Note to Reader:

This document sets out the BHP Billiton Iron Ore Pty Ltd (BHP Billiton Iron Ore) Central Pilbara Water Resource Management Plan (CPWRMP) and summaries the technical considerations, assumptions and risks that underlie the development and implementation of the Pilbara Water Resource Management Plan (PWRMP).

The CPWRMP considers the hydrological changes resulting from BHP Billiton Iron Ore mining, the receiving receptors (water resources, environment, social and third-party operations), the potential impacts and the required risk-based adaptive management to mitigate potential impacts to acceptable levels. The plan shall be reviewed and if necessary amended annually following the Life of Asset (LOA), 5 year planning process and the Annual Aquifer Review (AAR).

Document Amendment Record

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1. Introduction
This Central Pilbara Water Resource Management Plan (CPWRMP) establishes specific water resource and water dependent ecosystem management requirements for the Central Pilbara mining area which sits within the Upper Weeli Wollo and Coondewanna sub-catchments. Based on current scientific understanding, two environmental receptors have been singled out as ‘key’ in this CPWRMP and requiring adaptive management to a level above and beyond the standard monitoring implemented through standard regulatory measures, such as Environmental Protection Act 1986 Part V Operating Licence requirements, and Groundwater Operating Strategies relevant to Section 5C licenses issued under the Rights in Water and Irrigation Act 1914. The two identified key environmental receptors are the Weeli Wolli Spring Community (including Ben’s Oasis) and Coondewanna Flats, both priority ecological communities (PECs).

The CPWRMP provides a standardised and consistent risk based approach to regional water management for multiple BHP Billiton Iron Ore Pty Ltd (BHP Billiton Iron Ore) operations in the Central Pilbara. It sets out the overarching approach and incorporates the technical considerations, assumptions and adaptive management that underlie the broader BHP Billiton Iron Ore Pilbara Water Resource Management Strategy (PWRMS).

The CPWRMP directs the consistent development and considerations of the catchment, hub and site-specific water resource management requirements for the Central Pilbara.

The CPWRMP considers the hydrological changes resulting from BHP Billiton Iron Ore mining, 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.

For Coondewanna Flats, early warning triggers, and trigger values and threshold values and/or management measures, as applicable, have been developed in this CPWRMP. These trigger and threshold values have been developed to meet current and future anticipated Ministerial Conditions and are also designed to meet the intent of the Environmental Protection Authority (EPA) Environmental Assessment Guideline (EAG) No. 17 for the Preparation of Management Plans under Part IV of the Environmental Protection Act 1986 (EPA, 2015).

1.1. CPWRMP Scope
The scope of the CPWRMP considers the specific water management requirements and the receiving receptors for the BHP Billiton Iron Ore Central Pilbara Hub of Mining Area C, which includes the existing Northern Flank operations and the proposed Southern Flank operations. Other long term deposits/mines in the catchment are at a concept stage only and as such are not considered as part of this plan.

1.2. CPWRMP Objective
The CPWRMP aims to provide a consistent method to identify the hydrological changes (groundwater and surface water quantity, levels and quality) resulting from BHP Billiton Iron Ore mining and closure activities, the receiving receptors (water resources, environment, social and third party operations), the potential impacts and the required risk-based adaptive management to mitigate potential impacts to acceptable levels.

Water Outcome-based Objective:
To manage the range of potential hydrological changes (groundwater, surface water and/or soil moisture) resulting from BHP Billiton Iron Ore Central Pilbara Hub operations impacting on receiving receptors to an acceptable level.

1.3. Water effects assessment and management methodology
The CPWRMP iteratively collates the key findings and knowledge of the eco-hydrogeology technical studies and changes of 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. The CPWRMP will be reviewed, and if necessary updated, annually following BHP Billiton Iron Ore internal planning process which is completed annually and reported externally through the Annual Aquifer Review (AAR) and the Groundwater Operating Strategy (GWOS). The CPWRMP shall also be reviewed as part of the assessment process for any new projects for which Hydrological Processes or Inland Waters Environmental Quality are potential key environmental factors. Review, including update of conceptual models, will also take place when significant technical knowledge becomes available, where there is an impact potential change and/or corrective action is required.

As outlined in Figure 1, the CPWRMP considers the following aspects:
- hydrological changes (baseline, current and future conditions of groundwater, soil moisture and surface water) resulting from BHP Billiton Iron Ore 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.
1.4. Operational water management context

Water management associated with mine operations involves the interrelationship between:
- Operations water supply;
- dewatering (and depressurisation);
- surplus water management;
- wet weather;
- environmental impact (and mine closure) management;
- license and ministerial conditions; and
- potable water supply.

These considerations cannot be viewed in isolation, together these interrelationships are managed by an Integrated Water Management System (based on the requirements of BHP Billiton Our Requirements [formerly Group Level Documents GLDs] and ISO 14001 – Environmental Management System) and the catchment, hubs and site-specific water balances.

The CPWRMP considers existing management objectives and applies the key findings from the eco-hydrogeological investigations, monitoring and literature to guide the development of outcome-based objectives. The outcome-based objectives are required for the BHP Billiton Iron Ore management of predicted and actual impacts directly resulting from BHP Billiton Iron Ore operations on receiving receptors at a catchment scale. The CPWRMP does not try to manage impacts on receiving receptors that are beyond BHP Billiton Iron Ore’s operational impact, control or responsibility, such as impacts resulting from prolonged dry periods, climate variability or third-party operations.

