not considered likely to propagate upstream of the dyke.

Based on the current conceptualisation and subsequent groundwater modelling there is a low likelihood of drawdown impacts at Ben’s Oasis resulting from to BHP activity at Mining Area C. Likely timing of potential impacts will be towards the end of the mine life following maximum extent of dewatering drawdown at Southern Flank. As described in Table 4, two potential impact pathways exist:

- Drawdown propagating from Northern Flank and R Deposit via Weeli Wolli creek sediments
- Drawdown propagating from Southern Flank through Brockman formation in the ridge separating Ben’s Oasis Valley and Pebble Mouse Creek Valley.

External Considerations

Similarly to Weeli Wolli Spring, changes at Ben’s Oasis are likely to result primarily from activity at RTIO’s Hope Downs operation. BHP’s catchment management activities will be planned and undertaken in the context of RTIO’s planned actions. A co-operative approach with RTIO with the purpose of optimising water management activities in the catchment to meet the environmental outcome described in Schedule 3.

Further work is required to establish access to tenure at, and adjacent to, Ben’s Oasis to allow confirmation of the current conceptual understanding for groundwater as well as the biological baseline.
2. EMP provisions

According to the Instructions, the EMP ‘Provisions’ are the “key component of an EMP and are the legal requirements to be met by the proponent in implementing the EMP” (EPA, 2017, p. iii).

To meet the requirements of this particular section of the Instructions (EPA, 2017), BHP has utilised the ‘Schedule’ approach to the ‘EMP Provisions (outcome-based) table/schedule’

BHP is of the understanding that these Schedules will be used as stand-alone documents, which the DWER can endorse as meeting the intent of a particular implementation condition or conditions. New and/or revised Schedules will be provided to the DWER for review and endorsement by the Director General as per the requirements of the respective Ministerial Statement conditions as applicable in future. This section and the Schedule also reflects BHP’s commitment to implement this Plan, in accordance with the requirements of MS 491.

Changes may arise from, but not limited to:

- new Proposals being approved and conditioned through Part IV of the EP Act;
- existing Proposals subject to historic EP Act Part IV conditions being revised and brought under this CPWRMP though a section 46 or Revised Proposal process;
- stakeholder consultation;
- the level of scientific knowledge relating to a key environmental or social receptor; and/or
- the Director General of the DWER confirming by notice in writing that it has been demonstrated that the objective in the relevant condition is being and will continue to be met and therefore implementation of commitments or aspects of this CPWRMP are no longer required.
### 3. Adaptive Management and review of this CPWRMP

BHP applies an adaptive management framework for implementing management measures identified in this CPWRMP. This CPWRMP iteratively collates the key findings and knowledge of the eco-hydrogeology technical studies and changes in water-affecting activities to inform the required adaptive management to enable achievement of outcome-based objectives. The adaptive management is risk-based and is expected to proactively counteract, mitigate or manage potential impacts (both predicted and actual) to an acceptable level.

As outlined in Figure 5, the CPWRMP considers the following aspects:

- hydrological changes (baseline, current and future conditions of groundwater, soil moisture and surface water) resulting from BHP groundwater abstraction and surface water diversion;
- receiving receptors (water resources, environment, social and third-party operations), identified value and hydrological dependency (groundwater, soil moisture and/or surface water);
- potential impacts (predicted and actual); and
- required risk-based adaptive management techniques that are feasible (tested and practicable) to mitigate potential impacts to acceptable levels during operations and closure.

![Figure 5: CPWRMP Adaptive (staged and iterative) management approach](image)

#### 3.1. Methodology for monitoring hydrological change

Adaptive management for the key receptors allows for three stages of response: investigation, action and mitigation. The approach ensures that any change and/or response observed is characterised and understood prior to implementing corrective action.

#### 3.2. Setting thresholds for significant impact

Trigger values are defined to provide the point at which water management options must be considered and implemented to avoid potential impact to a receiving receptor; the trigger is intended to operate...
sufficiently early to allow water management options to be put in place well before the threshold value for the receiving receptor is reached.

Threshold values are defined to provide the point at which corrective actions must be implemented in order to prevent unacceptable environmental impact or reverse the negative trends.

