Koolan Island Iron Ore Mine and Port Facility Project

Statement
Re-Implementation
(Stage 1 of 2 stages)

MARINE MANAGEMENT PLAN

2018

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MGX Standard 4.11 Marine Management
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<td>T.Collie</td>
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1 INTRODUCTION

1.1 BACKGROUND

Koolan Iron Ore Pty Ltd owns and operates the iron ore mine on Koolan Island in the West Kimberley region of Western Australia. Koolan Island is located approximately one kilometre from the mainland and 130 kilometres north of Derby at approximately 16° 8’ S and 123° 45’ E within Yampi Sound (Figure 1). Koolan Island has an area of 2,580 hectares and is approximately 13 km long and up to 4 km wide, with a high ridge along the southern side, representing the top of the iron formation. The coast is steep with narrow gullies and frequent embayments, but few beaches (Ecologia 2005).

Koolan Island is one of the largest of the many islands comprising the Buccaneer Archipelago located in the Kimberley region of Western Australia. Since Koolan Island is located within the boundaries of the West Kimberley it has been included in the heritage listing of the area to be considered in accordance with Environment Protection & Biodiversity Conservation Act.

Figure 1 - Location of Koolan Island in Western Australia
1.2 PROJECT COMPONENTS

Koolan Island was mined for iron ore between 1965 and 1993 by BHP. During that period approximately 68 million tonnes of high-grade hematite (67% Fe) ore was extracted from five pits, crushed and shipped from a wharf facility and this resulted in impacts to the marine environment.

A proposal by Aztec Resources Ltd to recommence mining and shipping of iron ore from Koolan Island (Ecologia 2005) was assessed by the Western Australian Environmental Protection Authority (EPA 2005) and approved in 2005. Construction for the operation began in June 2006, with sea wall construction completed in 2011, and mining commencing in 2007.

The project components of the Marine Management Plan (MMP) are those described in the Environmental Referral Document (Ecologia 2005), and Statement 715 and include the construction and operation of:

- A seawall that preceded a void for the mine’s Main Pit
- Dewatering of the pit contents to sea to ready the pit void, and ongoing discharges of small maintenance volumes during mining
- A wharf facility for docking of barges, loading iron ore and transfer stores and fuel
- Shipping operations associated with the facility

General mining and land disturbance activities which may increase sediment runoff to the marine environment

1.3 OBJECTIVES

The purpose of the Marine Management Plan is to manage the operation of the Koolan Iron Ore Mine within the approved development envelope with impacts to approved predicted levels. There should be no compromise of the ecological integrity and biodiversity of the area outside of the development envelope. This document has been prepared to meet the requirements for a Marine Management Plan under Ministerial Statement 715 Condition 7 (EPA 2005).

Ministerial Statement 715 (MS715), Condition 7 states that:

7-1 Prior to the commencement of activities that may affect the marine environment; the proponent shall prepare a Marine Management Plan to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority, the Department of Conservation and Land Management and the Department of Fisheries.

7-2 The proponent shall review and revise the Marine Management Plan required by condition 7-1 at intervals not exceeding four years.

7-3 The proponent shall implement the Marine Management Plan required by condition 7-1 and subsequent revisions required by condition 7-2.

7-4 The proponent shall make the Marine Management Plan required by condition 7-1 and subsequent revisions required by condition 7-2 publicly available.

