Rio Tinto Iron Ore

Brockman Syncline 4 Revised Proposal

Monitoring and Management Plan

- Water Discharge Monitoring and Management
- Riparian Vegetation Monitoring and Management

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1 Introduction

This plan describes the monitoring and management of dewatering discharge from the Brockman Syncline 4 (**B4**) Revised Proposal. The Minister for the Environment issued Ministerial Statement 717 (**MS717**) on 24 March 2006 allowing implementation of the B4 Project. The B4 Revised Proposal is a revision to the existing B4 Project, with some minor proposed changes to MS717 in addition to new clearing to support ongoing B4 operations and increased dewatering rates associated with mining the below water table orebody. Management of surplus dewatering water will include onsite use and controlled discharge to Boolgeeda Creek.

This Monitoring and Management Plan (**MMP**) specifically addresses surface discharge of surplus dewatering water to Boolgeeda Creek, to ensure this does not cause long term impacts to the environmental and conservation values of the Boolgeeda Creek System.

This MMP will be regularly reviewed during implementation of the proposal, and revised when appropriate. Major revisions to the MMP will be subject to approval of the Office of the Environmental Protection Authority (**OEPA**).

2 Background

2.1 Project overview

The B4 Iron Ore Project is located approximately 60 km west-north-west of Tom Price in the central Pilbara region of Western Australia. As implemented, the B4 project consists of three main mining areas (Western, Central and Eastern lenses of mineralisation) with approximately 20% of the orebody occurring below the water table. Below water table mining currently involves groundwater abstraction up to 12 ML/day (4.38 GL/annum) plus 400 kL/day (0.15 GL/annum) for mine camp needs.

The Minister for the Environment issued MS717 on 24 March 2006 allowing implementation of the B4 Project. Since then several changes have been approved under section 45C (**s45C**) of the *Environmental Protection Act 1986* (**EP Act**).

A revised proposal to the existing MS717 will be submitted to the OEPA to allow for assessment of the following further changes:

- Increased dewatering rate and surface discharge of surplus dewatering water to Boolgeeda Creek up to 6.4 GL/annum.
- New clearing of up to 950 ha to support ongoing B4 operations.
- Other changes to Schedule 1 of MS 717, such as:
  - provision of a Development Envelope;
  - waste dump optimisation; and
  - some changes to the Key Characteristics.

An Environmental Review (**ER**) document (Rio Tinto 2014) has been referred to the OEPA in order to enable assessment under the provisions of Part IV of the EP Act and has been prepared in accordance with the information requirements for an Assessment on Proponent Information (**API**) Category A as set out in the Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012 (2012 Administrative Procedures). Upon approval of this Proposal, a new Ministerial Statement will be issued which will supersede MS717 and any associated s45C attachments, providing one overall contemporary Ministerial Statement for the revised B4 Project.

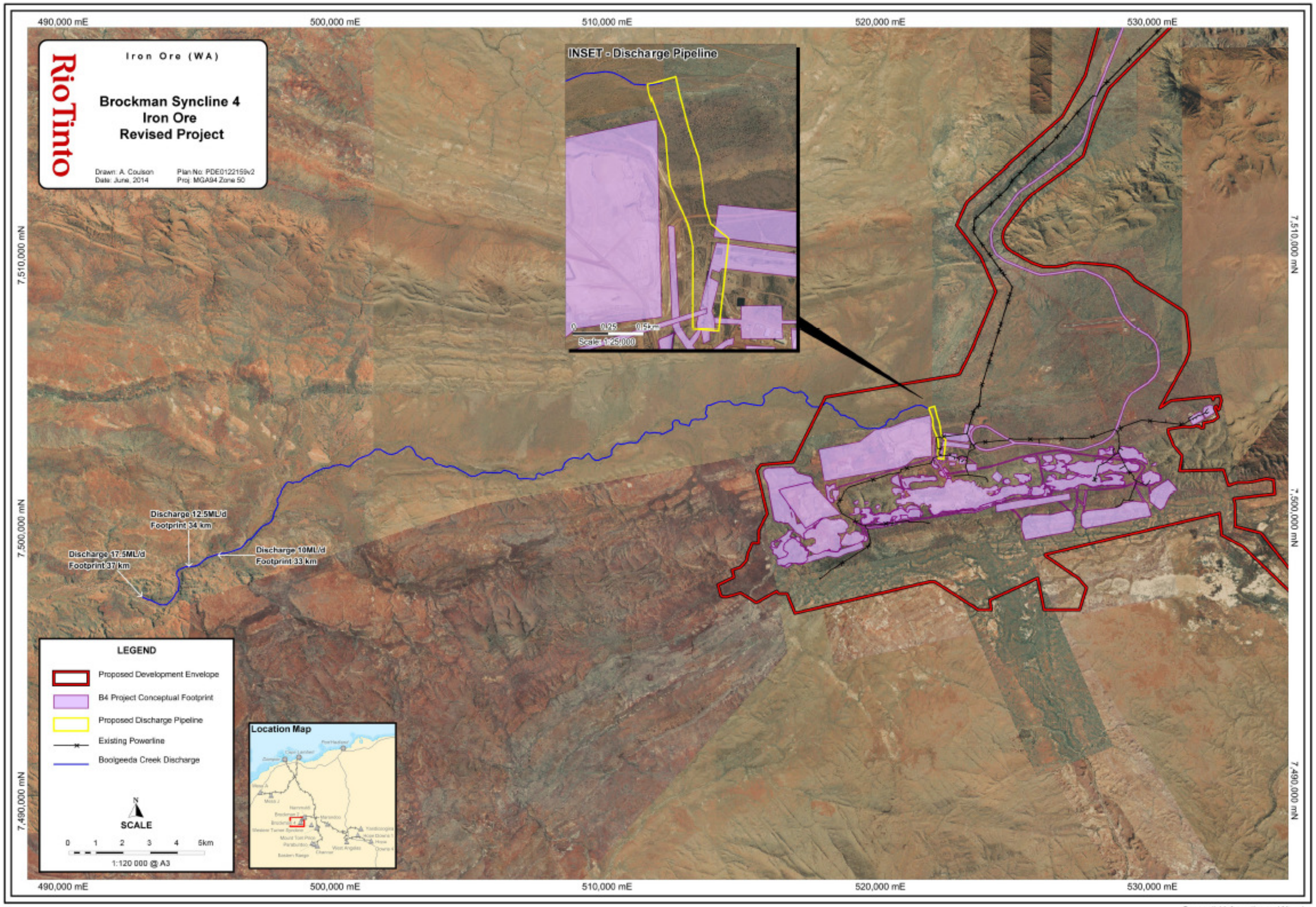
2.2 Dewatering Discharge into Boolgeeda Creek

