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<tr>
<td>CME</td>
<td>Chamber of Minerals and Energy of Western Australia</td>
</tr>
<tr>
<td>CSIRO</td>
<td>Commonwealth Scientific and Industrial Research Organisation</td>
</tr>
<tr>
<td>DAA</td>
<td>Department of Aboriginal Affairs</td>
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<tr>
<td>DAFWA</td>
<td>Department of Agriculture and Food</td>
</tr>
<tr>
<td>DER</td>
<td>Department of Environment Regulation</td>
</tr>
<tr>
<td>DMP</td>
<td>Department of Mines and Petroleum</td>
</tr>
<tr>
<td>DoW</td>
<td>Department of Water</td>
</tr>
<tr>
<td>DRD</td>
<td>Department of Regional Development</td>
</tr>
<tr>
<td>EPA</td>
<td>Environment Protection Authority</td>
</tr>
<tr>
<td>HAP</td>
<td>Hamersley Agricultural Project</td>
</tr>
<tr>
<td>MAR</td>
<td>Managed Aquifer Recharge</td>
</tr>
<tr>
<td>NAP</td>
<td>Nammuldi Agricultural Project</td>
</tr>
<tr>
<td>PDC</td>
<td>Pilbara Development Commission</td>
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<tr>
<td>PDWSA</td>
<td>Public Drinking Water Source Area</td>
</tr>
<tr>
<td>PHADI</td>
<td>Pilbara Hinterland Agricultural Development Initiative</td>
</tr>
<tr>
<td>RfR</td>
<td>Royalties for Regions</td>
</tr>
<tr>
<td>WfF</td>
<td>Water for Food</td>
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</table>
1. Introduction

1.1 Scope and Objectives

The Department of Water (DoW) commissioned this desktop study to inform and support strategic investment decisions on irrigated agriculture in the Pilbara Region. The key objective of the study is to inform the direction of future Royalties for Regions initiatives, and to scope future investigations in this regard. The primary focus of the study was to assess the availability and potential use of surplus mine dewater to supply irrigated agriculture.

The study involved the confirmation of surplus mine dewater in relation to prospective irrigation precincts in the region. This entailed the following:

- Assessment of surplus mine dewater through inspection of public records and stakeholder consultation to provide up-to-date information on mine dewatering programs;
- Identification and assessment of potential irrigation precincts by assessment of soil and land capability and proximity to the surplus dewater sources; and
- A preliminary review of available groundwater resources to augment surplus mine dewater supplies and improve security of supply.

1.2 Background and Context

The following sections provide an outline of the various initiatives promoting agricultural and pastoral development in the Region, which is linked to the potential for agriculture precincts using alternative water sources such as surplus mine dewater.

1.2.1 Royalties for Regions

The State Government has a strong focus on developing the regional areas of Western Australia, and since 2008, this commitment has been underpinned by the Royalties for Regions (RfR) initiative. This initiative invests royalties collected from mining and onshore petroleum operations in projects and programs designed to meet regional growth objectives.

RfR has a budget of some $4 billion over the next four years from 2015-16. Investment is channelled through State Government agencies and the State's nine Regional Development Commissions. The Pilbara Development Commission (PDC) has the mandate to lead and support the sustainable development of the Pilbara region.

The PDC has drafted a Regional Investment Blueprint outlining the aspirational social and economic growth and development strategies and priorities of the region. The Blueprint has a strong focus on diversification (a pillar of which is agriculture and aquaculture), value adding and enabling (including land access). The PDC is responsible for facilitating the implementation of the Blueprint through its administration of the RfR funded Regional Grants Scheme and Community Chest Fund.

1.2.2 Seizing the Opportunity Agriculture

Seizing the Opportunity Agriculture is a $300 million RfR funded program that was initiated in 2013 and which is being co-ordinated by the Department of Regional Development (DRD). Seizing the Opportunity Agriculture is an enabling initiative for the agricultural sector to identify and pursue opportunities arising from the growing global demand for agricultural produce and products.
1.2.3 Water for Food

*Water for Food* (WfF) is a $40 million State wide program being managed by the Department of Water (DoW) as part of the *Seizing the Opportunity Agriculture* initiative. The objective is to accelerate water resource investigations and optimise pastoral land tenure to facilitate the development of new irrigation areas and increase the size and water efficiency of existing irrigation districts.

Prior to the WfF initiative, the DoW commissioned the *Pilbara Integrated Water Supply Pre-Feasibility Study* in 2009, which identified a number of options to develop irrigation schemes supplied from surplus mine dewater. This study described concept options using surplus dewater from Consolidated Minerals’ Woodie Woodie Mine and the Rio Tinto Group’s Hamersley Iron Yandicoogina Mine to support the development of associated irrigation precincts.