This Marine Management Plan sets out procedures to:
1. identify the potential direct and indirect impacts on the marine environment during all phases of project activities;
2. minimise the disturbance footprint of the seawall and the revetment structure;
3. identify the cause and effect pathways associated with the potential impacts identified in point 1 above;
4. spatially and temporally define the zones of direct and indirect impact on sediment and water quality and benthic habitat health, as well as the boundary of the zone beyond which the marine environment will be protected;
5. manage the direct and indirect impacts, identified in point 1 above, on sediment and water quality and benthic habitat health, including the use of geotextile materials;
6. analyse the quality of the water to be discharged from dewatering the Main Pit;
7. spatially and temporally define the mixing zones where water will be discharged to the marine environment;
8. manage impacts associated with dewatering discharge to the marine environment;
9. manage stormwater to minimise impacts on the marine environment from existing and proposed sources of sediment runoff;
10. establish suitable reference sites from which to collect data for sediment and water quality and benthic habitat health indicators and derive site-specific environmental quality criteria for the direct and indirect impact zones;
11. develop a marine environmental quality monitoring programme, which incorporates:
   - scale maps showing the locations of each monitoring site and reference site;
   - procedures for routine monitoring of sediment and water quality and benthic habitat health during the life of the mine;
   - the environmental quality criteria for triggering pre-determined management action(s) and where necessary the rationale for their derivation;
   - methodologies for evaluating data collected at the monitoring and reference sites against the environmental quality criteria; and
   - the pre-determined adaptive management actions which will be implemented in the event that environmental quality criteria are not being achieved;
12. carry out a baseline survey and regular ongoing surveys for introduced marine pests;
13. develop a spill contingency plan;
14. restore or rehabilitate the marine environment, where impacts have occurred outside the identified indirect impact zone, during the life of the mine;
15. restore or rehabilitate the marine environment during the decommissioning phase, and ensure there is no net loss of benthic primary producer habitats and where possible generate a net gain in the area of benthic primary producer habitat and/or their associated communities.

To the extent that they apply, certain of these procedures relate to Stage 1 being for “Seawall re-construction and Main Pit capital dewatering”.

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2 BACKGROUND TO REVISION OF THE PLAN

2.1 PAST AND RECENT OPERATIONAL HISTORY

There are a number of stages of Main Pit activity, operations, closure and reopening that are required to be known to understand the requirements for partial re-implementation of the proposal.

2.1.1 Works and Operations until 2014

Construction and commissioning of Mine Infrastructure and the Port Facility was completed under MS715 in 2007 and associated works approvals under Part V of the Environmental Protection Act 1986, and a prescribed premises operating through Licence L8148.

MGX undertook mining on Koolan Island on mining leases M 04/461 and M 04/417 in accordance with approved Mining Proposals (NOI) 5194, 5261A, 5278, 5312, 5567, 5601, 5716, 6038, 19402, 20559, 23857, 31899 and 31828. Current approval was for up to 36 million tonnes of ore and waste to be extracted per year and up to 4 million tonnes of ore to be processed per year.

The Marine Management Plan was applied in various approved versions over the course of operations to 2014 (culminating in Version 19), which applied to mining at the site immediately prior to the seawall failure.

Mining in Main Pit occurred until October 2014.

2.1.2 Events from late 2014 to date

- In November 2014, a failure in the engineered seawall resulted in ocean waters inundating the Main Pit. This pit had been the source of hematite processed and shipped for export by KIO.
- During 2015, the mining rate at Koolan Island was reduced (as ore was then only sourced from small terrestrial pits).
- In early 2016, mining operations at the Island entered a formal period of care and maintenance.
- Since June 2016, KIO is progressing with its feasibility assessment and a design phase to give basis to a formal decision on re-instating the seawall with the plan to re-commencing Main Pit mining from late 2017.
- KIO believes that the seawall at Koolan Island can be re-instated on the basis of the approvals granted by Statement 715.

2.1.3 Plans for 2017 onwards

- Activities are required at Koolan Island to repair/re-build parts of the existing seawall.
- It would also require dewatering of surface water retained in the Main Pit, once the seawall breach is closed.
- The preferred conceptual seawall design is shown below (see Figure 2).
- Indications are that the seawall could be re-constructed by occupying the same development footprint as approved through MS715.
• Competent rock materials to fill the seawall breach would be sourced from rock previously mined on tenements and currently stored in WRLs on Koolan. Some of the fill materials would be graded (and/or crushed) using processing plant currently licensed at site. Because of the work to be done with mined materials, KIO would also actively seek a Mining Proposal to be lodged and approved by DMP under Mining Act.

• It is understood that re-instatement work would utilise similar construction techniques in accordance with MS715, particularly according to Condition 7.