Triggers and thresholds have been set to assess whether a hydrological change has resulted in an impact to a receiving receptor as a result of BHP operations. Three receptors have been identified as having the potential to be impacted by changes in hydrological processes associated with the implementation of additional discharge or abstraction volumes, these being the vegetation communities at Coondewanna Flats, Weeli Wolli Spring and Ben’s Oasis.

### 3.3. Scientific uncertainty - triggers and thresholds

To achieve the outcome-based objectives, triggers and thresholds will be used to monitor and verify predicted and actual impacts from BHP operations. These thresholds will be considered in the context of natural variance and influences from third parties and will be established where the operations area of influence has potential to impact key receptors.

Triggers and thresholds have been based on ongoing monitoring, however have been established in a conservative and precautionary way to allow for the uncertainty present in the environment. Key areas of uncertainty include the hydrologic function of the catchment, resilience and susceptibility of receptors to water changes and long term changes to mining activities.

As the scientific understanding improves the level of uncertainty decreases and thresholds will be iteratively refined to reflect current knowledge, as shown in Figure 6. BHP has had time to establish and revise the conceptual understanding through investigations that address key local uncertainties and monitoring to verify assumptions, and is therefore towards the narrow end of the spectrum.

This approach accommodates the persistence of hydrological and ecological uncertainty during operations and ultimately post closure. The approach also recognises that variation in mine plans and mine development rates are likely to remain.

![Figure 6: Iteratively refined thresholds to reflect scientific knowledge for the Eastern Pilbara Receptors](image)

### 3.4. Central Pilbara Regional Monitoring

BHP’s regional monitoring network includes data collection from various hydrological systems, including:

- aquifer water levels and quality, within the operational mining hub;
- surface water flow volumes;
• dewatering borefield water levels and quality;
• surplus water volumes and quality, prior to discharge into the environment; and
• weather and climatic conditions.

The Regional Monitoring Network is an operational and catchment scale monitoring program that collects important information for compliance monitoring and reporting and to improve the capacity to estimate receptor response to changing hydrological conditions resulting from BHP operations.

The Regional Monitoring Network is consistent with, and complimentary to, aspects of other regulatory reporting requirements such as EP Act Operating Licenses through the BHP Annual Environmental Report, as well as Annual and Triennial Aquifer Reviews.

3.5. Review and update of this CPWRMP

The CPWRMP is underpinned by current scientific understanding. The triggers, thresholds and outcome-based objectives also reflect current scientific understanding and will require iterative updating as uncertainty is addressed and actual results are compared against observed results.

The predicted footprint of water-affecting activities and the regional water balance is based on a midterm mine plan (5 year plan) and it is recognised that the extent of dewatering and surface water interception may change with further mine development planning. Mine Planning and hydrological modelling will also be iteratively updated to reflect predicted and actual changes.

The CPWRMP will be reviewed at intervals not exceeding five years and updated to ensure it addresses the relevant conditions and is being implemented effectively. This CPWRMP will be updated to include date of review and details of subsequent Schedules.

BHP undertakes regular and ongoing stakeholder engagement as part of its core business activities. BHP aims to facilitate regular, open and honest dialogue to understand expectations, concerns and interests of stakeholders and incorporate them into business planning to help build strong, mutually beneficial relationships. The main objectives of the consultation programme are to:

• provide information and the opportunity to comment to relevant government agencies, local authorities and to other groups or individuals who may potentially be interested in a Proposal;
• where relevant, discuss and allow stakeholder comments on Proposals to be incorporated into this CPWRMP; and
• BHP will continue to engage with Traditional Owners through targeted consultation and via administration of Native Title agreements.

Please refer to Appendix 2 for details of specific consultation activities, relevant to this CPWRMP.
4. Terminology

adaptive management  
n. planning, organising, leading and controlling an operation in a manner that changes iteratively as new knowledge comes to light.

Baseline Conditions  
n. the hydrological conditions that prevailed before BHP mining operations commenced, including natural variation.

cumulative impacts  
n. detrimental effects on a receiving receptor from more than one source; for example, two or more BHPBIO mining operations within one water catchment or a combination of BHP and third-party operations within one water catchment.

current conditions  
n. the hydrological conditions that prevail now that BHP has begun mining operations, including natural variation.

early warning trigger  
n. the point at which water management options must be considered and investigated to avoid potential impact to a receiving receptor; the trigger should operate sufficiently early to allow water management options to be put in place well before the threshold value for the receiving receptor is reached.