These findings were taken forward in the *Pilbara Hinterland Agricultural Development Initiative* (PHADI), which identified the need for pilot projects at these mine sites. In parallel, the DoW commissioned a study to assess and update the availability and potential use of surplus mine dewater in the Pilbara Region for irrigated agriculture (the subject of this Summary Report).

1.2.4 Pilbara Hinterland Agricultural Development Initiative

The Department of Agriculture and Food, Western Australia (DAFWA) is managing the PHADI, which is a $12.5 million initiative funded by RfR, and is aimed at creating economic diversification in the Pilbara. The potential for irrigated agriculture to attract capital investment in the Pilbara has been identified through previous initiatives and the PHADI seeks to better understand this potential, and to develop pathways for the development of medium to large scale agriculture precincts.

A key objective of the PHADI is to assess the potential of irrigated agriculture in the Pilbara and carry out field trials utilising surplus mine dewater and other local water resources. The initiative is focussing on practical research through pilot site crop trials and soil and water resource assessments.

The Woodie Woodie Mine on Warrawagine Station, which has significant surplus mine dewater, was selected as the first pilot site. Three centre pivots have been established irrigating a total of 114 ha, with crop trials due to commence this summer. The irrigation area identified for Yandicoogina Mine proved to be unviable due to future mining plans and as such, a second pilot site in the central Pilbara is under consideration.

1.2.5 Rio Tinto’s Agricultural Projects

Surplus mine dewater from Rio Tinto’s Hamersley Iron Marandoo operation is supplied to the *Hamersley Agricultural Project* (HAP), which was developed on Rio Tinto’s Hamersley Station in 2012 to support Rio Tinto’s various pastoral operations through the production of hay. This project comprises 17 centre pivots irrigating a total of some 850 ha. Following on the success of the HAP, Rio Tinto constructed the *Nammuldi Agricultural Project* (NAP) in 2014 to use surplus dewater from Nammuldi Mine, also located on Hamersley Station. The NAP irrigates a total of 900 ha via 19 centre pivots.
2. **Review of Surplus Mine Dewater**

A review of available documentation was carried out to ascertain the current status of surplus mine dewater in the Pilbara Region. The assessment of these records was undertaken to identify current mining operations in the Pilbara Region with surplus dewatering schedules. Details of the assessment are provided in the following sections.

### 2.1 Regional Resources Sector Outlook

The Chamber of Minerals and Energy of Western Australia (CME) commissioned the *2015-2025 Western Australian Resources Sector Outlook*\(^1\). This study forecasts change in the resources sector in relation to the key growth enablers of people, energy, water and infrastructure. It is noted that the study was based on a member survey during a period when iron ore prices were at historically high levels. Accordingly, the forecasts may reflect aspirations rather than future reality so the longer the forecast period, the greater the margin for error.

The following details summarise water management and use in the resources sector in the Pilbara Region:

- Water entitlements held in 2014 totalled 565 GL, predominantly within systems classified as fractured rock;
- Groundwater abstractions totalled 350 GL in 2013 with ~80% being derived from dewatering;
- ~49% of abstracted water is used for mine operations, beneficial usage (such as the HAP) and town drinking water (such as for Tom Price), the balance being returned to the environment through aquifer injection (~44%)\(^2\) or discharge to rivers and creeks (~7%);
- Groundwater abstractions are projected to increase to ~490 GL in 2020 with ~82% being derived from dewatering;
- Although an increase is projected, the quantum of water abstracted via dewatering is expected to fluctuate substantially from year to year due to a combination of the small number of high volume projects and the tendency for initial dewatering volumes to be significantly larger than ongoing dewatering volumes; and
- ~49% of abstracted water is projected to be used for mine operations and other uses in 2020, the balance, or surplus, being returned to the environment through aquifer injection (~42%) or discharge to rivers and creeks (~9%).

In summary, the *2015-2025 Western Australian Resources Sector Outlook* indicates that there was surplus mine dewater totalling ~152 GL of in 2013, and that this will increase to ~251 GL in 2020. It should be noted that, in certain cases, surplus mine dewater discharged to rivers and creeks is required to maintain environmental flows and surface water-groundwater interactions. Further, closure commitments for certain mining operations may require aquifer replenishment which could compete for surplus dewater. Finally, it is understood that this forecast surplus includes the aquifer injection project at the Fortescue Metals Group’s Chichester Operations, which is known to be saline. Accordingly, only a proportion of this surplus would be available and suitable for other beneficial use, such as irrigation.

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\(^1\) Deloitte Access Economics & CME 2014, *2015-2025 Western Australian Resources Sector Outlook*.

\(^2\) It is understood that aquifer injection at the Fortescue Metals Group’s Chichester Operations contributes significantly to this.
2.2 Dewatering Zones

2.2.1 Identification of Zones

The assessment of surplus mine dewater in the Pilbara necessitated more granularity than that provided by the 2015-2025 Western Australian Resources Sector Outlook. To this end, a Study Area was delineated to encompass potential mining operations (current and future) with dewatering surpluses. The Study Area comprised a number of zones defined by the distribution of the major mining projects relative to potentially viable soils, which are depicted in Figure A1 in Appendix A.