The initial groundwater modelling for the B4 project predicted that water generated from dewatering could be entirely used to meet onsite demand (Aquaterra 2005; 2008a and 2008b). Improved understanding of the hydrogeology of the B4 project area has resulted in updated dewatering predictions and the conclusion that a demand-based dewatering strategy can no longer be used to meet the mine plan and a surplus water management strategy is required.

Rio Tinto considered several alternatives for disposal of expected surplus water in line with the Western Australian Department of Water's (**DoW**) preferred options (DoW 2013), and concluded that the most feasible hierarchy of disposal would be for use on site followed by controlled surface discharge to Boolgeeda Creek (Rio Tinto 2014).

The proposed discharge outlet into Boolgeeda Creek is located 2.5 km north of the B4 Central pit requiring a 1.36 km pipeline extension from the existing pipe network. Water will be discharged into the upper reach of Boolgeeda Creek. Predicted dewatering requirements and B4 water demand indicates there will be a maximum discharge rate of 17.5 ML/day (6.4 GL/annum; 17.5 ML/day on an annualised basis) (Rio Tinto 2013a). This maximum discharge volume is predicted to extend 37 km downstream from the proposed discharge outlet after steady state conditions are reached (Figure 2-1; Rio Tinto 2013b).

Figure 2-1: Brockman Syncline 4 Iron Ore Revised Project



Geospatial Information and Mapping

3 Environmental Values Statement for the Boolgeeda Creek System

3.1 Hydrology

Boolgeeda Creek catchment covers an area of approximately 1,650 km^2 and is a tributary of Duck Creek within the regional Ashburton River catchment. It is characterised by a braided, meandering creek dominated by multiple active and inactive flow channels, that are likely to be reworked during flow events, within a broad valley. The creek becomes more defined when it enters a gorge system downstream of the B4 operations, before discharging into Duck Creek at Lawloit Range (Rio Tinto 2013b).

Reconnaissance of Boolgeeda Creek in November 2009 and April 2010 revealed no surface water pools present in the modelled discharge footprint (WRM 2011); in August 2013, following unseasonably high rainfall (150 mm over the preceding 3 months, approximately double the long-term average), a total of six pools were observed (Biota 2013a). The low number of permanent and semi-permanent water features suggests it is a relatively dry system, typical of ephemeral creeks in the Pilbara. Pools in Boolgeeda Creek are likely to be transient and dependent on rainfall, surface water and shallow alluvial interflow rather than regional groundwater (Rio Tinto 2013b). Water quality is therefore likely to vary with the season.

3.2 Flora and Vegetation

The flora and vegation of Boolgeeda Creek and adjacent floodplain was surveyed for the maximum predicted discharge footprint (37 km downstream) and approximately 10 km upstream of the proposed discharge location (the riparian survey area, Biota 2005a, 2013a). This area is located on the Hamersley Plateau, which is within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard (1975). Vegetation descriptions were considered alike when they shared a suite of perennial species with a similar range of cover values; these descriptions were grouped to form vegetation mapping units. Sixteen vegetation units were identified within the riparian survey area which were grouped into five broad categories. A full description of these units, represented by the codes below, are provided in Biota (2013a):

1. Creekline dominated by *Corymbia hamersleyana* (C1);
2. Creekline dominated by *Eucalyptus victrix* and/or *E. camuldulensis* (C2, C3, C4, C5, C6 and C7);
3. Floodplains with *Corymbia hamersleyana* (F1, F4 and F7);
4. Floodplains dominated by *Acacia citrinoviridis* and *A. pyrifolia* (F2, F3, F5 and F8);
5. Floodplains supporting *Acacia sclerosperma* subsp. *sclerosperma* (F6 and F7).

No vegetation comprising Threatened Ecological Communities (**TECs**) or Priority Ecological Communities (**PECs**) were recorded within the riparian survey area. The seven vegetation units within the creekline (1 and 2 above) were considered to be of conservation significance as they are at risk from a number of threats (including grazing, feral animals and invasion by weeds) known to impact on the vegetation of major ephemeral watercourses in the

Hamersley biogeographic subregion. The seven creekline units comprised 34% (443 ha) of the total riparian survey area.

During the baseline mapping, the vegetation condition of the creek bed was ranked as being Good or Very Good despite the presence of *Cenchrus ciliaris* (Buffel grass), which was found to be growing both as scattered grasses and very open tussock grasslands. A few areas in the most western mapped section of the creek were deemed as being in very poor condition due to Buffel grass and trampling by cattle and donkeys. The vegetation condition of surrounding floodplains was categorised as Good; the lower condition rating in comparison to the creek bed was due to the higher degree of invasion of Buffel grass and the presence of cattle and donkeys causing overgrazing, trampling of vegetation and some soil erosion.

No threatened flora species protected under the *Wildlife Conservation Act 1950* (**WC Act**) were recorded, or expected to occur within the riparian survey area (Biota 2013a). Four priority species were recorded in the riparian survey area:

- *Peplidium* sp. Fortescue Marsh (S. Van Leeuwen 4865), Priority 1 (P1).