Future Conditions  
n. the hydrological conditions that prevail post BHP operations including transitioning towards mine closure, mine closure final land form and relinquishment.

hub area (hub)  
n. a geographical location within which more than one BHP mine is operating in sufficient proximity to other BHP mines to, for example, allow sharing of resources or potentially increase detrimental effects. Hubs are based on tenements rather than on water catchments.

hydrological dependencies  
n. the numerous factors, such as scale, time, interconnectivity, recharge sources, topography and land use, that determine the hydrological characteristics and receiving receptors dependencies on surface water and groundwater.

outcome-based objectives  
n. a covenant setting out the result that will be met to ensure potential impacts on receiving receptors have been mitigated to acceptable levels.

receiving receptors  
n. the water resources, environmental, social and third-party operations that scientific study has shown have the potential to be detrimentally affected by a BHP mining operation. Environmental receiving receptors potentially include such things as flora and fauna, biodiversity. Social receiving receptors potentially include Indigenous cultural heritage sites and domestic or industrial water bore users. Third-party operations potentially include other mining operations in the vicinity of the BHP mining operation.

significant hydrological impact  
n. a detrimental change in hydrological condition causing an effect on a receiving receptor that inhibits its ability to continue to function, such as a lowering of the groundwater level outside the natural variation of Baseline Conditions.

third party  
n. a party other than BHP living or doing business within the area of interest.

third-party operations  
n. mining activities other than those of BHP occurring within the area of interest.

trigger  
n. a scientifically informed value, informed by baseline studies, to the amount of hydrological change that a receiving receptor can accommodate before reaching the point at which impact may occur.

threshold  
n. a scientifically informed value, informed by baseline studies, to the amount of hydrological change that a receiving receptor can accommodate before reaching the point at which unacceptable impact may occur.

transparency  
n. operating with openness, communication, and accountability in such a way that it is easy for others to see what actions are performed and for all observers to have the ability to see what is wrong, to see what the problems are, or to see potential trouble.

water management area  
n. a geographical extent within which all surface water drains to the same point, such as a river, or at which the drained surface water percolates into the groundwater. Water management areas are based on water catchments and are divided one from the other by a ridge, hill or mountain.

water management option  
n. a mitigation activity that is tested and practicable (i.e., known to produce the desired outcome and feasible both technically and economically).
5. References


### Schedule 1 – Ministerial Statement XXX – Mining Area C (Coondewanna Flats)

To meet the requirements of Condition X of Ministerial Statement 10XX.

#### EPA Factor and objective:
Hydrological Processes - To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.

#### Key Environmental Values:
Coondewanna Flats Priority Ecological Community

#### Outcome:
No net-loss of the biological diversity and/or ecological integrity of the Coondewanna Flats Priority Ecological Community, as a result of BHP activities.

#### Key Impacts and Risks:
Coondewanna Flats Priority Ecological Community has the potential to be impacted from changes in groundwater levels dewatering and reinjection activities associated with Mining Area C operations.

<table>
<thead>
<tr>
<th>Outcome-based provisions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Environment criteria:</strong></td>
</tr>
<tr>
<td>• Trigger criteria</td>
</tr>
<tr>
<td>• Threshold criteria</td>
</tr>
<tr>
<td><strong>Response actions:</strong></td>
</tr>
<tr>
<td>• Trigger level actions</td>
</tr>
<tr>
<td>• Threshold level Actions</td>
</tr>
<tr>
<td><strong>Monitoring</strong></td>
</tr>
<tr>
<td><strong>Reporting</strong></td>
</tr>
<tr>
<td><strong>Condition XX-3</strong></td>
</tr>
<tr>
<td>The Water Management Plan required by condition XX-2 shall include provisions to address impacts on ground or surface water dependent ecology including, from, but not limited to, changes to groundwater levels and groundwater quality and or changes to surface flows.</td>
</tr>
<tr>
<td>Condition XX-4</td>
</tr>
<tr>
<td>In the event that the monitoring outlined in the Water Management Plan indicates that the requirements of condition 15-1 are not met, the proponent shall implement contingency actions as outlined in the management plan approved by the CEO, and any subsequent approved revisions.</td>
</tr>
<tr>
<td><strong>Condition XX-3</strong></td>
</tr>
<tr>
<td>The proponent shall manage groundwater abstraction and dewatering activities proposal to meet the following environmental objectives:</td>
</tr>
<tr>
<td>(1) ensure minimal adverse impacts on ground or surface water dependent ecology at Weeli Wollo Spring, Bens Oasis and Coondewanna Flats</td>
</tr>
<tr>
<td><strong>Condition XX-2</strong></td>
</tr>
<tr>
<td>The proponent shall consult with Department of Water and Environment Regulation to prepare a Water Management Plan that:</td>
</tr>
<tr>
<td>(1) specify the environmental objectives to be achieved,</td>
</tr>
<tr>
<td>(2) specify risk-based management actions that will be implemented to demonstrate compliance with the environmental objectives specified in 15-1. Failure to implement one or more of the management actions represents non-compliance with these conditions;</td>
</tr>
<tr>
<td>(3) specify measurable management target(s) to determine the effectiveness of the risk-based management actions.</td>
</tr>
</tbody>
</table>