Major mining projects were identified using the MINDEX dataset from the Department of Mines and Petroleum (DMP)\(^3\). This dataset includes projects operating or currently under development with production value greater than $10 million, proposed or potential projects with a capital expenditure greater than $20 million and projects under care and maintenance. Potentially viable soils were as defined in the Pilbara Integrated Water Supply Pre-Feasibility Study\(^4\), which depicts the land systems containing soils that may be suitable for irrigated agricultural development.

Major projects along the coastal areas, those to the east of Marble Bar and in the vicinity of Paraburdoo were excluded due to there being limited likelihood of significant dewatering surpluses. Surplus mine dewater generated from operations on the littoral of Fortescue Marsh are known to be too saline for irrigation so these water sources were not considered. The resultant Study Area is largely focused along the Hamersley and Ophthalmia Ranges, where the majority of major projects and potentially viable soils are concentrated. Consolidated Minerals’ Woodie Woodie operation has also been included as a zone since this is known to have significant surplus dewater and is already the focus of one of the PHADI pilot irrigation trial sites.

2.2.2 Department of Water Reported Discharges

Licensing for dewatering is regulated under the provisions of s5C of the Rights in Water and Irrigation Act 1914 (the RIWI Act 1914). Dewatering licensing decisions by the DoW are based on detailed assessments of the local target aquifers undertaken by proponents, and are guided by the Western Australian Water in Mining Guideline (DoW, 2013b) and the Strategic Policy on the Use of Mine Dewatering Surplus (DoW, 2013a).

Licences specify abstraction limits and the conditions thereof, and usually have a requirement for reporting on groundwater abstraction and use. A review of licence compliance reports was undertaken to compile a record of surplus mine dewatering discharges within the dewatering zones. The reported dewatering surpluses in 2013 are summarised in Table 1.

Table 1: Reported 2013 DoW Discharges\(^5\)

<table>
<thead>
<tr>
<th>Dewatering Zone</th>
<th>Reported 2013 Disposed Surplus Water (GL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oakover River Zone</td>
<td>28.3</td>
</tr>
<tr>
<td>West Pilbara Zone</td>
<td>10.0</td>
</tr>
<tr>
<td>Central Pilbara Zone</td>
<td>73.8</td>
</tr>
<tr>
<td>East Pilbara Zone</td>
<td>11.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>123.2</strong></td>
</tr>
</tbody>
</table>

\(^4\) MWH 2009, Pilbara Integrated Water Supply Pre-Feasibility Study. Prepared for the DoW.
\(^5\) As at July 2014.
It should be noted that the reported discharges include stored water in on-site storages, releases to surface water systems (e.g., Ophthalmia Dam and Weeli Wolli Creek), water supplies (e.g. Hamersley Agricultural Project) and Managed Aquifer Recharge (MAR) trials. Accordingly, not all of the reported discharges are necessarily surplus to operations.
3. Identification of Potential Irrigation Precincts

Potential irrigation precincts were identified based on the locations and extents of soils potentially viable for irrigation, determination of potential constraints to the development of the land and distance from the locations of dewatering surpluses. An initial screening assessment of constraints to agricultural development was undertaken to shortlist potential precincts for further assessment. Constraints included steep terrain, presence of areas of sensitive environmental conservation concern or heritage interest and existence of mineral deposits. Land tenure and requirements for diversification of land use were not considered. The PHADI project is focusing on the issues of tenure and how to best facilitate agricultural developments.

3.1 Identification of Suitability of Soils

MWH (2009) identified areas totalling 14,795 km² that contain soils considered to be suitable for irrigated agriculture. These were identified using the land systems defined in the Inventory and Condition Survey of the Pilbara Region conducted by DAFWA (2004)⁶. The distribution of soils detailed by MWH (2009) is shown in Figure A1 in Appendix A. It is noted that large tracts of these soils could be subjected to a variety of environmental, social, land tenure and mining constraints which could diminish the potential area available for agricultural development. Additionally, a significant proportion of these soils are remote from the dewatering zones outlined in Section 2.2.

In this light, a further assessment of land resources was undertaken to identify additional areas that may be potentially viable for irrigated agricultural. This assessment included soils with possible marginal potential but still feasible for agricultural development. The following datasets were used in the assessment:

- Soil Hydrological Properties for Australia⁷ compiled by the University of Melbourne in 2004; and
- National soil data provided by the Australian Collaborative Land Evaluation Program⁸, compiled in 2011 and endorsed through the National Committee on Soil and Terrain.