  One specimen of this species was recorded in a creekline location upstream of the proposed discharge point. There is only one other record of this species, at the Fortescue March approximately 270 km east of the B4 area.

- *Pentalepis trichodesmoides* subsp. *hispida,* Priority 2 (P2).

  This species was recorded in one floodplain location downstream of the proposed discharge point. This species has also been recorded nearby in the Western Turner Syncline area (Biota 2013b)

- *Indigofera* sp. Bungaroo Creek (S. Van Leeuwen), Priority 3 (P3).

  There were 1626 individuals of this species recorded in 134 locations within the riparian study area, in both creek bed and floodplain habitats, upstream and downstream of the proposed discharge point.

- *Goodenia nuda,* Priority 4 (P4).

  This species was recorded in five locations within the riparian study area, in both creek bed and floodplain habitats, upstream and downstream of the proposed discharge point. This species has a broad distribution throughout the Pilbara bioregion.

Thirteen introduced flora (weed) species were recorded in the riparian survey area, typical for creekline systems and habitats disturbed by livestock (Biota 2013a). *Argemone ochroleuca* subsp. *ochroleuca* (Mexican Poppy) and *Cenchrus ciliaris* (Buffel Grass) were both found extensively, at more than 150 locations throughout the riparian survey area. *Malvastrum americanum* (Spiked Malvastrum) was recorded at 33 locations, *Vachellia farnesiana* (Mimosa Bush) at 16 locations and *Cenchrus setiger* (Birdwood Grass) at 7 locations. Other species were found at fewer than five locations with fewer than five individuals at each location; *Bidens bipinnata* (Bipinnate Beggartick), *Cucumis melo* subsp. *agrestis* (Ulcardo Melon), *Flaveria trinervia* (Speedy Weed), *Portulaca oleracea/intraterranea* (Purslane), *Setaria verticillata* (Whorled Pigeon Grass), *Sigesbeckia orientalis* (Indian Weed), *Sonchus oleraceus* (Common Sowthistle) and *Tribulus terrestris* (Caltrop).

Of the weed species found, only Mexican Poppy is a declared pest under section 22 of the Biosecurity and Agriculture Management Act 2007 (DEC 2011). This is rated as category C3 (Management), i.e. control measures can prevent an increase in population size or density, but eradication is not considered feasible. The other weed species encountered in the potential discharge footprint are permitted organisms under section 11 of the Biosecurity and Agriculture Management Act 2007 (DEC 2011).

3.3 Fauna

The riparian woodland on Boolgeeda Creek provides habitat for a range of terrestrial and avian fauna. A baseline survey of the terrestrial fauna of the general B4 Project area recorded 123 taxa of terrestrial vertebrate fauna belonging to 54 families comprising two frogs, 49 reptiles, 57 birds, 7 bats and 8 nonvolant mammals (Biota 2005b). Two priority vertebrate fauna species were recorded in the B4 survey area (Biota 2005b), the Australian Bustard (*Ardeotis australis*), and a skink (*Notoscincus butleri*). There was one sighting of a feral cat, a house mouse and several dingoes seen and heard in the survey area (Biota 2005b). For 10 out of the 19 quadrats in the riparian vegetation survey of Boolgeeda Creek, it was noted that cattle and donkeys were either sighted directly or scats/grazing disturbance seen (Biota 2013a).

As there is limited occurrence of permanent or semi-permanent pools on Boolgeeda Creek there has been little monitoring of aquatic fauna to date. One site on Boolgeeda Creek, downstream of the maximum predicted B4 discharge footprint, near the confluence with Duck Creek, has been monitored annually since 2010 as part of baseline creek monitoring for the Nammuldi-Silvergrass Expansion (WRM 2014). In general, the composition of micro- and macroinvertebrate and fish taxa were similar in Boolgeeda Creek to other creeks in the area (Duck and Caves Creek, and the Beasley River). There was large variation over time in the microinvertebrate taxa richness, but in general the richness was similar to other creeks in the area. The majority of taxa were common, ubiquitous species. The composition of macroinvertebrate taxa was typical of freshwater systems throughout northern Australia and was dominated by Insecta. Stygofauna sampling has been undertaken in 9 bores on Boolgeeda Creek, with no stygofauna specimens recorded (Biota 2007).

Fish abundance and species richness was considered good and comparable to other systems nearby in the Pilbara (WRM 2014). The majority of fish recorded within Boolgeeda Creek have wide ranging distributions across the north of Australia. A Priority 4 species on the Western Australian Department of Environment and Conservation (**DEC**) Priority Fauna list (DEC 2010), the Fortescue grunter *Leiopotherapon aheneus*, was recorded (WRM 2014). This species has a restricted distribution within the Pilbara Region of Western Australia but it is considered to be reasonably common within it’s range.

It should be noted that this information on aquatic fauna is derived from only one semi-permanent pool, and may not be representative of other areas of Boolgeeda Creek.

4 Prevention of long term, irreversible impacts to the Environmental values of the boolgeeda creek System

4.1 Potential impacts to the environmental values of Boolgeeda creek during dewatering discharge

The total length of Boolgeeda Creek is approximately 106 km, so the maximum predicted discharge footprint of 37 km equates to approximately 30% of the creek. The bedrock units underlying Boolgeeda Creek are of low permeability, as a result discharge water is predicted to be retained within the surface alluvials and water loss to the environment via recharge will be minimal. The predicted maximum discharge volume of 17.5 ML/day is equivalent to 0.2 m^3/s at the proposed discharge outlet. This compares to the peak flow of Boolgeeda Creek at this location[1] due to rainfall runoff estimated at 148 m^3/s for a 2 year average recurrence interval (ARI) event and 3310 m^3/s for a 100 year ARI flood. Therefore, modelled flow from surplus water discharge is small in comparison to a natural flood event and is predicted to be confined within the low flow channel with no overtopping of creek banks. While the creek bed is predicted to be saturated within parts of the discharge footprint, the creek banks are likely to remain unsaturated (Rio Tinto 2013b).