The Pilbara Water Resource Management Strategy is substantiated by the CPWRMP and will have other catchment scale plans, which provide a consistent approach to water management across the technical and operational groups of the business, as well as providing operational and approval flexibility as shown in Figure 2.

![Figure 2: Overview of the Pilbara Water Resource Management Strategy](image-url)
2. Central Pilbara mining operations

This section summarises BHP Billiton Iron Ore’s operations within the Central Pilbara catchment and the range of potential hydrological changes (groundwater, surface water and/or soil moisture) resulting from BHP Billiton Iron Ore mine operations.

2.1. Overview of the Central Pilbara mining hubs

For the purpose of this plan the Central Pilbara catchment currently consists of the following grouped deposits/mines:

- Mining Area C: Northern Flank (existing)
- Mining Area C: Southern Flank (proposed)

These operations are described in Appendix B, along with a summary of the range of potential hydrological changes (groundwater, surface water and/or soil moisture) resulting from BHP Billiton Iron Ore mine operations which are covered by the CPWRMP.

2.2. Hydrological change and mining operations

Mine dewatering and surface water diversion activities at Central Pilbara mines will continue and in some areas increase to support below the water table mining. The dewatering activities are predicted to generate a net surplus water scenario over the next 18 years which will continue to require management on a local and regional scale. A summary of the surplus water management approach is outlined in this plan (Appendix B).

Mining Area C will continue dewatering of mine pits in accordance with the mine plan to facilitate dry mining conditions. A Managed Aquifer Recharge (MAR) scheme is currently in operation at A deposit to re-inject 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).

The potential regional drawdowns, mounding and impacts associated with these changes have been simulated by using regional numerical and analytical models calibrated, using data from existing operations and Mining Area C (including dewatering activities), Managed Aquifer Recharge and regional surface and groundwater monitoring results. The models accommodate for technical uncertainty, a range of mine planning options and the various existing and planned Central Pilbara Hubs water balance scenarios which consider dewatering activities and water supply borefields.
3. Protect values – Environmental and community receptors

3.1. Central Pilbara Environmental key receptors

The Pilbara biodiversity baseline development (consisting of over 6000 biodiversity field studies covering 90% of BHP Billiton Iron Ore tenure) has identified the following environmental receptors within Central Pilbara catchment.

- Ben’s Oasis
- Karijini National Park (conservation estate)
- Wanna Munna Flats (PEC)
- Wanna Munna Pool
- Weeli Wolli Calcretes
- Weeli Wolli Springs (PEC)
- Coondewanna Flats (PEC)
- Pebble Mouse Creek

The Coondewanna Flats and Weeli Wolli Springs are two environmental receptors which have been identified as important receptors of value by the Minister for Environment, listed as containing PECs and the EPA, via Ministerial Statements issued to BHP Billiton Iron Ore. A description of these key environmental receptors is presented in Appendix C. The potential hydrological change, key considerations and adaptive management of these two key receptors are discussed further in Section 6 and 7.

3.2. Central Pilbara Community receptors

3.2.1. Central Pilbara Indigenous receptors

Community (Indigenous) receiving receptors in the Pilbara Region have been formally identified and their values have been defined and in some instances outlined in individual Traditional Owner agreements. These receptors are considered via the BHP Billiton Iron Ore Project Environment and Aboriginal Heritage Review (PEAHR) process which is subject to confidential agreements.

Interaction between BHP Billiton Iron Ore and Traditional Owners continues to expand on the understanding of the values of the social receptors and will continue to be inputs into the adaptive management approach, as required.
4. Regional catchment management approach

The CPWRMP applies an adaptive management approach to manage the range of potential hydrological changes resulting from BHP Billiton Iron Ore operations and potential impacts on a receiving receptor.

This approach can accommodate the uncertainty associated with predicting dewatering volumes and the resulting area of influence whilst maintaining the value of the receiving receptor which may be impacted by changes in hydrological processes or by water quality. This is done through a combination of

1. preventative water management controls, such as surplus water returned to the aquifer;
2. allowing for the application of precautionary principles to be considered as the scientific knowledge evolves through baseline assessments and the monitoring of predicted and actual outcomes; and
3. utilising practicable and feasible water mitigation controls to mitigate and offset impacts.

This approach provides a systematic and iterative process for decision-making and establishing management objectives, particularly where uncertainty exists, to achieve the desired outcome as per Figure 1.

4.1. 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. This is generally the result of either abstraction of water to facilitate from below water table mining 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 operational mining hub is presented in Appendix B.

4.2. 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.

Three stages are described under the following hierarchy:

1. **Investigation Stage** – undertakes investigation to evaluate and characterise the change identified (aligns with ‘early warning trigger’ values used in this Plan). The investigation results may establish a revised investigation program (including further monitoring) and management options are proposed, should the trigger values be reached.
2. **Action Stage** – prepares and implements water management options to avoid potential impact to a receiving receptor (aligns with the ‘trigger values’, as defined by the EPA (EAG 17; EPA, 2015). The trigger values are considered to be precautionary and conservative to ensure there is sufficient time available to prevent impact. If trigger levels are reached the proponent will initiate an assessment to investigate whether there is a potential for the unpredicted trend to impose a negative impact on the environment, and if so, recommend further adaptive management options, including potential corrective actions.
3. **Mitigation Stage** – corrective action is immediately required to prevent unacceptable impact or reverse the trends (aligns with ‘threshold values’, as defined by the EPA (EAG 17; EPA, 2015)). Corrective actions to be identified in Action Stage.