Soils considered to be potentially viable for irrigated agricultural were assumed to have the typical characteristics of loams and were identified based on their physical properties, including solum depth, clay content and plant available water capacity.

3.2 Constraints to Agricultural Development

3.2.1 Steep Terrain

Steep terrain presents difficulties with soil and water management, as well as the operation of irrigation and agricultural equipment. Flatter plains and valley floors are typically preferred for agricultural development. The potentially viable soils were assessed against terrain slope using the national dataset of Multi-resolution Valley Bottom Flatness⁹ indices developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO, 2011), and those soils located on steeper slopes were excluded.

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⁶ DAFWA 2004, An inventory and condition survey of the Pilbara region, Western Australia, Technical Bulletin No. 92.
⁷ http://www.toolkit.net.au/Tools/Category-Soil_hydrology
3.2.2 Environmental and Heritage Constraints

Intensive or extensive agricultural developments may not be permitted in areas which are environmentally sensitive or of significant heritage interest. Consequently, the locations of the potentially viable soils were assessed against publically available mapping of such areas and all such areas were excluded from further assessment. Karijini National Park, the Millstream Public Drinking Water Source Area and the Fortescue Marsh Management Area are of particular importance, since these coincide with significant expanses of potentially viable soils. Other constraints included the aboriginal heritage sites as identified by the Department of Aboriginal Affairs (DAA), areas of acid sulphate soils risk, contaminated sites and environmentally sensitive areas mapped by the Department of Environment Regulation (DER) and conservation reserves recommended by the Environment Protection Authority (EPA).

3.2.3 Mineral Deposits

The encroachment on, and potential sterilisation of mineral ore deposits by agricultural development could interfere with the progression of existing mining operations or the establishment of future mines. Mapping of the iron ore deposits by the DMP (2013) reveals that most of the occurrences of surface iron ore deposits do not intersect with the potentially viable soils, so no further exclusion of the soils was warranted.

3.3 Selection of Potential Irrigation Precincts

The potentially viable soils were screened according to the various constraints outlined above, the resulting extents of which are mapped in Figure A2 in Appendix A. It is noted that the areas of contiguous soils vary considerably as do their proximities to the dewatering zones. A review of the areas of existing irrigation schemes in Western Australia and their distances from their water sources was undertaken to provide an indication of the likely scale of a typical irrigation precinct. The adopted criteria were:

- Minimum irrigation area of 5,000 ha; and
- Maximum distance from water source of 30 km.

These criteria were applied to ensure that the identified precincts are large enough to sustain an agricultural scheme of reasonable commercial value. A total of ten potential irrigation precincts were identified for further assessment, the locations of which are depicted in Figure A3 in Appendix A and details of which are summarised in Table 2. The buffers delineated around the potential irrigation precincts are ‘catchments’ depicting the maximum distance of 30 km to a water source.
### Table 2: Summary Potential Irrigation Precincts

<table>
<thead>
<tr>
<th>Precinct</th>
<th>Indicative location</th>
<th>Indicative area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hamersley Station some 50 km north-west of Tom Price</td>
<td>25,000</td>
</tr>
<tr>
<td>2</td>
<td>Coolawanyah Station some 80 km north-north-west of Tom Price</td>
<td>15,000</td>
</tr>
<tr>
<td>3</td>
<td>Hamersley Station adjacent to the Karijini National Park</td>
<td>40,000</td>
</tr>
<tr>
<td>4</td>
<td>On Nanutarra-Wittenoom Rd near Wittenoom</td>
<td>15,000</td>
</tr>
<tr>
<td>5</td>
<td>Juna Downs Station adjacent to the Great Northern Highway</td>
<td>60,000</td>
</tr>
<tr>
<td>6</td>
<td>UCL adjacent to the Munjina-Roy Hill Rd</td>
<td>15,000</td>
</tr>
<tr>
<td>7</td>
<td>UCL between the Great Northern Highway and Turee Creek Rd</td>
<td>25,000</td>
</tr>
<tr>
<td>8</td>
<td>Marillana and Roy Hill Stations west of Marble Bar Rd</td>
<td>150,000</td>
</tr>
<tr>
<td>9</td>
<td>Ethel Creek Station east of Marble Bar Rd</td>
<td>250,000</td>
</tr>
<tr>
<td>10</td>
<td>UCL adjacent to Warrawagine and Wandanya Stations</td>
<td>250,000</td>
</tr>
</tbody>
</table>
4. **Assessment of Potential Irrigation Precincts**

The ten potential irrigation precincts were assessed to ascertain a shortlist for consideration by the DoW to progress further research. The opportunities and constraints of each precinct were identified and assessed and the options were narrowed to four precincts (Precincts 3, 5, 9 and 10) for further review.