Therefore, the potential impact due to waterlogging is expected to be confined to vegetation growing within or immediately adjacent to the low flow channel. Prolonged saturated soil conditions may cause decline in the health and abundance of flora species that are not adapted to waterlogged/saturated soil conditions. Different flora species vary in their tolerance to the spatial extent of waterlogging (i.e. partial or complete root system exposure) and the temporal duration of waterlogged conditions. Potential impacts on vegetation communities in proximity to watercourses affected by dewatering discharge include:

- Decline in health and/or death of overstorey eucalypts (*E. victrix* has lower tolerance to waterlogging when compared to *E. camaldulensis*). Any tree deaths would be expected to be restricted to substrates in close proximity to the watercourse channels affected by dewatering discharge and that are fully saturated for prolonged periods.
- Increased abundance of waterlogging tolerant native species.
- Increased water availability may enable expansion of existing weed populations, and establishment of new weed species.
- Increased duration or extent of surface water may attract more feral herbivores to the area, potentially resulting in grazing/trampling damage to native vegetation.

Potential disturbance of riparian vegetation may have impacts on native terrestrial fauna populations; native vegetation extent and condition is acknowledged as a surrogate for biodiveristy (DEWHA 2009). Therefore, management of the riparian vegetation communities will conserve the habitat utilised by terrestrial fauna.

Aquatic fauna may be impacted by discharge due to changes in flow duration or changes to water quality. The low number of semi-permanent or permanent pools observed on

[1] Sub-catchment area of 246 km^2

Boolgeeda Creek indicate that impacts on aquatic faunal communities are likely to be low. However, discharge water quality will be monitored to manage potential impacts on aquatic fauna. A discharge water quality management and monitoring strategy will be developed, in accordance with the framework set out in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000), and in consultation with the Department of Water. This strategy will then be submitted as part of the application for approval to discharge under Part V of the EP Act.

Therefore, this MMP does not specify monitoring and management in relation to water quality or aquatic fauna, or specific monitoring of native terrestrial fauna. The focus of this MMP is preventing long term, irreversible impacts to the riparian vegetation of Boolgeeda Creek resulting from dewatering discharge from the B4 Project. Riparian vegetation is considered to represent the broader ecological functioning of the riparian ecosystem including native terrestrial fauna. In addition, monitoring of the vegetation will include general assessment of habitat disturbance, including feral herbivore traffic and impacts.

4.2 Irreversible impact thresholds for riparian vegetation

After cessation of dewatering discharge, riparian vegetation is expected to gradually revert to a pre-impact condition (e.g. structural composition, functional behaviour, habitat elements and recruitment dynamics). However, there is likely to be an "irreversible" impact threshold, where exceedance of this threshold may result in a permanent loss of significant environmental values or where restoration of the significant environmental values may require intensive remediation, potentially over a long timeframe (>30 years). Scientific knowledge is not sufficiently developed to enable irreversible impact thresholds to be specified with confidence. However, irreversible impact thresholds for riparian vegetation have recently been developed as part of discharge MMP's approved by the OEPA for other Rio Tinto managed operations[2]. Table 4-1 specifies the irreversible impact thresholds for riparian vegetation that will be applied to the B4 revised proposal. There are separate thresholds for the overstorey (trees), understorey and weed component of the riparian vegetation, each defining the irreversible impact to that component that this MMP aims to avoid. These thresholds are based on those applied to other Rio Tinto operations. The suitability of the thresholds will be subject to critical review over the life of the project in accordance with adaptive management principles.

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[2] Western Turner Syncline Stage 2 Water Discharge and Riparian Vegetation MMP (RTIO-HSE-0204147), authorised by the EPA on 19 May 2014; Nammuldi-Silvergrass Vegetation and Ground Water Dependent Ecosystems MMP (RTIO-HSE-0185273), authorised by the EPA on 27 June 2013; Yandicoogina Groundwater Dependent Vegetation MMP (RTIO-HSE-0170457), authorised by the EPA on 21 December 2012.

Table 4-1: Irreversible Impact Thresholds for Riparian Vegetation, Associated with Dewatering Discharge

Threshold #	Irreversible impact threshold
1	Death of 30% of mature[i] trees due to impacts of dewatering discharge on Boolgeeda Creek, in excess of mature tree death in reference areas.
2	≥50% loss in the number of species relative to baseline, of common[ii] native perennial riparian understorey and groundcover species due to impacts of dewatering discharge on Boolgeeda Creek, in excess of losses in reference areas.
3	Invasion and domination (>80% of total understorey cover) of riparian vegetation by weed species not previously recorded within the vegetation survey area of Boolgeeda Creek, and classified by DEC (2011) as having High Ecological Impact and Low Feasibility of Control for the Pilbara Bioregion.

i Diameter of a mature tree to be defined following analysis of baseline data.

ii Species present at ≥50% of potential impact monitoring transects on Boolgeeda Creek (within the predicted discharge footprint) during baseline measurements.