• Once the pit void had been readied by removal of rock and sediment to WRLs, mining of hematite ore would re-commence in accordance with Statement 715, Mining Proposals and Licence 8148.

2.2 Predicted Impacts and Their Management

Environmental aspects of seawall partial re-construction and Pit capital dewatering are entirely consistent with the original seawall development including:

• Graded rock fill placed into the seawall core and large size rock armour as a seawall facia – potentially resulting in limited spatial effects on water quality for a limited period of time ie. from newly placed fill on ebbing tides during the three month build period;

• Pump out of seawater retained within the Pit upon closure of the seawall – very limited or no spatial effects on water quality with discharge subject to Part V licence (L8148/206/5 as held by KIO);

• Potentially, recovery of marine fauna potentially enclosed in the pit upon closure of the seawall – very limited numbers of marine fauna, subject to Fisheries and Parks & Wildlife provisions.

• An additional design element is installation of a vertical grout curtain within the core of the seawall’s earthworks (See Figure 2).

• There is no indication that dredging at the base of the breach would be required; there may be limited areas beneath the central core where large boulders may be removed or relocated. As the vertical grout curtain will be used, there is no design requirement for a purpose-filled clay core for “sealing” the wall.

In general, impacts during the project’s re-implementation phase (Stage 1) may be caused by sediments emitted seawards from seawall re-construction and/or pit dewatering. These activities are better controlled by management prescriptions at the source rather than adaptive management applied from real time or lagged from monitoring. For the majority of construction activities, the environmental management strategy will be to describe procedures to minimise the risk of impacts, then monitor to test whether impacts have occurred outside predicted impact footprints.
Figure 2: Working concept of engineered zones of re-constructed seawall section (note rock armour zone truncates at existing extent and a matching geometry of the existing wall)

2.2.1 Stage 1 - Re-construction of a section of the Seawall

Descriptions, comments and commitment in the Marine Management Plan (Version 16) remain valid and relevant to this Version 20 of the MMP. These are stated verbatim below:

“Section 7.1.5 of the Ministerial Statement suggests that management of sediment derived from construction of the seawall may be facilitated by use of a sediment curtain. The extreme tidal range, considerable depth and weather aspect of the seawall face mitigate against the use of a sediment curtain at this site. Sediment management techniques in the NOI will need to consider design rather than barrier methods.

It is likely that the very fine suspended sediments generated from impacts ii & iii of Table 8 will have a noticeable impact on turbidity levels well beyond the spatial footprint of (sic, ecological) impacts. Plumes with high turbidity caused by fine suspended sediments are common occurrences in this area and are unlikely to have a significant and irreversible impact on biota within the timeframes of Table 8. Thus the principal concerns for indirect impacts will relate to increased rates of sedimentation around the construction work.

Monitoring of potential impacts:

- **Direct Impacts** – remote video analysis of benthic communities as outlined in Ch.6 will be used to confirm compliance with predicted footprints.

- **Indirect Impacts** – the primary indicator of indirect impacts outside the infrastructure footprint will be water quality criteria as described in Ch. 4 which if breached will trigger habitat monitoring.
Table 8: Seawall Impacts: timing, area and management.