#### Water Quantity in the Coondewanna Flats Priority Ecological Community Monitoring Zone - Groundwater level

- **Trigger criteria** – <15 mbgl at any of the following monitoring bores: GWB0039M, HCF0032M, HCF0044M and HCF0045M
- **Threshold criteria** – <7 mbgl at any of the following monitoring bores: GWB0039M, HCF0032M, HCF0044M and HCF0045M

#### Tree health of indicator tree species in the Coondewanna Flats Priority Ecological Community Monitoring Zone.

- **Monitoring zone** - Groundwater level
- **Trigger criteria** – Statistically significant canopy decline (defined as Crown Condition Score (CCS)) compared to reference trees over four consecutive monitoring periods within monitoring sites 12, 15 or 20.
- **Threshold criteria** – Statistically significant canopy decline (defined as Crown Condition Score (CCS)) compared to reference trees over eight consecutive monitoring periods; or death of any tree (attributable to water stress), within monitoring sites 12, 15 or 20.

#### Water Quantity in the Coondewanna Flats Priority Ecological Community Monitoring Zone - Groundwater level

- **Trigger criteria** – >663.75 mRL at GWB0039M, <663.75 mRL at HCF0044M
- **Trigger criteria** – >15 mbgl at GWB0039M or a reduction in water level >0.5 m/year.
- **Threshold criteria** – >663.75 mRL at GWB0039M, <662 mRL at GWB0039M

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## Schedule 2 – Ministerial Statement XXX – Mining Area C (Weeli Wolli Spring)

To meet the requirements of Condition X of Ministerial Statement 10XX.

<table>
<thead>
<tr>
<th>EPA Factor and objective:</th>
<th>Hydrological Processes - To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key Environmental Values:</td>
<td>Weeli Wolli Spring Priority Ecological Community</td>
</tr>
<tr>
<td>Outcome:</td>
<td>No net-loss of the biological diversity and/or ecological integrity of the Weeli Wolli Spring Priority Ecological Community, as a result of BHP activities.</td>
</tr>
<tr>
<td>Key Impacts and Risks:</td>
<td>Weeli Wolli Spring Priority Ecological Community (PEC) has the potential to be impacted from groundwater, resulting in changes to the biological diversity and/or ecological integrity of the PEC. However, this drawdown is predominantly associated with abstraction from Hope Downs.</td>
</tr>
</tbody>
</table>

### Outcome-based provisions

<table>
<thead>
<tr>
<th>Environment criteria:</th>
<th>Response actions:</th>
<th>Monitoring</th>
<th>Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trigger criteria</td>
<td>Trigger level actions</td>
<td>Monthly monitoring of groundwater levels (mbgl) within the Weeli Wolli Spring Priority Ecological Community Monitoring Zone during operations (i.e. active dewatering / surplus water discharge):</td>
<td>Reporting in the event that the trigger criteria has been exceeded will be as per the Ministerial Statement Compliance Assessment Plan and relevant Groundwater Operating Strategy.</td>
</tr>
<tr>
<td>Threshold criteria</td>
<td>Threshold level Actions</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Trigger criteria for change in risk profile of impacts attributable to BHP activities:**

- At notification of pre-closure of Rio Tinto Iron Ore’s Hope Downs mining operation;
- If other below water table operations are approved in the catchment;
- If changes are identified via the annual or triennial aquifer review process; and
- As required by BHP.