4.3. 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 Billiton Iron Ore operations. Two 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 and Weeli Wolli Spring. A description of the receptors of value is presented in Appendix C, while trigger values are presented in Section 6 and 7.

4.4. Scientific uncertainty - Early warning triggers, triggers and thresholds

To achieve the outcome-based objectives, early warning triggers, triggers and thresholds will be developed within the area of influence, receptor location and surrounding pathways (laterally and vertically through the aquifers) to monitor predicted and actual BHP Billiton Iron Ore impacts, isolate and characterise natural variance and influences from 3rd parties and to enable receiving receptor protection.

Initially, early warning triggers, triggers and thresholds will reflect existing scientific knowledge to deal with the risks of uncertainty and the need to interpolate catchment-wide data and a range of mine water balance scenarios. In the absence of technical knowledge, a mine planning process which introduces variability, plus the requirement for impact assessment conclusions to be validated in the field, conservative and precautionary thresholds will be enacted. As the scientific understanding evolves and transitions from catchment-wide to site-specific interpretative investigations, the level of uncertainty and the amount of interpolation will decrease and thresholds will be iteratively refined, as shown in Figure 4. The approach accommodates the persistence of hydrological and ecological uncertainty during operations and ultimately post closure. However, the approach also recognises that the persistence of uncertainty associated with variations to mine plans and mine development rates may always exist to provide operational flexibility.

Figure 4: Iteratively refined thresholds to reflect scientific knowledge for the Central Pilbara Receptors

4.5. Central Pilbara Regional Monitoring

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

- Groundwater aquifers water levels and quality, within the operational mining hubs and a regional groundwater monitoring network.
- Surface water drainage features and creeks flow volumes.
- Water supply Borefield water levels and quality.
- Surplus water volumes and quality, prior to discharge into the environment.
- Weather and climatic conditions.

The Regional Monitoring Network has been installed as 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 and natural climatic variations and stresses.

The Regional Monitoring Network is consistent with, and complimentary of, aspects of other regulatory reporting requirements such as water quality parameters, for example, under EP Act Operating Licenses through the BHP Billiton Iron Ore Annual Environmental Report (AER), as well as AARs and TARs.

4.6. Water management options

The water management options outlined in Figure 5 consider feasible options and controls (preventative and mitigating) to counteract hydrological changes resulting from BHP Billiton Iron Ore operations and the potential impacts to receiving receptors during BHP Billiton Iron Ore operations and closure. This enables an innovative flexibility with regards to water management and takes into account optimising of mine dewatering, storage and use. This approach is consistent with the 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.
4.7. Cumulative effects

Hydrological conditions can be impacted by more than one mining operation, depending on the surface water and groundwater hydrological interconnectivity at the catchment scale.

The Central Pilbara currently has two operators within the catchment, BHP Billiton Iron Ore (Mining Area C) and Rio Tinto (Hope Downs operations). BHP Billiton Iron Ore has taken into account third party operations in modelling (conceptual and numerical) as far as the available data allows. Findings are further discussed in Section 7 and Appendix C.

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

5. Monitor, review and take corrective action

The specific monitoring and corrective actions (if necessary) for the key Central Pilbara receptors are detailed in Section 6 for Coondewanna Flats and in Section 7 for Weeli Wolli Creek. This plan outlines the specific monitoring requirements, triggers and preventative and corrective actions.

Below is a summary of the monitoring and corrective action process.

5.1. Monitor and review

5.1.1. Monitoring and management zones

Monitoring facilities will characterise groundwater, soil water, surface water and where necessary ecological health and abundance. When relevant, monitoring zones will be established that represent the risk, the receptor location and surrounding pathways (laterally and vertically through the aquifers) to allow the predicted and actual BHP Billiton Iron Ore impacts to be monitored. The monitoring frequency and parameters will depend upon the risk characteristic, the location of the monitoring facility and extent of technical uncertainty.

Management zones or facilities will allow preventative and mitigating controls to be implemented. Details are provided for receptor-specific management approaches in Sections 6 and 7.

5.1.2. Review of the plan and triggers

The CPWRMP is underpinned by current scientific understanding. The early warning triggers, 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-effecting 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 shall be reviewed, and if necessary amended, annually following the BHP Billiton Iron Ore internal planning process. Monitoring is reported externally through the (AAR) as per the Groundwater Operating Strategy (GWOS). The CPWRMP shall also be reviewed as part of the assessment process for any new projects for which Hydrological Processes or Inland Waters Environmental Quality are potential key environmental factors.
Triggers and Thresholds will be reviewed when either:

- a new project is proposed for which Hydrological Processes or Inland Waters Environmental Quality is a key environmental factor;
- the level of scientific knowledge relating to a key environmental or social receptor produces results which justify a change in the current triggers and thresholds; or
- when monitoring results justify a change in the current triggers and thresholds.

Reviewing results on an iterative basis will lead to an increased scientific understanding of the ecological resilience, adaptability and hydrological dependency, and also the hydrological environment and change resulting from BHP Billiton operations.