<table>
<thead>
<tr>
<th>Impact</th>
<th>Timing</th>
<th>Area</th>
</tr>
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<tbody>
<tr>
<td>i) Direct overtopping of marine benthos by the rockfill</td>
<td>Immediately at construction</td>
<td>The entire footprint shown in Erd Figure 2.4 (Fig 3 here)</td>
</tr>
<tr>
<td>ii) Sediment smothering of marine benthos by settlement of suspended sediments generated from the 14-17% fines fraction of the rockfill during placement and subsequent remobilisation by tides and waves</td>
<td>From start of construction to 4 months after completion</td>
<td>Impacts will be likely in an area approximately 50m around the toe of the rockfill – indicated by the dotted red line in Figure 3’</td>
</tr>
<tr>
<td>iii) Sediment smothering of marine benthos from fine sediments mobilised by seawater contacting the wall’s clay core and rock shell.</td>
<td>From start of construction to completion of armouring</td>
<td>Impacts likely within the same footprint as i) above.</td>
</tr>
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<table>
<thead>
<tr>
<th>Impact</th>
<th>Management</th>
</tr>
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<tbody>
<tr>
<td>i) Direct overtopping of marine benthos by the rockfill</td>
<td>Careful placement of rockfill will avoid rocks rolling beyond the planned footprint and restrict spread of impacts outside that area. See Aztec (2006) for details of construction management.</td>
</tr>
<tr>
<td>ii) Sediment smothering of marine benthos by settlement of suspended sediments generated from the 14-17% fines fraction of the rockfill during placement and subsequent remobilisation by tides and waves.</td>
<td>The amount of the fines contained in rockfill used will be minimised by careful selection of fill. Placement of fill will be timed to minimise placement during flood tides. See Aztec (2006) for details of construction management.</td>
</tr>
<tr>
<td>iii) Sediment smothering of marine benthos from fine sediments mobilised by seawater contacting the wall’s clay core and rock shell.</td>
<td>The outer shells of the wall will be constructed first so as to minimise the time that the clay core is exposed to high tides. See Aztec 2006 for details of construction management.</td>
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</table>

Note that impact mechanisms i) and iii) in MScience (2010) will not occur in the re-implementation phase. No direct impacts will occur as the same developed footprint for the seawall will be re-developed. There are many of the impacting mechanisms that would be eliminated or reduced by virtue of the re-implementation and partial rebuild requirement for the seawall preceding planned for return to Main Pit mining as shown in Table 2.1.

In general, the primary indicator of potential indirect impacts outside the infrastructure footprint will be water quality criteria (as turbidity which is related directly to suspended solids) which, if exceeded, would trigger habitat monitoring. These indicators and trigger levels are described in Section 3.
Table 2.1: Seawall Impacts: timing, area and management.

<table>
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<th>Potential Impact</th>
<th>Timing</th>
<th>Area</th>
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<tr>
<td>ii) Sediment smothering of marine benthos by settlement of suspended sediments</td>
<td>Start of construction to completion (within 3 months) and perhaps for a</td>
<td>Likely in an area approximately 50m beyond the face of the rockfill/</td>
</tr>
<tr>
<td>generated by placement of the rockfill and subsequent remobilisation by tides</td>
<td>month afterwards</td>
<td>wall (see MMP Ver16; Figure 3; MScience 2010)).</td>
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<td>and currents.</td>
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Potential Impact Management

ii) Sediment smothering of marine benthos by settlement of suspended sediments generated by placement of the rockfill and subsequent remobilisation by tides and currents.

The amount of fines contained (adhered) in rockfill used will be minimised by grading and screening of fill or source selection of engineered fill. A construction management method will be applied to limit seaward emissions of suspended sediment by avoiding runout and high velocity tidal conditions.

2.2.2 Stage 1 - Main Pit Dewatering

Descriptions, comments and commitment in the Marine Management Plan (Version 16; MScience 2010) remain valid and relevant to this Version 20 of the MMP. Stage 1 is comprised of three Phases: 1, 2 and 3. Note that the first phase required a civil engineered re-instatement of a section across the seawall that formed a temporary breach since 2014.

Text and diagrams from Version 16 for the following two phases is stated verbatim below:

"Dewatering of the pit will result in discharge of water with the potential for indirect impacts on EQO 1 – biodiversity and BPPH. While the early discharge of water from the pit will be of similar quality to ambient seawater, water quality will worsen progressively as dewatering approaches the Main Pit floor. The salinity of discharge water will become progressively lower as inflows from the freshwater aquifer increase with increasing drawdown and sediments mobilised from the Main Pit floor and walls will increase sediment loads and possibly elevate metals levels. Nitrates from blasting may increase nutrient levels during operation.

The final design of the (sic, permanent) discharge pipe and outfall are shown below.