The reliability of ongoing dewatering surpluses from mining operations is likely to be of concern for the establishment of an irrigation precinct. To this end, an assessment of available groundwater resources in the vicinity of the four precincts was undertaken, which resulted in the narrowing of the shortlisted precincts to three (Precincts 5, 9 and 10). Summaries of the assessments for each precinct are provided in the following sections.

**4.1 Precinct 1**

Precinct 1, located on Rio Tinto’s Hamersley Station, comprises an area of some 25,000 ha. The precinct is within the West Pilbara dewatering zone and incorporates Rio Tinto’s 950 ha *Nammuldi Agricultural Project* (NAP). Rio Tinto’s Hamersley Iron Brockman 2/Nammuldi operation is within the precinct’s 30 km supply catchment.

The precinct has few obvious environmental or heritage constraints. Surplus dewater from the Brockman 2/Nammuldi operation is already used for irrigation at the NAP. It is understood that the NAP has been sized to accommodate the future surplus dewater requirements of this operation and is unlikely to expand beyond these requirements. Further consideration of this precinct, if any, will need to be done in collaboration with Rio Tinto.

**4.2 Precinct 2**

Precinct 2 is also within the West Pilbara dewatering zone. It comprises an area of some 15,000 ha and is located on Coolawanyah Station. The precinct is located entirely within the Millstream PDWSA, the specific area of which is classified as Priority 2 (P2). Although P2 areas are compatible for broad acre cropping, constraints to the extents or nature of an irrigation precinct could arise. There are a number of other PDWSAs that cover large areas of the Pilbara, so further research is required to assess whether irrigation would need to be constrained and, if so, to what extent.

The main source of water supply is likely to be surplus dewater from the Brockman 2/Nammuldi operations, which is located at the extremity of the 30 km supply catchment necessitating a significant conveyance distance. As mentioned above, surplus dewater from this operation is already allocated to the NAP. To this end, this precinct is not considered viable for further investigation.

**4.3 Precinct 3**

Precinct 3 is located on Rio Tinto’s Hamersley Station adjacent to the Karijini National Park and covers an area of some 40,000 ha. The precinct is within the West Pilbara dewatering zone in the vicinity of Rio Tinto’s Hamersley Iron Marandoo operation. It comprises a large and contiguous expanse of potentially viable soils. This operation reports a large dewatering surplus which Rio Tinto utilise to supply drinking water to Tom Price and to irrigate the 800 ha *Hamersley Agricultural Project* (HAP). As with the NAP, it is understood that the HAP has been sized to accommodate future surplus dewater requirements of the Marandoo operation.
It is noted that the Southern Fortescue Borefield is also located within the precinct, which has supplied water to Tom Price and local mining operations for some 40 years\textsuperscript{10}. There is a possibility that the associated aquifer system could offer sufficient water to expand irrigation at the HAP. However, this is unlikely as the Marandoo surplus water management scheme now affords the opportunity to replenish the aquifer through natural recharge for potential future town and mine water supplies.

Expansion of the HAP is currently unlikely and further consideration of this precinct, if any, will need to be done in collaboration with Rio Tinto.

### 4.4 Precinct 4

Precinct 4 covers an area of around 15,000 ha and is located in the Fortescue Valley at the southern extent of Mulga Downs Station. The western extent of the area is constrained by the Wittenoom contaminated site, which could present negative perceptions. The precinct is located between the West and Central Pilbara dewatering zones and there are no existing mines within the 30 km supply catchment. Despite not satisfying this criterion, Precinct 4 was included in the assessment due to its ease of access, its large contiguous and flat area, the absence of mining and related services and the possible existence of a local water source.

The Fortescue Valley is understood to comprise surficial alluvial and valley fill aquifers overlying localised basement aquifers. The main paleochannel lies along the southern extent of the valley, which is overlain by alluvial fans associated with drainage from the northern slopes of the Hamersley Range\textsuperscript{10}. These areas could represent zones of aquifer recharge and groundwater availability, but fresh water yields are likely to be limited. Other precincts (Precincts 6, 8 and 9) within the Fortescue Valley offer more benefits, so Precinct 4 is not considered viable for further investigation.

### 4.5 Precinct 5

Precinct 5, comprising approximately 60,000 ha of potentially viable soils, is located on the Marillana Creek plains on Juna Downs Station. Wetlands have been mapped on these plains and this area is located upstream of Weeli Wolli Creek and Fortescue Marsh, which are known to be sensitive environmental receptors\textsuperscript{10}.

The precinct is within the Central Pilbara dewatering zone which contains a number of mines with significant dewatering operations. The 30 km supply catchment includes BHP Billiton’s Mining Area C and Yandi (Marillana Creek) mines, Rio Tinto’s Hamersley Iron Yandicoogina mine and the Hope Downs 1 operation of Rio Tinto’s Hope Downs Joint Venture. Much of the surplus dewater from these operations is discharged to Weeli Wolli and Marillana Creeks and there are requirements for operators to maintain environmental flows and surface water-groundwater interactions in these systems. Further, closure commitments for certain operations may require aquifer replenishment which could compete for surplus dewater.