5.1.3. Monitoring Programs

DER licenses discharges to the environment under Part V of the EP Act by issuing a License to Operate. These licenses have discharge limits and monitoring requirements of water discharged into the environment from BHP Billiton Iron Ore operations.

GWOS are required as a condition of Groundwater Licenses for BHP Billiton Iron Ore mining operations in the Pilbara. The GWOS for the operations within the CPWMRP include the operational approach to managing groundwater abstraction within the limits of the licenses issued and a detailed monitoring program for groundwater quality of water abstracted.

Additionally, the regional monitoring network is consistent with, and complimentary of, aspects of other regulatory monitoring requirements, under EP Act Operating Licenses and Groundwater Licenses. Given these approvals manage the water source inputs, the CPWRMP does not address these further.

5.2. Reporting

Reporting of monitoring results shall be provided to Office of the Environmental Protection Authority (OEPA) and the Department of Water (DoW) via the AER and the AAR, respectively, on an annual basis. Reporting will be in accordance with the requirements of the relevant approvals, particularly Ministerial Statement conditions, DER licenses and DoW Groundwater License conditions.

6. Coondewanna Flats Ecological Community

Coondewanna Flats is a PEC located about 18 km south west of BHP Billiton Iron Ore’s Mining Area C operations. 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. Lake Robinson is an ephemeral shallow lake which forms within Coondewanna Flats during the wet season.

Coondewanna Flats is an internally-draining surface water feature, with a catchment area of approximately 866 km². 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.

Surface water flows towards the flats from the north, west and south. Surface water runoff accumulates on the flats before being lost to evaporation or infiltrating into the Tertiary detritals, where it replenishes soil water in the unsaturated zone and potentially contributes to groundwater recharge. Lake Robinson occurs within a topographic low at the northeastern extent of the flats and is ultimate terminus for catchment runoff. It supports distinct Coolibah (Eucalyptus victrix) woodland vegetation communities, two of which have been identified by Department of Parks and Wildlife (DPaW) as PECs. These are the Coolibah woodlands over lignum over swamp wandiree (Priority 1) and Coolibah and Mulga woodland over lignum and tussock grass on clay plains (Priority 3). The surrounding flats are characterised by poorly-defined drainages with Coolibah and mulga (Acacia aptaneura) woodland vegetation.

The depth to groundwater beneath the Coondewanna Flats is about 20 mbgl suggesting that Coondewanna ecological communities are unlikely to be dependent upon groundwater and therefore the magnitude and rate of change in hydrological conditions resulting from BHP Billiton Iron Ore’s operations are unlikely to result in an impact to the PEC.

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 predicted zone of groundwater mounding intersects the Coondewanna Flats, in an area of broad flats and closed depressions containing Mulga (Acacia aptaneura) woodlands and two unusual Western Coolibah (Eucalyptus victrix) woodland vegetation communities that are listed as PECs) by the DPaW (DPaW, 2015).

The maximum predicted increase in groundwater levels associated with the Juna Downs MAR scheme could potentially create a connection between the deep roots of mature E. victrix trees and the groundwater system. This could occur via direct saturation of roots or interaction with the capillary fringe immediately above the water table. The following sections establish upper water level targets and thresholds along with ecological indicators to prevent detrimental changes at the PEC.

A detailed description of the hydrological and ecological characteristics of Coondewanna Flats is provided in Appendix C.
6.1. Outcome-baseline environmental objective

The outcome-based objectives for Coondewanna Flats aim to minimise the short and long-term impacts on groundwater resources and groundwater dependent ecology caused by BHP Billiton Iron Ore mining operations and groundwater use:

- prevent any significant impact on priority vegetation communities within Coondewanna Flats (including Lake Robinson) as a result of BHP Billiton Iron Ore operations; and
- minimise impact on groundwater levels and quality and to minimise potential impacts on the surrounding environment.

6.2. Adaptive management – Trigger and Threshold Values

The water management objectives have been set as monitoring triggers and corrective action thresholds for the Coondewanna Flats environment based on changes in ground water levels.

The trigger values have been established to manage the potential impacts to the Coondewanna Flats ecological community and are set to maintain hydrological conditions (ground water levels and soil ) in the Coondewanna Flats within scientifically determined ranges (see Appendix C for basis for nominating these as the trigger aspects). The hydrological values based on baseline groundwater ranges of the aquifer are as per Table 1 below.

Table 1: Triggers and Thresholds for Coondewanna Flats

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<th>Aspect</th>
<th>Monitoring and Management Values</th>
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<td>Investigate (early warning trigger)</td>
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<tr>
<td>Coondewanna Flats</td>
<td>Groundwater Level</td>
<td>Groundwater level rises to 17 mgbgl at monitoring bore GWB0039M</td>
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1 Corresponds to the point at which groundwater levels at monitoring bore GWB0039M exceed the highest modelled groundwater level (in the modelling scenario which includes injection at Juna Downs and dewatering at Mining Area C), detailed in Appendix B.
2 Corresponds to the point at which groundwater levels could interact with the roots of E. victrix, further details in Appendix C.
3 Groundwater Level: Corresponds to the point at which groundwater levels could interact with the roots Acacia species, further details in Appendix C

These triggers are considered precautionary and will seek to transition during subsequent iterations of the CPWMP towards ecological thresholds which may represent the soil moisture dependency, additional refinement of the groundwater model and associated update of the ecohydrological conceptualisation of Coondewanna Flats.