Response actions to *trigger* criteria exceedance may include, but are not limited to:

- If there is a change in risk profile of impacts attributable to BHP activities, BHP will review Weeli Wolli Spring management provisions, and submit to the DWER for review and endorsement.

**Trigger criteria for change in risk profile of impacts attributable to BHP activities due to below water table mining at R Deposit:**

- **Trigger criteria** – 2 years prior to dewatering activities commencing at R Deposit.
- **Threshold criteria** – commencement of dewatering activities at R Deposit

Response actions to *trigger* criteria exceedance may include, but are not limited to:

- Pathway and receptor monitoring network established between R deposit and Weeli Wolli Spring
- Mitigation and aquifer recovery approach developed in consideration of current aquifer conditions (including RTIO mining and remediation activity)
- Discussions with RTIO begin to determine most effective approach for catchment water management to meet ecological outcomes.

Response actions to *threshold* criteria exceedance may include, but are not limited to:

- Baseline data for pathway and receptor established
- Mitigation and recovery approach approved by regulators
- Trigger and threshold criteria for mitigation and recovery approved by regulator
- Agreement with RTIO in place for combined catchment management approach.

Monthly monitoring of groundwater levels (mbgl) within the Weeli Wolli Spring Priority Ecological Community Monitoring Zone during operations (i.e. active dewatering / surplus water discharge):

- At receptor:
  - GWB0016DM;
  - GWB0016SM;
  - GWB0017DM;
  - GWB0017SM;
  - GWB0018DM;
  - GWB0018SM;
  - GWB0032DM; and
  - GWB0021SM;
- Early warning:
  - GWB0013M;
  - GWB0014BM;
  - GWB0015M;
  - HEPX0001

**Response actions to threshold criteria exceedance may include, but are not limited to:**

- Baseline data for pathway and receptor established
- Mitigation and recovery approach approved by regulators
- Agreement with RTIO in place for combined catchment management approach.

- Monthly monitoring of groundwater levels (mbgl) within the Weeli Wolli Spring Priority Ecological Community Monitoring Zone during operations (i.e. active dewatering / surplus water discharge) as above.

- Monthly monitoring of groundwater levels (mbgl) along impact pathway between R Deposit and Weeli Wolli Spring.
**Schedule 3 – Ministerial Statement XXX – Mining Area C (Ben’s Oasis)**

To meet the requirements of Condition X of Ministerial Statement 10XX.

**EPA Factor and objective:** Hydrological Processes - To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.

**Key Environmental Values:** Ben’s Oasis Priority Ecological Community

**Outcome:** No net-loss of the biological diversity and/or ecological integrity of the Ben’s Oasis Priority Ecological Community, as a result of BHP activities.

**Key Impacts and Risks:** Ben’s Oasis Priority Ecological Community (PEC) has the potential to be impacted from groundwater, resulting in changes to the biological diversity and/or ecological integrity of the PEC.

### Management based provisions

<table>
<thead>
<tr>
<th>Environment criteria</th>
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<tr>
<td>Threshold criteria</td>
<td>Threshold level Actions</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Trigger criteria for change in risk profile of impacts attributable to BHP activities:**

- At notification of pre-closure of Rio Tinto Iron Ore’s Hope Downs mining operation;
- If other below water table operations are approved in the catchment;
- If changes are identified via the annual or triennial aquifer review process; and
- As required by BHP.

Response actions to trigger criteria exceedance may include, but are not limited to:

- If there is a change in risk profile of impacts attributable to BHP activities, BHP will review Ben’s Oasis management provisions, and submit to the DWER for review and endorsement.

**Trigger criteria for change in risk profile of impacts attributable to BHP activities due to below water table mining at Southern Flank:**

- Trigger criteria – 2 years prior to dewatering activities at Vista Oriental deposits adjacent to Pebble Mouse Creek valley.
- Threshold criteria – commencement of dewatering activities at Vista Oriental deposits in Pebble Mouse Creek valley.

Response actions to trigger criteria exceedance may include, but are not limited to:

- Pathway and receptor monitoring network established between Southern Flank pit and Ben’s Oasis;
- Mitigation and aquifer recovery approach developed in consideration of current aquifer conditions (including RTIO mining and remediation activity);
- Discussions with RTIO begin to determine optimal effective approach for catchment water management to meet ecological outcomes.