Figure 4-1: Brockman Syncline 4 Iron Ore Revised Project – Riparian Vegetation Monitoring Potential Impact and Upstream Sites

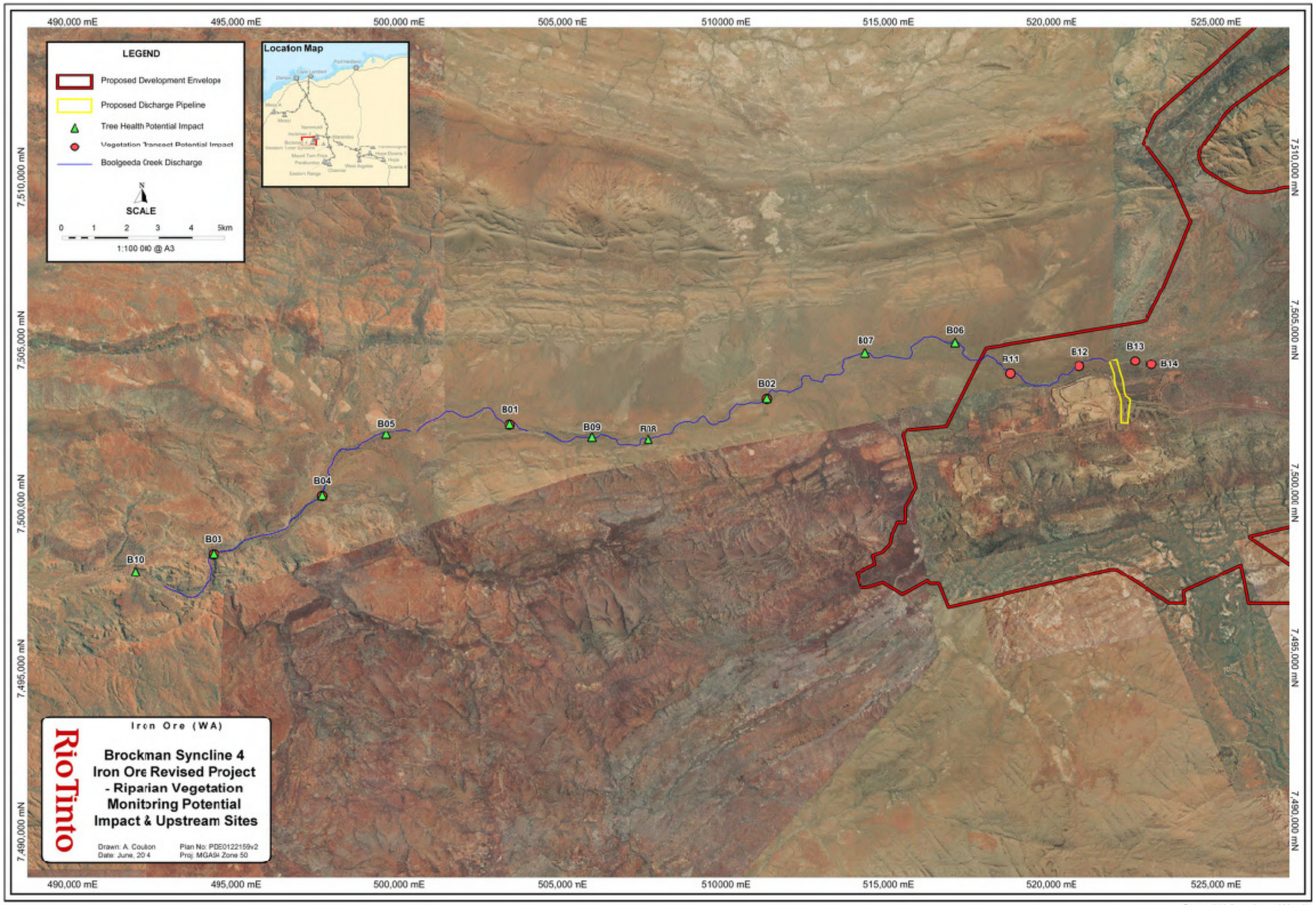
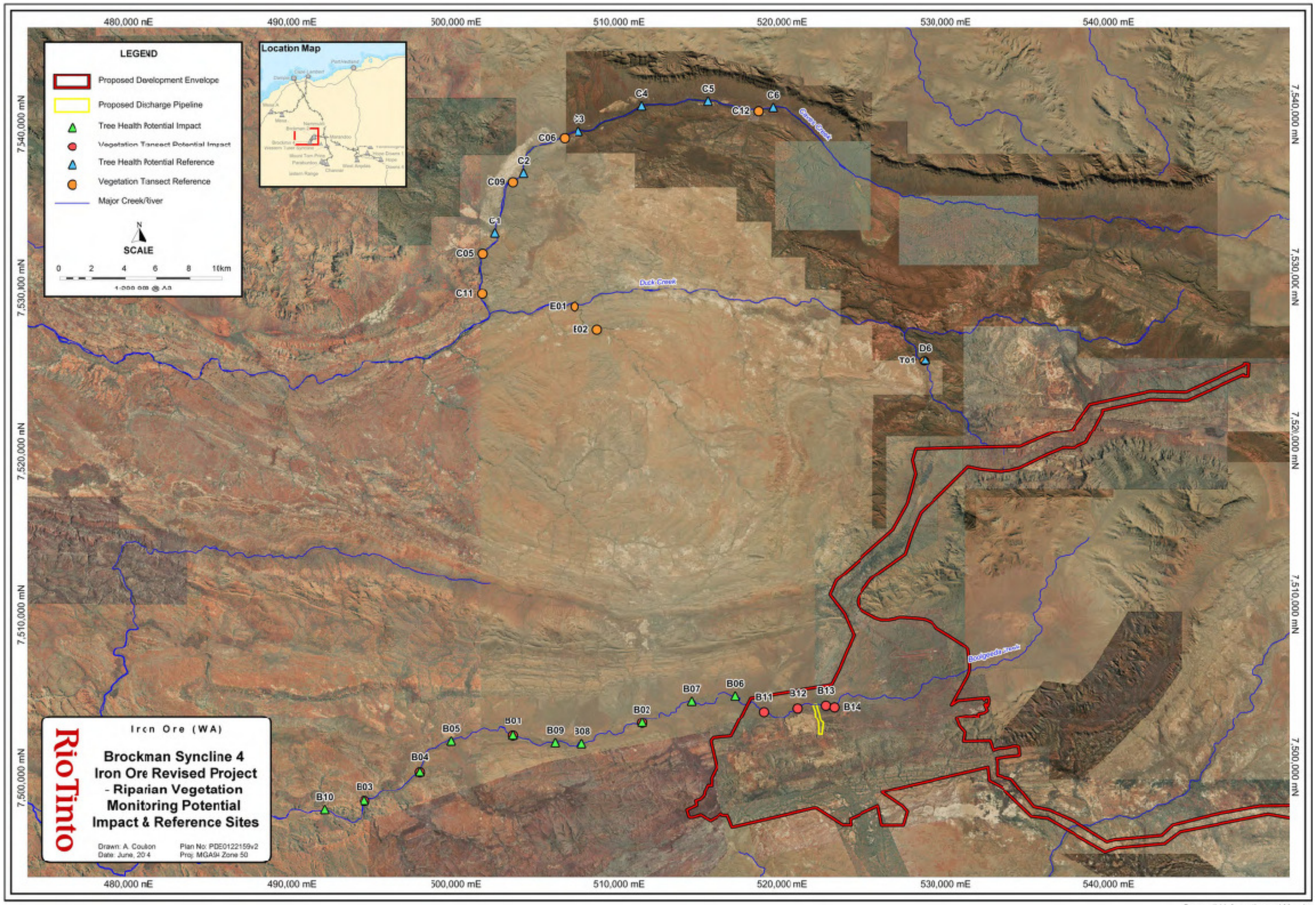