To verify the effectiveness of water management in relation to the vegetation health, monitoring of key locations will be undertaken, in accordance with Table 2. These feed into the key indicators for that will inform the management actions.

Table 2: Verification of effectiveness of water management for the Coondewanna Flats which supports priority ecological communities

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Objective / Requirement</th>
<th>Measure</th>
<th>Monitoring</th>
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<tr>
<td>Vegetation Health</td>
<td>Minimise impacts to priority ecological communities within Coondewanna Flats</td>
<td>Sustained canopy decline (defined as Crown Condition Score (CCS) below baseline for 3 or more consecutive measurement events, or as determined during Action Stage) or death of any monitored tree</td>
<td>On-ground monitoring of indicator tree species* at monitoring sites 12, 15 and 20 – biannual Crown Condition Score (CCS) and Diameter at Breast Height (DBH)</td>
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* Species: E. victrix (AQ2, 2016). Details of species water dependency provided in Appendix C.
6.3. Adaptive management – Management Approach

BHP Billiton Iron Ore management of impacts to Coondewanna Flats will be undertaken in accordance with 5C license, Part V license requirements, the site GWOS and in compliance to the Mine Closure Plan.

The adaptive management hierarchy for Coondewanna Flats focuses on investigation, action and mitigation of potential environmental impacts and exceedances of management targets. The approach ensures that any change and/or response observed is characterised and understood prior to implementing corrective action.

Three stages are described under the following hierarchy:

1. **Investigation Stage** – undertake an investigation to evaluate and characterise the change identified. The investigation results may inform future surplus water discharge programs (timing, volume, rate of discharge etc.) and management options proposed, should the threshold values be reached.

   **Specifically, the following will be undertaken:**
   - Undertake a comprehensive review of monitoring results, looking at groundwater levels, rates of change and comparing these to the hydrogeological conceptual model and numerical groundwater model.
   - Following the review of monitoring results, review hydrogeological conceptual model and recalibrate numerical groundwater model, if warranted.
   - Produce revised predictions of groundwater level response to ongoing operation of MAR borefields.

2. **Action Stage** – prepares and implements water management options to avoid potential impact to a receiving receptor or exceedance of threshold values. If the trigger values are reached the proponent will initiate an assessment to investigate whether there is a potential for the unpredicted trend to impose a negative impact on the environment, and if so, recommend further adaptive management options, including potential corrective actions.

   **Specifically, the following will be undertaken, if the trigger values are reached:**
   - Notify OEPA of trigger exceedance.
   - Commence biannual measurement of Leaf Water Potential (LWP) at monitoring sites 12, 15 and 20 to assess the response of tree water use to elevated groundwater levels.
   - Use first three years of LWP data to review, and if necessary revise, the Ecological Rehydration Index (ERI) baseline.
   - For changes attributable to BHP Billiton Iron Ore activities, develop and instigate measures to limit potential negative impacts on tree health based on conceptual model of ecosystem response at both Action and Mitigation Stages.
   - Engage with DER, DPaW and DoW on findings and proposed approach.

3. **Mitigation Stage** – corrective action is immediately required to prevent unacceptable impact or reverse the trends. Corrective actions to be identified in Action Stage.

   **Specifically, the following will be undertaken, if the threshold values are reached:**
   - Instigate measures to mitigate impacts to vegetation (to be informed by Action Stage).
   - Take measures to reduce groundwater levels to acceptable level (to be informed by Action Stage).
   - Engage with DER, DPaW and DoW on findings and proposed approach, in line with any regulatory requirements.
7. Weeli Wolli Springs – Adaptive management

Weeli Wolli Spring is located approximately 14 km east of Mining Area C and comprises an area where surface water and groundwater flows discharge from the Upper Weeli Wolli Creek sub-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.

The Weeli Wolli Spring area is recognised as having multiple ecological values that collectively contribute to its status as a Priority 1 Ecological Community (DEC, 2009; DPaW, 2014). Groundwater dependent vegetation may occur at Weeli Wolli Spring and the adjoining channel of Weeli Wolli Creek extending upstream and downstream of the spring, situated approximately 10 km east of Mining Area C. This area supports the true phreatophyte *Melaleuca argentea* which is highly sensitive to groundwater drawdown.

The Weeli Wolli Spring PEC also occurs at Ben’s Oasis, located about 20 km further upstream and south of Weeli Wolli Spring. Ben’s Oasis is a name that is locally used by BHP Billiton Iron Ore. At this location, the vegetation is concentrated along a relatively narrow creek channel adjacent to some surface water pools. Ben’s Oasis also supports the true phreatophyte *Melaleuca argentea*. There is very little documented information about the geology, hydrology and ecology of Ben’s Oasis.

Potential hydrological changes resulting from BHP Billiton Iron Ore’s operations in relation to the Weeli Wolli Springs is groundwater drawdown. The predicted groundwater drawdown at both Weeli Wolli Spring and Ben’s Oasis from Mining Area C activities is less than 1 m. This impact alone is unlikely to result in any decline in vegetation at either location.