Response actions to threshold criteria exceedance may include, but are not limited to:

- Baseline data for pathway and receptor established
- Mitigation and recovery approach approved by regulator
- Trigger and threshold criteria for application of mitigation and recovery actions approved by regulator
- Agreement with RTIO in place for combined catchment management approach.

**Trigger criteria number and text**

- Monthly monitoring of groundwater levels (mbgl) adjacent to Ben’s Oasis prior to operations (i.e. active dewatering / surplus water discharge):
  - HDD0001M
  - HDD0002M
  - HDD0003M
  - HDD0004M

**Response actions to threshold criteria exceedance may include, but are not limited to:**

- Baseline data for pathway and receptor established
- Mitigation and recovery approach approved by regulators
- Trigger and threshold criteria for application of mitigation and recovery actions approved by regulator
- Agreement with RTIO in place for combined catchment management approach.

**Condition clause number and text**

- Monthly monitoring of groundwater levels (mbgl) along identified impact pathways (such as Pebble Mouse Creek valley) between Southern Flank and Ben’s Oasis.

**Reporting in the event that the trigger criteria has been exceeded will be as per the Ministerial Statement Compliance Assessment Plan and relevant Groundwater Operating Strategy.**

- Annual reporting will be conducted as per the Ministerial Statement Compliance Assessment Plan and relevant Groundwater Operating Strategy.

**Response actions to threshold criteria exceedance may include, but are not limited to:**

- Baseline data for pathway and receptor established
- Mitigation and recovery approach approved by regulators
- Trigger and threshold criteria for application of mitigation and recovery actions approved by regulator
- Agreement with RTIO in place for combined catchment management approach.

**Monitoring**

- Monthly monitoring of groundwater levels (mbgl) along identified impact pathways (such as Pebble Mouse Creek valley) between Southern Flank and Ben’s Oasis.

**Reporting**

- Reporting in the event that the trigger criteria has been exceeded will be as per the Ministerial Statement Compliance Assessment Plan and relevant Groundwater Operating Strategy.
Appendix 1 – Proposal / Operation Summary

Mining Area C Hub

Mining Area C is located approximately 100 km north-west of the town of Newman in the Pilbara region of Western Australia. The mine is situated within Mining Lease ML281SA and is operated by BHP in accordance with the Iron Ore (Mount Goldsworthy) Agreement Act 1964.

BHP was granted approval under Part IV of the Environmental Protection Act 1986 (EP Act) for the mining of 14 iron ore deposits (A, B, C, D, E, F, R, P1, P2, P3, P4, P5, P6 and the Brockman Detrital deposits) in the Northern Flank area of Mining Area C in 1998, under Ministerial Statement 491.

Ministerial Statement 491 provides an on-going mechanism for the development of the Mining Area C deposits, subject to the Life of Project EMP being reviewed and updated as deposits are developed (as per condition 7 and proponent commitments 1 - 3 in Ministerial Statement 491).

Mining Area C has been an operational mine since 2003. Mining Area C operations comprise campaign mining of iron ore and overburden through conventional open cut mining methods. Campaign mining involves drilling, blasting, and categorisation of blasted material into iron ore or waste rock.

Mining Area C will continue dewatering of nominated pits in accordance with the mine plan to facilitate dry mining conditions. Groundwater abstraction (i.e. dewatering volumes and monitoring) is regulated by the DWER 5C licensing process and various groundwater operating strategies under the Rights in Water and Irrigation Act 1914 (the RIWI Act). A Managed Aquifer Recharge (MAR) is currently in operation to reinject surplus water back into the aquifer. This activity is managed under the Mining Area C operating license. Some of the excess water generated from mine dewatering is also re-used by operations on site (for example, dust suppression and ore processing requirements).

Existing Environment

Regional groundwater flow occurs predominantly in the regional aquifers of the Wittenoom Dolomite (particularly the karstic Paraburdoo member) and overlaying Tertiary detritals. As such, regional groundwater flow is concentrated in the valleys and intervening alluvial plains of Mining Area C.

Prior to mining related activities in the catchment, groundwater flows were from west to east (from Coondewanna Flats to Weeli Wolli Spring). Water levels ranged from ~660 mAHDe to ~560 mAHDe over this area.