Koolan Iron Ore’s current approach is to separate dewatering into two phases:

**Phase 1** - Phase I dewatering will involve removal of water via pumping of approximately the first 40 m. Water in the first 40 m is essentially seawater due to tidal flushing, and is not expected to have significant environmental impacts (MScience 2006). Phase I seawater was <17 mg/L TSS (Total Suspended Solids) (<5.7 NTU) and will be discharged directly to the ocean without treatment.

**Phase II** – Phase II will involve removal of water via pumping of the bottom profile and expected to have lower water quality than Phase 1 (>17 mg/L TSS, > 5.7 NTU). Water from Phase II will be discharged to the ocean, if required, after passing through a sediment sump to remove excess suspended solids.

1 Note that the Phases 2 & 3 of the 2017-18 rebuild campaign equate to Phase 1 (capital dewatering) and Phase 2 (maintenance dewatering) described in the original V16 MMP.
While the two phases are generally described by depth in Pit, for operational purposes, they will be defined by suspended sediment (ie turbidity) content in the discharge to be made.

Water quality (physical and chemical) over the 80 m profile of the water column was similar to that of surrounding waters with some drops in temperature, and salinity (2-4%) with increases in turbidity (<2 NTU) and nutrients (10-50%) at depth. Aquaterra predicted that salinity of the upper pit waters will not be significantly impacted (decline of <500 mg/L) by any inflow of groundwater during dewatering. Metals in water were below ANZECC guidelines at all depths within the pit. Dissolved oxygen decreased with depth both inside and outside of the Main Pit.

The potential for suspended sediments from the Main Pit floor to impact on water quality has also been assessed (MScience 2008). A series of samples were elutriated in local seawater and elutriate tested for metals and organic contaminants. Within the elutriate samples, most metals and all organics occurred at levels which are below the ANZECC target guidelines for 99% species protection.

For both discharges of water and elutriated sediment, there is a further dilution of at least 1:10 by the edge of the mixing zone. This has been verified using a dye dispersion test (MScience 2010).
MMP Ver 16 - Table 10. Dewatering discharge potential impacts

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<thead>
<tr>
<th>Impact</th>
<th>Timing</th>
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<tbody>
<tr>
<td>i)</td>
<td>Death of benthic organisms due to lowered salinity</td>
<td>Latter stages of Phase II dewatering</td>
</tr>
<tr>
<td>ii)</td>
<td>Sediment smothering of corals and associated benthos</td>
<td>Dewatering nears the Main Pit floor</td>
</tr>
<tr>
<td>iii)</td>
<td>Elevation of heavy metals in biota</td>
<td>During mining operation</td>
</tr>
<tr>
<td>iv)</td>
<td>Enhanced algal growth at the expense of benthic fauna</td>
<td>During mining operation</td>
</tr>
<tr>
<td>v)</td>
<td>Physical damage to benthic habitats during outfall construction</td>
<td>Phase 1 dewatering construction</td>
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<tr>
<th>Impact</th>
<th>Management</th>
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<tbody>
<tr>
<td>i)</td>
<td>Maximise mixing with design of outlet</td>
</tr>
<tr>
<td>ii)</td>
<td>Use settlement pond to reduce pre-discharge levels of sediment</td>
</tr>
<tr>
<td>iii)</td>
<td>Use settlement pond to reduce pre-discharge levels of sediment</td>
</tr>
<tr>
<td>iv)</td>
<td>Investigate the use of non-nitrate explosives</td>
</tr>
<tr>
<td>v)</td>
<td>Construct the outfall as described in the NOI (Aztec 2006)</td>
</tr>
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The relationship between turbidity (NTU) and TSS has been calibrated by measuring both parameters in Main Pit water containing various amounts of added pit sediment.