However, the spring’s natural function is currently being impacted from Hope Downs operations and is being maintained through artificial discharge through a series of spigots, masking any potential impact to Weeli Wolli Spring. The maximum predicted cumulative groundwater drawdown (from Mining Area C and Hope Downs operations) is between 3m and 14m for Weeli Wolli Spring and 2 m to 5 m for Ben’s Oasis. This drawdown is associated predominantly with abstraction from Hope Downs. This cumulative impact would result in decline of groundwater dependent vegetation at both sites (Onshore Environmental 2015). However, it is impossible to determine accurate trigger and threshold values which attribute to BHP Billiton Iron Ore’s operations alone until Hope Downs closure plans are known.

Additionally, further hydrological studies are indicating there is an aquifer divide between the Mining Area C operations and the Weeli Wolli Creek environment. This is discussed in further detail in Appendix C.

7.1. Outcome-based environmental objectives

The following has helped inform defining environmental objectives for the Weeli Wolli Springs environment, which monitor for changes to the environment that may result from BHP Billiton Iron Ore’s operations.

- prevent any significant impact on Weeli Wolli Spring (including Ben’s Oasis) as a result of BHP Billiton Iron Ore operations.

Ministerial Statement 491 (Section 46C amendment) – Mining Area C – Northern Flank – Condition 5-1 states that:

- 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.

7.2. Adaptive management – Triggers, Thresholds and Monitoring

Further hydrological work is required to formulate a practical and meaningful threshold for Weeli Wolli Spring to demonstrate the efficiency of management actions and the achievement of the environmental objective. BHP Billiton Iron Ore will review the requirement for triggers at Weeli Wolli Spring:

- At notification of pre-closure of Rio Tinto Iron Ore’s Hope Downs mining operation;
- If other BHP Billiton Iron Ore 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 Billiton Iron Ore.
8. 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 Billiton Iron Ore 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 BHP Billiton Iron Ore mining operations within one water catchment or a combination of BHP Billiton Iron Ore and third-party operations within one water catchment.

**Current Conditions n.** the hydrological conditions that prevail now that BHP Billiton Iron Ore has begun mining operations, including natural variation.

**early warning trigger n.** the point at which water management options must be considered and implemented 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 Billiton Iron Ore 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 Billiton Iron Ore mine is operating in sufficient proximity to other BHP Billiton Iron Ore 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 Billiton Iron Ore 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 Billiton Iron Ore 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 Billiton Iron Ore living or doing business within the area of interest.

**third-party operations n.** mining activities other than those of BHP Billiton Iron Ore 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).
### Table 3: Index list for Ministerial Statement conditions addressed by this Plan*

<table>
<thead>
<tr>
<th>Ministerial Statement No.</th>
<th>Title</th>
<th>Condition No.</th>
<th>Type of Condition</th>
<th>Environmental Factor</th>
<th>Schedule</th>
<th>Version/Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ministerial Statement No. TBA*</td>
<td>Mining Area C – Southern Flank</td>
<td>Condition X*</td>
<td>Management action</td>
<td>Hydrological Processes</td>
<td>Schedule 1</td>
<td>Draft Revision A October 2016</td>
</tr>
</tbody>
</table>

* Details to be updated when known
**Schedule 1 – Ministerial Statement XXX – Mining Area C (Coondewanna Flats)**

**Purpose of this Condition EMP:** The Central Pilbara Water Resource Management Plan is submitted to fulfill the requirements of Condition X of Ministerial Statement 10XX.

**Condition objective:** The proponent shall manage the potential impact of groundwater drawdown from the Mining Area C Iron Ore Mine in a manner that minimises impacts to the Coondewanna Flats Community.

**Rationale for management actions/targets:**
- **Coondewanna Flats Priority Ecological Community** – Coondewanna Flats Priority Ecological Community has the potential to be impacted from changes in groundwater levels through raising of the regional groundwater resulting from re-injection activities associated with Mining Area C operations at Juna Downs. Monitoring of the community will be undertaken in order to validate the groundwater dependency of the community and our predicted impacts.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Key Impact</th>
<th>Management Targets</th>
<th>Monitoring</th>
<th>Adaptive Management</th>
<th>Management Action</th>
<th>Reporting Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater level (trigger value)</td>
<td>Groundwater level rises to 15 mbgl (trigger level) at any of the following monitoring bores: GWB0039M, HCF0032M, HCF0044M and HCF0045M</td>
<td>Monitoring of groundwater levels at GWB0039M, HCF0032M, HCF0044M and HCF0045M during operations (i.e. active reinjection) will be undertaken quarterly.</td>
<td><strong>Action Stage</strong> – prepares and implements water management options to avoid potential impact to a receiving receptor (aligns with the 'trigger values', as defined by the EPA (EAG 17, EPA, 2015)). The trigger values are considered to be precautionary and conservative to ensure there is sufficient time available to prevent impact. If trigger levels are reached the proponent will initiate an assessment to investigate whether there is a potential for the unpredicted trend to impose a negative impact on the environment, and if so, recommend further adaptive management options, including potential corrective actions.</td>
<td><strong>Notify CEO of trigger exceedance</strong></td>
<td><strong>Environmental Aquifer Review (EAR)</strong></td>
<td></td>
</tr>
<tr>
<td>Groundwater level (threshold value)</td>
<td>Groundwater level rises to 7 mbgl (or other level to be determined during Action Stage) at any of the following monitoring bores: GWB0039M, HCF0032M, HCF0044M and HCF0045M</td>
<td>Monitoring of groundwater levels at GWB0039M, HCF0032M, HCF0044M and HCF0045M during operations (i.e. active reinjection) will be undertaken quarterly.</td>
<td><strong>Mitigation Stage</strong> – corrective action is immediately required to prevent unacceptable impact or reverse the trends (aligns with 'threshold values', as defined by the EPA (EAG 17, EPA, 2015)). Corrective actions to be identified in Action Stage</td>
<td>Engage with DER, DPaW and DoW on findings and proposed approach.</td>
<td>Report to the CEO within 30 days of a management target being exceeded, in accordance with the requirements of condition 8-4.</td>
<td></td>
</tr>
</tbody>
</table>

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 as part of the compliance reports required by condition 11.
Appendix B  Summary of existing operations

Mining Area C: Northern Flank

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 Billiton Iron Ore in accordance with the *Iron Ore (Mount Goldsworthy) Agreement Act 1964*.