Figure 4-2: Brockman Syncline 4 Iron Ore Revised Project – Riparian Vegetation Monitoring Potential Impact and Reference Sites



4.3 Monitoring and trigger levels

The standard three trigger levels utilised in Rio Tinto MMP's are applied in this MMP, comprising Focus, Investigate and Action, for each of the irreversible impact thresholds defined above. That is, these three triggers are defined individually for the i) overstorey eucalypt canopy cover ii) composition of the understorey riparian vegetation and iii) abundance and composition of weeds. Each trigger is designed to prevent irreversible impact thresholds for each of these components being reached. The 'no irreversible impact' trigger is aligned with the 'Action' trigger level. The level of investigative response increases at each trigger level for each component of the riparian vegetation as specified in Tables 4-2 to 4-4.

4.3.1 Vegetation monitoring transects

Vegetation mapping has been undertaken on Boolgeeda Creek for the extent of the maximum predicted discharge footprint (37 km downstream) and approximately 10 km upstream of the proposed discharge point (Biota 2005a, 2013a). Monitoring sites were selected to encompass the six creekline vegetation units that were mapped within the potential discharge impact area (C2 to C7). Although monitoring will encompass the banks of Boolgeeda Creek, floodplain vegetation units were not specifically targeted as discharge water is predicted to be contained within the low flow channel and therefore to predominantly impact creekline vegetation.

Two sites on Boolgeeda Creek within the predicted discharge footprint were monitored in 2010, as part of the baseline creek surveys for the Nammuldi-Silvergrass Expansion (Biota 2012). During 2014 these original sites were surveyed again, a further four monitoring sites were established within the predicted discharge footprint on Boolgeeda Creek and two sites were selected upstream of the proposed discharge location (Figure 4-1). The proposed discharge location is in the upper reach of Boolgeeda Creek; upstream of this location the creek becomes more braided and meandering, and the vegetation composition also changes (Biota 2005a, 2013a). Given the nature of the watercourse, it was not possible to select sites further upstream, that have vegetation representative of the potential impact area, to use as reference sites. Sites on the nearby Duck and Caves Creek, that are monitored as part of the Nammuldi-Silvergrass Vegetation and Ground Water Dependent Ecosystems MMP (RTIO-HSE-0185273), will be used as reference sites for comparison with potential impact sites on Boolgeeda Creek (Figure 4-2). Reference sites were selected that are not potentially impacted by dewatering or surplus water discharge, and with similar vegetation composition to the potential impact sites on Boolgeeda Creek.

At each monitoring site, transects were established perpendicular to the watercourse, extending the width of vegetation considered to be associated with the watercourse and encompassing creek bed and banks[3]. Each transect comprises a belt of multiple 10 × 10 m quadrats. Within each quadrat the following parameters were recorded:

- Species present (including weeds).
- Percentage foliar cover for all species (including weeds).

[3] Methodology for transects aligned with transects established as part of the Nammuldi-Silvergrass Vegetation and Ground Water Dependent Ecosystems MMP (RTIO-HSE-0185273), authorised by the EPA on 27 June 2013.

- Number of individuals of perennial trees and shrubs that would usually grow >1m in height, (including weeds).
- Vegetation description based on the height and estimated cover of dominant species, utilising Aplin's (1979) modification of the vegetation classification system of Specht (1970).
- Vegetation condition ranked according to Trudgen (1988), with notation of disturbance such as grazing, other signs of cattle and feral animal activity, fire, weed invasions, presence of any defoliated/dead trees, other perturbations.
- Diameter at breast height (**DBH**) for trees with DBH >3 cm.
- Colour photographs from set photo points.

Baseline data was captured in May 2014. Potential impact monitoring will occur on an ongoing basis and potential corrective actions taken according to Table 4-3 and Table 4-4.

Vegetation surveys include an assessment of feral herbivore (donkey/cattle) activity within the predicted maximum discharge footprint. Evaluation is made through direct sighting of animals, scat density and rating of grazing intensity in each quadrat, and a qualitative assessment of any trampling disturbance to vegetation and soil. If feral herbivore activity increases as a result of surplus water discharge to Boolgeeda Creek, (i.e. in comparison to baseline and upstream/reference sites), causing disturbance to understorey vegetation, animal numbers will be controlled as described in Table 4.3, and after consultation with pastoral managers.

The presence of other feral animals will be monitored opportunistically within the discharge wetting front in conjunction with other environmental monitoring and site visits. Control measures will be implemented as deemed appropriate, in line with other site feral animal management practices.