The relationship is described by the equation:

\[ \text{TSS (mg/L)} = 3 \times \text{NTU} \quad (R^2 = 0.99) \quad (\text{MScience 2009a}) \]

This relationship has been used to provide a turbidity trigger for discharge from the Main Pit. On the basis of water and sediment chemistry, potential dewatering impacts are as follows:

- For Phase I dewatering to approximately -40 mRL, there are unlikely to be any impacts from the discharge other than:
  - Accidental creation of suspended sediments by the dewatering uptake in the Main Pit, then transferred to the ambient seawater – this could mark transition to the Phase II component

- For Phase II dewatering, there are unlikely to be any impacts other than:
  - The possible increase in suspended sediments discharged when pumping from near the bottom of the Main Pit and then from the settlement pond;
  - Possible increased concentrations of nutrients, including nitrate-nitrite resulting from blasting products and run-off into the Main Pit.
While the two phases are described by depth, for operational purposes they will be defined by TSS in the discharge.

MScience (2010) identified that capital dewatering "...seawater...will be discharged directly to the ocean without treatment." Furthermore, KIO can clarify this by undertaking to release high quality seawater (<6NTU) to ocean from the seaward face of the seawall / Main Pit exterior at points that are more than 100m distant from mapped BPPH according to Hydrobiology (2015).

To the extent that they existed as potential impacting mechanisms or occurred at the original dewatering of Main Pit by KIO, impacts specified in MScience (2010; Table 10) may also re-occur during re-implementation. In general, the primary indicator of potential indirect impacts outside the infrastructure footprint will be water quality criteria (as turbidity) which, if exceeded, would trigger habitat monitoring and based on its findings further corrective actions. These indicators are described in Section 3.

At the completion of Stage 1 activity, this Version 20 of the plan would be suspended.

2.2.3 Stage 2 – Dewatering during Mine Operations

A future stage of marine monitoring would be for the routine mine operations, once the construction phase is re-implemented and completed. That monitoring would aim to detect changes in the condition of the marine environment and to trigger management actions if the measured values at a site fall outside acceptable levels because of emissions from the site once mining re-commences.

Note Version 19 of the MMP was approved and applied to site operations.

Should ‘Stage 1 – Re-construction and Pit capital dewatering’ occur during 2017/18, and at least three months before commencement of scheduled ‘Stage 2 – Mine Operations’, Version 19 MMP would, should it be required, be made to DWER for its further review.

Stage 2 of the pit dewatering upon mining would be licensable and L8148 applies as issued by DWER.
3 MONITORING AND MANAGEMENT – STAGE 1

In order to achieve the marine management objectives, the MMP consists of both monitoring and management obligations (Table 3-1). These obligations are to be carried out at different frequencies depending on their significance and the likelihood and severity of impact. Monitoring is broken down into major programmes to assess water quality, benthic communities, wildlife and introduced species.

So that it is understood for all monitoring, a B-A-C-I design will be applied for statistical analysis of monitoring data for objective assessment of any detectable changes. This means that operational data will be compared to parameters for equivalent spatial data and historical temporal data sets.

Appendix D explains the summary information presented in Tables 3-1 to 3-4.

Table 3-1 - A quick reference summary of monitoring and management obligations to be carried out

<table>
<thead>
<tr>
<th>Monitoring requirements</th>
<th>Frequency</th>
<th>Summary of Monitoring/Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water quality (discharge and receiving waters)</td>
<td>Daily before release&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Confirm turbidity meets trigger levels or apply trigger actions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Make observations and records of turbidity occurrence if more than 50m distant from seaward side of seawall</td>
</tr>
<tr>
<td></td>
<td>Weekly - monthly&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Quality of surface waters within closed Pit to be discharged and upon discharge in the receiving waters</td>
</tr>
<tr>
<td></td>
<td>Annual (post wet season)</td>
<td>Marine nutrients and collect water samples for metal analysis at specified monitoring sites</td>
</tr>
<tr>
<td>Habitat</td>
<td>Every two months&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Measure coral health and BPP cover at sites near seawall works and compare with reference sites (if triggered by Table 3-3)</td>
</tr>
<tr>
<td></td>
<td>Annual (post wet season)</td>
<td>Measure coral health and cover at monitoring sites around the Island</td>
</tr>
<tr>
<td>Marine sediment</td>
<td>Every 3 years</td>
<td>Collect sediment samples for analysis</td>
</tr>
<tr>
<td>Invasive pests</td>
<td>Every 3 years</td>
<td>Deploy (and collect after 3 to 6 months) pest collectors</td>
</tr>
</tbody>
</table>