BHP Billiton Iron Ore 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 Department of Water (DoW) 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 mAHHD to ~560 mAHHD 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 North 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 Billiton Iron Ore 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. 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 has been used to simulate the effect on the groundwater system of cumulative water management activities, mitigation and closure options at Mining Area C and Hope Downs mines.

The modelling has shown that for the proposed mining below the water table at Mining Area C for EMP Revision 6 Base and High Cases (based on the 2014 mine plan):
The water management associated with both the Base Case and High Cases have a very similar effect on the groundwater system.

The maximum dewatering rate may be up to 42,000 kL/d (15.3 GL/a).

The maximum cumulative groundwater drawdown at:
- Coondewanna is predicted to be between 6m and 9.5m. With mitigation this can be reduced and maintained at less than 1 m;
- Ben’s Oasis is likely to be less than about 2 m; and
- Weeli Wolli Spring is likely to be less than 1 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 A and E 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 South 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 South 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 South 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 C  Description of the Key Receptors

The water dependent receptors which could potentially be impacted from changes in hydrological conditions associated with the Mining Area C operations have been assessed based on depth to groundwater monitoring, surface water flow and inundation mapping and vegetation mapping over multiple years.

The primary water dependent assets identified are:

1. The Water Resource (surface and groundwater)
2. Coondewanna Flats (including Lake Robinson)
3. Weeli Wolli Spring
4. Ben’s Oasis

The locations of the assets are presented on Figure B2 and a detailed description of the environmental receptors and hydrological dependency of Coondewanna Flats (including Lake Robinson) and Weeli Wolli Spring is provided below and has also been detailed in the Strategic Environmental Approval (SEA) Ecohydrological Change Assessment report (BHP Billiton Iron Ore, 2015).

Coondewanna Flats PEC – Adaptive management

Coondewanna Flats is a PEC located about 18 km south west of BHP Billiton Iron Ore’s Mining Area C operations. 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. Lake Robinson is an ephemeral shallow lake which forms within Coondewanna flats during the wet season.

Hydrological baseline conditions

Coondewanna Flats is an internally-draining surface water feature, with a catchment area of approximately 866 km². 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.

Surface water flows towards the flats from the north, west and south. Surface water runoff accumulates on the flats before being lost to evaporation or infiltrating into the Tertiary detritals, where it replenishes soil water in the unsaturated zone and potentially contributes to groundwater recharge. Lake Robinson (EHU 9 in Figure C1) occurs within a topographic low at the northeastern extent of the flats and is ultimate terminus for catchment runoff. It supports distinct Coolibah (Eucalyptus victrix) woodland vegetation communities. The surrounding flats (EHU 6 in Figure C1) are characterised by poorly-defined drainages with Coolibah and mulga (Acacia aptaneura) woodland vegetation.

The depth to groundwater beneath the Coondewanna Flats is about 20 m below ground level suggesting that interaction between the groundwater system and terrestrial ecosystems is unlikely. Ongoing studies on the hydrology and vegetation water use have found that vegetation communities of the flats are likely to be dependent on the surface water regime of the flats.

An ecohydrological conceptualisation of Coondewanna Flats is provided in Figure C1 with the key aspects being:

- 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 calcrete aquifer is present at a depth of 20 to 30 m below ground level. It is overlain by largely unsaturated Tertiary detritals 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 is considered an important groundwater recharge area for Weeli Wolli Spring.
- Groundwater discharge occurs as outflow to the South Flank and Mining Area C Valleys, which hydraulically connect the Coondewanna and Weeli Wolli Spring catchments from a groundwater perspective.
- A southwest-northeast trending dyke may act as a partial groundwater flow barrier to regional throughflow at the eastern end of Coondewanna Flats.
Protect values – Ecological values of the Coondewanna Flats

Ecological understanding

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.

Water bodies formed on the Coondewanna Flats from flood waters are ephemeral, but may persist for several months following periods of heavy rainfall depending on the volume of surface water contribution. Little is known about the water quality or aquatic invertebrate assemblages of the flooded waterbody (Pinder et al. 2009).

Hydrological dependency

- *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 m bgl), which is replenished by rainfall and runoff.
- The Lake Robinson waterbody is ephemeral but may persist for several months.