Weed species composition and abundance will be determined as part of vegetation surveys, and changes within the discharge wetting front compared to baseline and upstream/reference sites as described in Table 4-3 and 4-4. In addition to these systematic surveys, opportunistic surveillance of weeds will be done by qualified Rio Tinto personnel during other environmental monitoring and visits to the discharge point and wetting front. If new weed species, (not present during baseline surveys), are encountered within the wetting front, management will be undertaken as described in Table 4-4. If declines in understorey vegetation are related to an increase in existing weed species populations, weeds in the discharge wetting front will be managed as described in Table 4-3. Management priority will be assigned depending on the weed risk of each species, according to the Biosecurity and Agriculture Management Act 2007, local and regional abundance and species characteristics described under the Invasive Plant Prioritisation Process (DEC 2011). Depending on the priority determined, the appropriate management level may be to inspect, control or eradicate the weed from the management area.

4.3.2 Tree health monitoring

During 2014, ten tree health monitoring sites were established encompassing the maximum predicted discharge footprint on Boolgeeda Creek (Figure 4-1). At each monitoring location, ten eucalypt trees (comprised of *E. victrix* and *E. camldulensis*) across the creek bed and banks were selected for digital cover photography (**DCP**), to provide a quantitative measurement of the canopy foliage density (Macfarlane 2007). Canopy foliage density and/or leaf area index, is an established proxy for tree health, and severe defoliation can be a precursor of tree death (Kozlowski 1981), which is the parameter defining the irreversible impact threshold for overstorey vegetation.

The tree health monitoring sites coincide with the locations of vegetation monitoring transects where a significant eucalypt overstorey component was present. In the upper reach of Boolgeeda Creek, the overstorey is less abundant and eucalypts are not present at all sites. Upstream of the proposed discharge location eucalypts are particularly sparse and it was not possible to establish reference sites due to insufficient trees being present. As for the vegetation transect monitoring, sites on Duck and Caves Creek, that are not potentially impacted by dewatering or surplus water discharge, will be used as a reference for tree health monitoring on Boolgeeda Creek (Figure 4-2).

Baseline measurements were made in May 2014. Potential impact monitoring will occur on an ongoing basis according to Table 4-2.

4.3.3 Airborne Digital Multi-Spectral Imagery

During November 2014 high-resolution, airborne, Digital Multispectral Imagery (**DMSI**) of the vegetation will be captured on the full extent of Boolgeeda Creek and in reference areas on Duck and Caves Creek, as part of a regional DMSI data capture program. The images will be analysed to derive a vegetation index calculated from the ratio of the near infra-red to red reflectance. This index can be used to indicate change with time in vegetation health and cover with coarser resolution but greater spatial extent than can be assessed by ground survey. The 2014 imagery will be used as baseline data for comparison with future measurements, as specified in Table 4-2.

Table 4-2: Monitoring and Trigger Levels for Riparian Vegetation (overstorey) Health

No irreversible impact threshold (as defined in Table 4-1): Death of 30% of mature trees due to impacts of dewatering discharge on Boolgeeda Creek, in excess of mature tree death in reference areas.

Monitoring aspect	Method	Parameter(s)	Frequency	Trigger Parameter	Management Actions and Strategies
Riparian vegetation; tree health (overstorey)	(i) Digital Cover Photography (**DCP**) (ii) Airborne Digital Multi-Spectral imagery (**DMSI**)	(i) DCP analysis to detect changes in canopy foliage cover of mature eucalypts (ii) DMSI analysis to detect changes in tree foliage	(i) Annually post wet season (Q1/Q2) (ii) Once during pre-impact period, then as required	**Focus:** 15% decrease in mean foliage cover at potential impact sites relative to baseline[4], in excess of change in reference areas.	1. Review degree of exposure of impacted trees to dewatering discharge, via review of site-specific surface inundation extent and duration, discharge volumes and hydrological model and; 2. Review reference site data to ascertain if change has also occurred at reference sites and; 3. Review site and tree condition information from impact and reference sites to determine if other environmental factors may have caused the change (i.e. fire, storm damage, insect activity, etc.).
				Investigate: 25% decrease in mean foliage cover at potential impact sites relative to baseline[4], in excess of change in reference areas.	As for **Focus**, with addition of the following: 1. If causal environmental factors for foliage cover decline other than dewatering discharge cannot be identified then; during next regional flyover, capture DMSI of the potential impact and reference areas and; 2. Review DMSI to investigate extent of trees with foliage cover decline, within the impact and reference areas. Depending on outcomes of the investigation of DMSI, take some or all of the following actions as warranted: 3. If review of DMSI indicates widespread foliage cover decline, undertake expanded on-ground assessment of tree condition within the impact and reference areas. 4. If preliminary assessment indicates it is warranted, undertake investigations of water levels/waterlogging in the rooting zone of impacted trees. 5. If investigations indicate it is appropriate, expand the extent and frequency of tree condition monitoring within the impact and reference areas. 6. Review potential remediation actions/strategy. 7. Consultation with the OEPA and external stakeholders may be considered appropriate, particularly if investigations indicate "Action" trigger likely to be exceeded.
				Action ['no irreversible impact' trigger level]: 40% decrease in mean foliage cover at potential impact sites relative to baseline[4], in excess of change in reference areas.	As for **Focus** and **Investigate**, with addition of the following: 1. Within 21 days of confirmation of this trigger level being exceeded, provide a report to the OEPA. 2. If trigger level exceedance is considered likely to be due to dewatering discharge, report to include proposed remediation actions, to prevent the 'no irreversible impact threshold' being reached.