The precinct is located in the vicinity of the Yandi–Marillana Palaeovalley aquifer, which is intersected by many of the mining operations in the area. It is possible that this aquifer system could yield sufficient water to augment the supply to the potential precinct. The key target aquifers are the Wittenoom Dolomite (present along the valley floor and roughly aligned with Weeli Wolli Creek and tributaries), covering an area of over 1,200 km\textsuperscript{2}, and a smaller detrital aquifer system (present along the alignment of Marillana Creek), covering an area of almost 150 km\textsuperscript{2}.

The Wittenoom Dolomite aquifer is overlain by surficial sediments that may also offer aquifer potential and increased recharge. These include mapped colluvials and alluvials which may

also contain palaeochannels. The aquifer offers increased recharge from drainage lines with the system being aligned within the valleys that form the headwater of Weeli Wolli Creek.

The detrital target aquifer has also been identified as a ‘limestone, calcrete’ aquifer in the Statewide Hydrogeology dataset (DoW 2009). This area coincides with an area surface mapped as Robe Pisolite (Channel Iron Deposits). The aquifer offers increased recharge from drainage lines with the system being aligned within the valleys that form the headwater of Marillana Creek.

Both target areas contain bore data that indicate some relatively high yielding groundwater units, particularly so for the detrital system along Marillana Creek. Given the large dewatering surplus and the indications that there is potential to exploit these aquifer units, this precinct may be viable for development to irrigated agriculture and should be investigated further. Planning will need to be undertaken in collaboration with the station lessee, Rio Tinto, and other stakeholders.

4.6 Precinct 6

Precinct 6 is located on unallocated Crown land in the Fortescue Valley between the Great Northern Highway and Marillana Creek. The precinct is adjacent to the Central Pilbara dewatering zone and comprises a narrow strip of some 15,000 ha of potentially viable soils. This area is remote from existing and planned mining operations and related services, which would facilitate ease of agricultural operations.

There are a number of existing mines present in the eastern extent of the 30 km supply catchment, including Rio Tinto’s Hamersley Iron Yandicoogina operation and BHP Billiton’s Yandi (Marillana Creek) operation. However, a supply from these would require a significant conveyance distance.

This precinct is not considered viable for further investigation, particularly given that Precinct 5 may be more suitable given its closer proximity to the same water sources.

4.7 Precinct 7

A total of some 25,000 ha of potentially viable soils are mapped in Precinct 7, which is located on unallocated Crown land south of the Great Northern Highway. This precinct lies within the Central Pilbara dewatering zone, but is remote and somewhat inaccessible. However, the area is largely contiguous and generally free of any known environmental constraints.

Rio Tinto’s Robe River Iron Associates West Angelas mine is located reasonably close to the precinct, but this operation is not known to have a significant dewatering surplus. BHP Billiton’s Mining Area C operation and the Hope Downs 1 operation of the Rio Tinto’s Hope Downs Joint Venture are located just beyond the northern extent of the 30 km supply catchment so would necessitate a significant conveyance distance.

Given that Precinct 5 may be more suitable with its closer proximity to the same water sources, this precinct is not considered viable for further investigation.

4.8 Precinct 8

Precinct 8 is located in the Fortescue Valley to the west of the Marble Bar Road and comprises some 150,000 ha of potentially viable soils. The 30 km supply catchment intersects both the Central and East Pilbara dewatering zones and encompasses a large number of mining operations between Weeli Wolli Creek and Newman. Separate dewater collection and conveyance systems would be required for these southern and eastern water sources.
It is noted that most of the precinct lies within the Fortescue Marsh Management Zone, so the development of irrigated agriculture is not aligned with the management objectives of this area. Given that Precinct 5 may be more suitable with its closer proximity to the same water sources in the Central Pilbara dewatering zone and that Precinct 9 may be more suitable with its closer proximity to the same water sources in the East Pilbara dewatering zone, this precinct is not considered viable for further investigation.

### 4.9 Precinct 9

Around 250,000 ha of potentially viable soils located east of the Marble Bar Road on Ethel Creek Station have been identified in Precinct 9. Access to the area would be convenient and the close proximity to Newman would be opportune for the development of supporting industries. The precinct is remote from existing or planned mining operations and related services which would facilitate ease of agricultural operations.

The 30 km supply catchment intersects the East Pilbara dewatering zone and encompasses BHP Billiton's various Mt Newman operations and their Jimblebar Hub. These operations report large dewatering surpluses, which are currently deployed for aquifer recharge and supply augmentation to Newman and surrounding mining operations.

The area is located upstream of Fortescue Marsh and is largely free from any known environmental constraints. Although outside of the Fortescue Marsh Management Zone, the marsh is known to be a sensitive environmental receptor and planned developments would need to demonstrate acceptable impacts.