Management actions

| Water quality (discharge and receiving waters) | Daily | Trigger actions are given in Table 3-3. |
| Wildlife | July – September | Vessels must travel at < 10 knots around Koolan Island and < 14 knots through cetacean migration pathways |
| Spill response | All times | Staff inductions to prevent human interactions with wildlife |
|  |  | Relocate crocodiles where animals pose threats and safe to do so |
| Reporting | Annual/4 years | Annual report to DWER, revise this MMP within one year and every four years |

<sup>a</sup> Appendix D has details
3.1 **Environmental Quality Criteria Specifically for Seawall Rebuild and Pit Dewatering**

Section 2 described potential impacts and recommended indicators of potential indirect impacts outside the infrastructure footprint to be water quality criteria (as turbidity or TSS) which, if exceeded, would trigger habitat monitoring after a period of time.

**Figure 4** shows the location of the closest mapped BPPH that may be susceptible to effects of changes to water quality. As the seawall re-build occurs by placement of engineered fill, turbidity and suspended sediments may egress from the breach in the seawall as tidal movements naturally occur. The nearest mapped sensitive BPPH are corals at Site C1 in Arbitration Cove approximately 100m south-east from the seawall. These corals and benthic habitat parameters are monitored annually.

During the build of Aztec/KIO Arbitration Cove seawall, no evidence arose of indirect effects on benthic habitat (as described in KIO’s Section 45C application, 2016). Given the shorter duration and lesser tonnages of fill to be emplaced into the seawall breach (with no natural or benthic habitat value), it is reasonable to interpret a very low likelihood of impact or effect from suspended sediments emitted from the breach causing smothering of benthos in The Canal. To check that status, water quality will be monitored and, if required based on triggers being exceeded, corals and other benthos comprising BPPH will also be assessed. To validate this, monitoring will be conducted at Site C1 during the engineered section’s re-build (Phase 1).

![Figure 3: Site C1 for Water Quality Monitoring over Nearest BPPH during Capital Seawall Civil Works. Base figures shows locations of long term and ongoing annual monitoring sites.](image-url)
During Phase 1 (civil works), daily observations of turbidity in the water column would be made by either:

- visual records and photographs of turbid plumes; and/or
- water quality spot testing; or
- moored routinely logging nephelometer.

For the seawall reconstruction (Phase 1) period, the effects evident at Site C1 would be compared to ambient conditions at reference sites including Mangrove Inlet (at wharf or barge landing) and/or Jap Bay.

For the Pit dewatering phases (Phase 2 and 3 in Tables 3-2 and 3-3), direct discharge from the pit to the discharge zone (i.e. not via the existing settlement pond diffuser) would be monitored at the closest hard coral sites to the discharge zone. Water quality at the hard coral locations would be compared to the conditions at the reference site SOUTHREF. Water quality submersible dataloggers (SDLs) will be installed at SOUTHREF and each of the hard coral locations (x2) to the north and south of the proposed dewatering discharge zone. Loggers will record temperature, depth, salinity, turbidity and dissolved oxygen at half hourly intervals. The loggers will be placed below the low tide mark at the level of live hard coral (receptors) to ensure measurements are directly relevant to protection of these receptors and their habitats.