[4] *Baseline values are the mean % canopy foliage cover of all measurements in the predicted dewatering discharge footprint prior to discharge.*

Table 4-3: Monitoring and Trigger Levels for Riparian Vegetation (understorey) Health and Abundance

No irreversible impact threshold (as defined in Table 4-1): ≥50% loss[5] of common[6] native perennial riparian understorey and groundcover species due to impacts of dewatering discharge on Boolgeeda Creek, in excess of losses in reference areas.					
Monitoring aspect	**Method**	**Parameter(s)**	**Frequency**	**Trigger Parameter**	**Management Actions and Strategies**
Riparian vegetation; understorey health and abundance	Vegetation monitoring transects	(i) Species present (ii) Number of individuals and/or percentage foliar cover (iii) Vegetation condition	Annually post wet season (Q1/Q2)	**Focus**: 15% deline in number[5] of common[6] native perennial riparian understorey and groundcover species at potential impact sites, in excess of declines in reference areas.	1. Review degree of exposure to dewatering discharge of transect quadrats where declines have occurred, via review of site-specific surface inundation extent and duration, discharge volumes and extent, and hydrological model and; 2. Review reference monitoring sites data to ascertain if declines have also occurred at control sites and; 3. Review impact and reference site data to ascertain if existing weed populations, or populations of other native species, are expanding at the same transect quadrats where declines in number of common native species have occurred and; 4. Review site and vegetation condition information from impact and reference monitoring sites to determine if other environmental factors may have caused declines (i.e. fire, storm damage, insect activity, grazing disturbance etc.).
				Investigate: 20% decline in number[5] of common[6] native perennial riparian understorey and groundcover species at potential impact sites, in excess of declines in reference areas.	As for **Focus**, with addition of the following: 1. If causal environmental factors other than dewatering discharge cannot be identified, and on-ground observations indicate appropriate, then during next annual regional flyover, capture DMSI of the potential impact area, and assess if observed changes in understorey can be distinguished in imagery and; 2. Investigate the extent of decline within the impact and reference areas, via: (i) Review of DMSI from latest capture date, if on-ground observations and imagery assessment indicates observed changes in understorey can be distinguished; and/or (ii) Expanded on-ground assessment within the impact and reference areas. Depending on outcomes of the investigation of DMSI, take some or all of the following actions as warranted: 3. If investigations indicate it is appropriate, expand the extent and frequency of understorey monitoring within the impact and reference areas. 4. Review potential management actions/strategy, including: (i) If investigations indicate disturbance to vegetation by feral herbivores has increased from baseline and is in excess of that observed at reference sites, implement control measures to reduce herbivore abundance in the discharge footprint and adjacent areas (e.g. aerial cull of feral donkeys/wild cattle), in consultation with pastoral managers. (ii) If investigations indicate that existing weed species have increased in abundance and are negatively impacting on native understorey vegetation, management of weeds will be undertaken at the level appropriate to the weed risk and priority identified for each species (in accordance with the Invasive Plant Prioritisation Process , DEC 2011). (iii) other remediation strategies in consultation with stakeholders. 5. Consultation with the OEPA and external stakeholders may be considered appropriate, particularly if investigations indicate “Action” trigger likely to be exceeded.

No irreversible impact threshold (as defined in Table 4-1): ≥50% loss[5] of common[6] native perennial riparian understorey and groundcover species due to impacts of dewatering discharge on Boolgeeda Creek, in excess of losses in reference areas.					
Monitoring aspect	**Method**	**Parameter(s)**	**Frequency**	**Trigger Parameter**	**Management Actions and Strategies**
				Action ['no irreversible impact' trigger level]: 25% decline in number[5] of common[6] native perennial riparian understorey and groundcover species at potential impact sites, in excess of declines in reference areas.	As for **Focus** and **Investigate**, with addition of the following: 1. Within 21 days of confirmation of this trigger level being exceeded, provide a report to the OEPA. 2. If trigger level exceedance is considered likely to be due to dewatering discharge, report to include proposed remediation actions, to prevent the 'no irreversible impact threshold' being reached.
[5] number of species present relative to baseline. [6] species that were present at ≥50% of potential impact monitoring transects on Boolgeeda Creek during baseline.					

Table 4-4: Monitoring and Trigger Levels for Establishment of New Weed Species in Riparian Vegetation

<table>
<tr><td colspan="6">No irreversible impact threshold (as defined in Table 4-1): Invasion and domination (>80% of total understorey cover) by weed species not previously recorded within the vegetation survey area of Boolgeeda Creek and classified by DEC (2011) as having High Ecological Impact and Low Feasibility of Control for the Pilbara bioregion.</td></tr>
<tr><th>Monitoring aspect</th><th>Method</th><th>Parameter(s)</th><th>Frequency</th><th>Trigger Parameter</th><th>Management Actions and Strategies</th></tr>
<tr><td rowspan="2">Establishment of new weed species in riparian vegetation</td><td rowspan="2">Vegetation monitoring transects</td><td rowspan="2">(i) Weed species present
(ii) Number of individuals and/or percentage foliar cover (weeds)
(iii) Vegetation condition</td><td rowspan="2">Annually post wet season (Q1/Q2)</td><td>Focus and Investigate:
Weed species recorded at a potential impact site, which has not previously been recorded within the vegetation survey area of Boolgeeda Creek.</td><td>1. Review reference site data to ascertain if weed species has also established at reference sites.
2. If causal environmental factors for establishment of new weed species other than dewatering discharge cannot be identified then:
(i) Undertake expanded on-ground assessment within the dewatering impact area for other occurrences of the species and;
(ii) Implement control or eradication measures for these species within the dewatering impact area according to the weed risk identified (in accordance with the Invasive Plant Prioritisation Process, DEC 2011).</td></tr>
<tr><td>Action [‘no irreversible impact’ trigger level]:
Weed species recorded at a potential impact site, which has not previously been recorded within the vegetation survey area of Boolgeeda Creek, and classified by DEC (2011) as having High Ecological Impact, and Low Feasibility of Control, exceeds 60% of total understorey cover at impact sites.</td><td>1. Within 21 days of confirmation of this trigger level being exceeded, provide a report to the OEPA.
2. If trigger level exceedance is considered likely to be due to dewatering discharge, report to include proposed remediation actions, to prevent the ‘no irreversible impact threshold’ being reached.</td></tr>
</table>

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