The precinct traverses the Ophthalmia/Fortescue River aquifer system, which is the primary water source for Newman and a number of BHP Billiton's operations\(^\text{11}\). It is possible that this system could yield sufficient additional water to augment the supply to the precinct. The key target aquifer would be the detrital aquifer system that may have some underlying connectivity to the Wittenoom Dolomite in the south and west of the area and the Carawine Dolomite and Pinjian Chert Breccia in the east.

The target area covers over 4,000 km\(^2\) and is predominately located proximate to the wide upper Fortescue River valley. The unit continues south through the relatively narrow valley of the upper Fortescue where it passes through the eastern Hamersley Range just north of Newman. The aquifer offers increased recharge from the drainage lines of Jimblebar, Caramulla, Jiggalong and Condy Creeks. There is limited bore data for the central area of the target aquifer and a risk that that the aquifer in this area may be saline. However, relatively high bore yields of low salinity water are reported for the upper Fortescue Valley.

Given the extensive area of potentially viable soils, the proximity of the precinct to Newman, the reported large dewatering surpluses and the indications that there is potential to exploit the aquifer units in this area, this precinct may be viable for development to irrigated agriculture and should be investigated further. Planning will need to be undertaken in collaboration with the station lessee and BHP Billiton. Continuity of supply to existing water users will have to be taken into consideration in any future planning.

### 4.10 Precinct 10

Precinct 10 is located on unallocated Crown land east of the Oakover River and north of the Rudall River National Park. The precinct has an extensive area of potentially viable soils totalling some 250,000 ha lying adjacent to Warrawagine and Wandanya Stations. The agricultural potential of the area adjacent to the Oakover River has been established through a

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150 ha trial irrigation project currently underway on Warrawagine Station under the auspices of PHADI.

There are no existing or planned mining operations or related services within the precinct that could create barriers or constraints to agricultural development or operation. With the exception of the Rudall River National Park at the southern extremity, the precinct seems to be devoid of any known environmental or heritage constraints.

Consolidated Mineral’s Woodie Woodie operation is the only mine within the 30 km supply catchment, which is known to produce significant dewatering surpluses. This is the source of water for the PHADI project. The significant dewatering requirements of the Woodie Woodie operation and the presence of some relatively high yielding bores along the Ripon Hills Road indicate that the detrital aquifer system present along the current and paleo drainage channels of the Oakover River may be suitable for exploitation to augment the irrigation water supply.

The target detrital aquifer system may overlie the Carawine Dolomite and Pinjian Chert Breccia, which are proven water supplies in the area of Woodie Woodie. The system covers an area of over 6,500 km². However, it is likely that within this target area there will be regions that will not offer a thick enough sequence of sediments for significant aquifer potential. The far east of the precinct also contains a ‘limestone, calcrete’ and a ‘Surficial sedimentary’ aquifer as mapped in the Statewide Hydrogeology dataset (DoW 2009). However, due to its remoteness and likely poorer recharge potential with comparison to the system within the Oakover River catchment, this unit is not considered a significant aquifer potential.

This precinct may be viable for development to irrigated agriculture given the large area of potentially viable soils, the reported large dewatering surpluses and the indications that there is potential to exploit the aquifer units in this area. Accordingly, it is recommended that this precinct should be investigated further and that planning will need to be undertaken in collaboration with the all relevant stakeholders.
5. Conclusions and Recommendations

5.1 Conclusions

An assessment of mine dewatering was undertaken to identify current and proposed mining operations in the Pilbara Region with surplus dewatering schedules. A Study Area comprising a number of dewatering zones was delineated to encompass current and potential future mining operations. A review of available data and information was carried out to ascertain the current status of dewater surpluses, from which the following can be concluded:

- The ability and willingness of mining companies to provide future dewatering schedules is severely constrained by:
  - Such schedules being based on production strategies which are highly confidential;
  - Market uncertainties relating to predicting demand and supply; and
  - Uncertainty around the hydrogeology of future dewatering operations which are normally investigated closer to the time of development.
- Apart from Consolidated Minerals’ Woodie Woodie mine, concentrations of mining operations with surplus dewatering are currently limited to the Hamersley and Ophthalmia Ranges;
- Of the various dewatering zones assessed, only four of these reported a surplus dewater schedule in 2013, namely Oakover River (~28GL), West Pilbara (~10GL), Central Pilbara (~74GL) and East Pilbara (~11GL);
- Of these four zones, one comprises a single operation (namely Oakover River), with the remainder comprising multiple operations;
- Dewatering surpluses may be required for maintenance of environmental flows, to replenish depleted aquifers or for supply to other users, specifically:
  - The NAP and HAP irrigation areas in the West Pilbara dewatering zone, which could limit opportunities for additional irrigation development;
  - There are requirements in place for operators in the Weeli Wolli and Marillana Creek areas to maintain environmental flows in these systems in the Central Pilbara dewatering zone;
  - Surplus water in the East Pilbara dewatering zone is required for aquifer recharge and supply augmentation to Newman and surrounding mining operations; and
  - Closure commitments for certain operations where aquifers have been depleted may require aquifer replenishment which could compete for surplus dewater.