Ongoing investigations into water requirements for Coondewanna Flats priority communities suggest that the vegetation assemblage is unlikely to rely on groundwater to meet water requirements (AQ2, 2016). The key findings from studies undertaken within the PEC are as follows:

- Basal area per hectare indicative of a water limited community
- Symptoms of drought stress during dry season observed in leaf water potential measurements
- Matric potential indicating water access above 18m
- Size of soil moisture reservoir and surface water replenishment regime
• Depth to groundwater (>20m)

These results indicate that the soil moisture reservoir beneath the flats are fed by surface water runoff rather than groundwater and that this is expected to be the sustaining water source for this community:

Mulga and Muehlenbeckia are vadophytic and may not rely on groundwater to meet plant water requirements owing to deep water levels (>15 m) and seasonal surface water inundation (AQ2, 2016). Coolibah trees 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 and inundation in some place and of surface water drawdown into the unsaturated zone.

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.

Key considerations

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 South Flank and North Flank, and to a lesser extent through the cumulative effects of dewatering the remaining Marra Mamba deposits, the Packsaddle Range deposits and the Hope Downs deposits. Changes in surface water volumes are not considered to impact the PEC values as outlined above.

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 South 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 South Flank dewatering to the east.

Planned injection of surplus water at the Juna Downs MAR scheme has potential to 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).

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.

As a result of these findings, these assessments suggests that the Condition 5 of Ministerial Statement 491 of the Mining Area C Life of Project EMP Revision 6 (BHP Billiton Iron Ore 2015), outlining two water level investigation triggers for Coondewanna Flats be modified to remove the investigation triggers for change in water level at GWB0039M.

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 have the potential to 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. Section 6 establishes upper water level targets and thresholds along with ecological indicators to prevent detrimental changes at the PEC.

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.
This precautionary approach will be maintained for the monitoring, investigation and management of groundwater and vegetation, will require monitoring and investigation.

Changes in surface water volumes are not considered to impact the PEC values, as impacts to the surface water flow volume and quality is not expected to be significant. 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. As such the subsequent downstream impacts resulting from the implementation of BHP Billiton Iron Ore operations to aquifer recharge and riparian vegetation in the area of Coondewanna Flats is considered to be negligible.

Table 4 summarises the threats from current operations and controls in place under existing approvals to manage the potential impacts to Coondewanna Flats from BHP Billiton Iron Ore existing operations.

Table 4: 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</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 L7851/2002/6.</td>
</tr>
</tbody>
</table>

Improving Understanding – Coondewanna Flats

The following have been identified as aspects that BHP Billiton Iron Ore is going to do to improve understanding:

- Ongoing studies investigating the groundwater dependency of Coondewanna Flats vegetation communities and key tree species, i.e. Eucalyptus victrix (AQ2)
- Monitoring of groundwater drawdown extent and groundwater levels during operations
- Update of conceptual ecohydrological model, based on study findings.
Weeli Wolli Spring Priority Ecological Community

Weeli Wolli Spring is located approximately 14 km east of Mining Area C and comprises an area where surface water and groundwater flows 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 C2 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 C2: Weeli Wolli Spring Ecohydrological Conceptualisation

Significant Receptor Values

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 (DEC, 2009; 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 (Stylidium weeliwolli). The woodland trees include the obligate phreatophyte *Melaleuca argentea*, and facultative phreatophytes *Eucalyptus camaldulensis* and *E. victrix*.

- 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 calcrite 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 Weeli Wolli Spring PEC also occurs at Ben’s Oasis, located about 20 km further upstream and south of Weeli Wolli Spring. Ben’s Oasis is a name that is locally used by BHP Billiton Iron Ore. At this location, the vegetation is concentrated along a relatively narrow creek channel adjacent to some surface water pools. There is very little documented information about the geology, hydrology and ecology of Ben’s Oasis.

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 calcrite 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.

- 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*) (McKenzie and Bullen, 2009; Department of Environment and Conservation, 2009b).

No information is available regarding groundwater levels or seasonal variation at Ben’s Oasis. At present, there is insufficient information to formulate a conceptual ecohydrological model for Ben’s Oasis.

Assessment of Potential Impacts

Potential Impacts

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 calcrite aquifers) by 2 to 4 m. The predicted groundwater drawdown at both Weeli Wolli Spring and Ben’s Oasis from proposed North Flank and South Flank activities is less than 1 m and occurs following closure of Hope Downs. This impact alone is unlikely to result in any decline in vegetation at either location. However, the maximum predicted cumulative groundwater drawdown (from Mining Area C and Hope Downs operations) occurs prior to Hope Downs closure and is between 3 m and 14 m for Weeli Wolli Spring and 2 m to 5 m for Ben’s Oasis. 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 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 5 summarises the threats from current operations and controls in place under existing approvals to manage the potential impacts to Weeli Wolli Spring from BHP Billiton Iron Ore existing operations.
Table 5: 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) Abstraction volumes and rates are controlled via 5C Licence GWL110044(10)</td>
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<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>

Relevant 5C licenses and DER Licence will be sought for new projects.

**Assessment of potential impacts on the Weeli Wolli Spring**

Over the next 20 years Hope Downs will predominantly continue to impact 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.

**Improving Understanding – Weeli Wolli Spring**

The hydrological changes resulting from Mining Area C operations will be reviewed annually as part of the GWOS and AAR reporting and adaptive management process. The findings from the annual review will inform the routine updates of the Mine Closure Plan (nominally every 5 years).
<table>
<thead>
<tr>
<th>Version</th>
<th>Stakeholder</th>
<th>Date &amp; Description of Consultation</th>
<th>Topics / Issues Raised</th>
<th>BHP Billiton Iron Ore Response</th>
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