Water supply abstraction for Mining Area C commenced in 2001 from C Deposit (the local Marra Mamba aquifer) and the western end of the Northern Flank Valley (regional aquifer), with additional temporary abstractions used during construction of the railway line and Coondewanna airstrip. Dewatering commenced from C Deposit and E Deposit in mid-2010 and early 2011 respectively.

Rio Tinto Iron Ore's Hope Downs Mining operations are located within the Northern Flank Valley (North and South Deposits). Dewatering commenced in January 2007 and is proposed to continue until the end of 2025 (i.e. until the end of mining and infilling). This is predicted to have a significant impact on flows at Weeli Wolli Spring and Rio Tinto Iron Ore are artificially supporting the system until the natural flow returns to within 10% of pre-mining rates, potentially up to 20 years after decommissioning (HDMS 2000).

Potential Impacts

BHP commissioned RPS Aquaterra to undertake a hydrogeological assessment for Mining Area C. Pit designs and development rates for all deposits associated with EMP Revision 6 Base and High Cases (derived from the 2014 mine plan) were included in model predictions.

The model was used to test the significance of both the hydrogeological system and the EMP Revision 6 Base and High Cases on the response of the groundwater system to mining at Mining Area C. The model was run numerous times, with the following variables:

- Mining Area C (EMP Revision 6) mine plan Base Case and High Case;
- with and without Hope Downs mine related water management and mitigation measures;
• with Hope Downs but without historical or future Mining Area C related water management activities;
• open voids and in filled voids at A and E Deposits; and
• injection of water to mitigate the propagation of drawdown from Mining Area C towards Coondewanna Flats.

The Mining Area C regional model has been updated and calibrated to a significant amount of data to support the Mining Area C Southern Flank Revised Proposal. In places, this data spans many years and is representative of different aspects of the groundwater system (flows, spring baseflow and a regional water balance). The model uses an uncertainty approach to establish a plausible range of groundwater responses to mining activity in the catchment.

The modelling has shown that for the proposed mining below the water table at the combined Mining Area C operations (based on the 2016 mine plan):
• Regional connectivity will be a significant control for environmental impacts.
• The maximum dewatering rate may be up to 85,000 kL/d (31 GL/a).
• The maximum cumulative groundwater drawdown at:
  o Coondewanna is predicted to be between 10m and 22m.
  o Ben’s Oasis is likely to be less than about 2m; and
  o Weeli Wolli Spring is likely to be around 1.75 m (after the period of proposed mitigation by Rio Tinto Iron Ore).
• Post-closure, the recovery of the groundwater system is likely to take hundreds of years at Coondewanna Flats and Ben’s Oasis, but tens of years at the Weeli Wolli Spring.
• The scenario of leaving open voids at Highway Deposits post-closure is predicted to have a significant reduction in the final recovery groundwater levels, particularly at Coondewanna Flats.

Surface water flow is an important contribution of stream flow and groundwater recharge in the Coondewanna Flats and Weeli Wolli Spring areas. Runoff assessments indicate that the extent of surface water interference to the natural system from the proposed Mining Area C activities will be minimal due to the diversion of creeks and channel flow.

The volume of surface water intercepted by mining activities is estimated to be around 740 ML/a from the total catchment flow for the Upper Weeli Wolli catchment area. The interception and effective removal of surface water from which would ultimately discharge or infiltrate into the Weeli Wolli Spring region is around 4.2% of the total volumes and is considered to be insignificant in comparison to the disruption which has occurred owing to mining in the lower catchment. For Coondewanna, the volume of surface water flow may increase slightly to 0.3% owing to changes in landform runoff in the vicinity of the surface water catchment divide, which effectively increases the capture area.

The subsequent downstream impacts to aquifer recharge and riparian vegetation in the areas of Weeli Wolli and Coondewanna are considered to be insignificant and within natural variance.

**Mining Area C: Southern Flank**

Mining Area C Southern Flank is located approximately 8 km to the south of the existing Mining Area C (northern flank) operations and will comprise the development of the proposed new satellite deposits at Southern Flank.

Conventional open pit mining methods will continue to extract ore from the existing approved Mining Area C deposits and the proposed Southern Flank deposits. Overland conveyors will transport ore from the Southern Flank deposits to existing processing facilities at Mining Area C. Incremental mining activity will be supported by the construction of new infrastructure as required.