A desktop assessment of potential irrigation precincts was undertaken and entailed establishing the location and extent of soils suitable for irrigation, determination of potential constraints to the development of the land and distance from potential water sources. Existing soils datasets were interrogated to assess the locations and extents of soils with typical characteristics of loamy soils, which are considered appropriate for irrigated agriculture. An initial screening of soil parcels greater than 5,000 ha indicates that:

- There are extensive parcels of soils in the Pilbara Region that could be developed to irrigated agriculture; and
- Ten soil parcels ranging in size from 15,000 ha to 250,000 ha were identified as potential irrigation precincts within the Oakover River, West Pilbara, Central Pilbara and East Pilbara surplus dewater supply zones.
The potential irrigation precincts were assessed further to ascertain a shortlist of options. Of the ten potential irrigation precincts assessed, four were identified as being potentially viable, subject to available groundwater resources to augment surplus dewatering supplies. The assessment of groundwater resulted in a final shortlist of three precincts for further research, a summary of which follows:

- **Precinct 5**: Given the large dewatering surplus and the indications that there is potential to exploit local groundwater, this precinct may be viable for further consideration. The close proximity to the Karijini National Park may limit crop selection.

- **Precinct 9**: This precinct is promising based on the extensive area, close proximity to Newman, the reported large dewatering surpluses and the indications that there is potential to exploit local groundwater.

- **Precinct 10**: This precinct is also promising given the large area, the reported large dewatering surpluses and indications that there is a significant aquifer nearby.

### 5.2 Recommendations

The following recommendations are made with regard to the three potentially viable precincts:

- **Precinct 5**: A new irrigation precinct on Juna Downs Station may also be viable given the large surplus mine dewater reported in this area. Consideration of and planning for such a precinct should be undertaken in collaboration with the station lessee, Rio Tinto, and the various miners in the Central Pilbara dewatering zone. Future work would include soil investigations, a groundwater assessment, development of an appropriate groundwater use and allocation strategy, and conceptualisation of a dewatering collection and conveyance system.

- **Precinct 9**: This precinct is the most promising given that significant dewatering infrastructure has already been provided to the vicinity of Ophthalmia Dam and Newman. It is recommended this precinct should be investigated further in collaboration with the station lessee, BHP Billiton and other stakeholders. Soil investigations and further groundwater assessments would be required along with the planning of a dewatering collection, storage and conveyance system. Development of a groundwater use and allocation strategy would also be important in this precinct.

- **Precinct 10**: This precinct is also promising and it is recommended that this precinct should be investigated further in collaboration with all relevant stakeholders. Anecdotal information indicates that the area identified with potentially viable soils may be somewhat rocky. To this end, field soil investigations are recommended as a priority, following which further groundwater assessments would be required. This area may be suitable as a self-supplied precinct, the decision on which would be informed by the groundwater assessment.

The assessment of potentially viable soils in this study was undertaken at a desktop level without any site validation. Site specific conditions such as existence of rock in the terrain may render such soils non-viable for large automated systems such as centre pivots. It is recommended that site inspections and preliminary soil investigations be undertaken prior to advancing any planning of irrigation precincts to confirm these desktop findings.

The reliability of ongoing dewatering surpluses from mining operations is likely to be a major concern for the establishment of irrigation precincts and backup supplies are likely to be fundamental to the viability of such precincts. The preliminary groundwater assessments involved the initial identification and characterisation of the target aquifers for abstracting groundwater supplies based on available desktop information. Detailed assessments and site investigations are recommended to confirm the potential yield and water quality for supply
augmentation. There will also be a need to consider appropriate water allocation and licencing policies for such supplies given that there is unlikely to be competition for such resources.

Other considerations required in order to establish the viability of irrigated agriculture in the Pilbara include the following:

- Nature of commercial models for an irrigation body to accept and manage surplus mine dewater;
- Suitability of alternative crop types to climatic conditions and for environmental approval;
- Market opportunities and constraints; and
- Supply chain and value add opportunities and constraints.
6. References


2. DAFWA 2004, An inventory and condition survey of the Pilbara region, Western Australia, Technical Bulletin No. 92.

3. DoW 2013a, Use Of Mine Dewatering Surplus, Strategic policy 2.09.


Appendices
Appendix A – Figures

Figure A1  Locality Plan

Figure A2  Suitable Soils for Irrigated Agriculture

Figure A3  Potential Irrigation Precincts