Approximately 8% of the Southern Flank pits lie below water table. Dewatering is a key mining activity to access below water table ore and includes the Highway Pushbacks 1, 3, 5, Grand Central Pushbacks...
12, 13, 14, 15, 16, 19 and Vista Oriental Pushbacks 20, 21, 22, 23, 25, 27, 28. The lowering of groundwater levels during mine dewatering activities will result in a propagation of drawdown and the modification of the hydrological conditions away from the orebody aquifers and more regionally towards the key receptors of Coondewanna Flats, Weeli Wolli Spring and Ben’s Oasis.

Existing Environment

The Southern Flank deposits occur along the northern side of the Southern Flank valley with some deposits extending a short way into the valley floor. Similar to Area C, regional groundwater flow occurs predominantly in the regional aquifers of the Wittenoom Dolomite (particularly the karstic Paraburdoo member) and overlaying Tertiary detritals. As such, regional groundwater flow is concentrated in the valley and alluvial plains.

Prior to mining related activities in the catchment, groundwater flows were from west to east (from Coondewanna Flats to Weeli Wolli Spring). In the western end of Southern Flank valley a 30m groundwater drop is seen across one of the regional dolomite dykes that is likely to limit groundwater flow. Groundwater gradients in the central part of the valley are relatively flat and become steeper in the east as the valley narrows around Pebble Mouse Creek.

Potential Impacts

Groundwater modelling was carried out in support of the project assessment using an updated version of the Area C Model. Due to the early stage of the project uncertainty remains about the response of local groundwater systems within the project area to dewatering although the regional groundwater setting is well understood.

Additional change in regional aquifers as a result of Southern Flank dewatering will been seen primarily to the south and west in the regional dolomite aquifer, including beneath Coondewanna Flats. Cumulative drawdown from Northern Flank and Southern Flank beneath Coondewanna Flats is modelled to be between 10 and 22m by 2047.

Southern Flank is likely to contribute to drawdown in the lower catchment to the east in the vicinity of Weeli Wolli Creek. Modelling shows a relatively small change of between 0.2 and 0.5m in 2054 at GWB0018 in response to Southern Flank dewatering. This change is seen following aquifer recovery and closure activities at Hope Downs.

Change at Ben’s Oasis due to Southern Flank dewatering is expected to be unlikely and cumulative impacts from Northern Flank and Hope Downs are expected to be less than 1m in 2054.

Mining Area C: Juna Downs and Camp Hill Managed Aquifer Recharge (MAR) Schemes

The Juna Downs MAR Borefield is located approximately 10 km south-west of the Mining Area C – Northern Flank operations, shown in Figure B1.

The discharge of surplus mine water will occur during periods when the mine water demand is less than the dewatering rate. MAR (through infiltration and injection) is the preferred method of surplus management. MAR injection at Camp Hill and Juna Downs was assessed as part of EMP Rev 6. The ongoing MAR trial at Mining Area C (currently located at A Deposit) appears to be a feasible alternative to mitigating drawdown at a key receptor.

Groundwater levels are expected to rise and fall in the vicinity of the Juna Downs and Camp Hill borefields as the areas are used for surplus MAR and subsequently as Camp Hill is used as a water supply borefield.

Potential Impacts

Operation of a MAR borefield at Juna Downs at the maximum proposed rate of 20 ML/d for a period of 18 years leads to development of a groundwater mound which propagates throughout the Juna Downs and Coondewanna Flats area. The aquifer drawdown effects from Camp Hill are predicted to be isolated from the mine dewatering area of influence owing to the ridge of low permeability BIF and shale separating the pumping centers.
Based on the current conceptual hydrogeological model (and corresponding numerical model set-up), which includes drawdown from MAC extending into the Coondewanna Flats area, the result is a net increase in groundwater levels of between 5 and 8 m. This corresponds to a minimum depth to groundwater of 14 to 16 m in the north-eastern part of the Flats.

Figure B1: Water effecting activities in the Upper Weeli Wolli Catchment
## Appendix 2 – Stakeholder Consultation

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<th>Description of Consultation</th>
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<td>April 2017</td>
<td>Submitted as part of Mining Area C Southern Flank Revised Proposal</td>
<td>Update document to new format as per Instructions Reinstate drawdown triggers for Coondewanna Flats</td>
<td>Updated document as per feedback.</td>
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