Should turbidity effects be elevated and extended in time (i.e. greater than five consecutive days), then more spatially extensive measurements will be made as will measurements of BPPH health. Trigger levels and trigger actions (according to EAG17) are presented in Table 3-2.
FIGURE 4: ARRANGEMENT OF SITES FOR WATER QUALITY MONITORING IN RELATION TO NEAREST BPPH (GREEN) DURING PIT DewaterING
FIGURE 4 (INSET): ZOOM-IN: ARRANGEMENT OF SITES FOR WATER QUALITY MONITORING IN RELATION TO RELEASE FROM THE OCEAN DIFFUSER. THE LEPA

As shown in Figure 4 (INSET), pit dewatering releases would be made into the direct discharge zone, seaward of the built face of the re-instated Seawall, and/or the Diffuser discharge zone shown as the Lowe Ecological Protection Area (LEPA). The circumstances for commencing and continuing discharges are summarised in Flow Charts below. It is highly likely that discharges through the two release zones would NOT happen concurrently because of the single source of water. Note that DIFF-A and DIFF-B monitoring sites sit within the strip of mapped hard corals on the LEPA boundary.

These Flow Charts present the content of Tables 3-2, 3-3 and 3-4 for each of the monitored elements within Figure 4
FLOW CHART SUMMARY OF PLAN ELEMENTS – DIRECT RELEASE

Steps in Check, Release, Monitor, Act

Offtake water from less than 5 m below pit lake surface

Fig 4

Monitor release water (DO, Temp, Turbidity, Salinity) at in-line chamber after manifold on seawall; use SDL with at 30min intervals

Make direct release at single floating moored surface outlet at average of up to 1600L/s

Use SDLs for continuous logging (30 min intervals) all parameters at receiving waters sites; Near-coral (i) NC-2; ii) SC-1 versus iii) SOUTHREP

Check using Table 3-2

if compliant, continue operations

Comments on key matters

Offtake at average of 1600L/s dependent on rate of rockbolting and shotcrete at existing footwall

Daily examination for suitability of pit lake quality with in-house “lock up” mixing tables.

Set alerts for ‘extreme’ water quality characteristics at intake

Release mixed by outlet spread onto sea surface. Direct release into zone mapped as “Moderate level of Ecological Protection”

All SDLs set at depth and amongst live hard corals; remote deployed; telemetered.

Compare daily data sets for compliance checks (two test sites vs reference). Use other comparisons for verification

Assess data against triggers and warehouse recorded data

Act using Table 3-3

If trigger not met
Reduce release rate at outfall

Act using Table 3-4

If trigger not met
Monitor condition of corals at three sites

If trigger not met
Cease release at outfall

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FLOW CHART SUMMARY – LICENSED DIFFUSER RELEASE

Steps in Check, Release, Monitor, Act

Offtake from less than 5 m below pit lake surface

Monitor release water (DO, Temp, Turbidity, Salinity) at Settlement Pond at 30min intervals over every 24 hours

Make release via licensed ocean diffuser

Use SDLs for continuous logging (30 min intervals) all parameters at receiving water sites; within edge of LEPA

(i) DIFF A; (ii) DIFF B versus iii) SOUTHREF

Check using Table 3-2
If compliant, continue operations

Comments on key matters
Offtake and retention via Settlement Pond, particularly when Pit waters do not meet triggers for direct release into Moderate Ecological Protection area in The Canal.

Daily (24hr) examination for suitability of Settlement Pond release to Diffuser.

Set alerts for ‘extreme’ water quality characteristics at intake

Waters mixed upwards by diffuser port outlets at seabed. Release into zone mapped as “Low level of Ecological Protection”.

All SDLs set at depth of hard coral habitat at LEPA boundary; remote deployed & telemetered.

Compare daily data sets for compliance checks (two test sites vs reference). Use other comparisons for verification.

Assess data against triggers and warehouse recorded data.

Act using Table 3-3

If trigger not met
Reduce release rate at outfall
(increase retention time)

If trigger not met
Re-use waters on site

If trigger not met
Cease release at diffuser

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Table 3-2 - Water quality monitoring parameters which, if exceeded, triggers a management response

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Trigger Levels at Test Sites (refer Figures 3 &amp; 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phase 1</strong> - Water Quality associated with Seawall Section Re-build (Figure 3)</td>
<td>Median turbidity at site C1 &gt; 90(^{th}) percentile(^{\wedge}) at reference data for more than five consecutive days and also exceeds 4NTU</td>
</tr>
<tr>
<td><strong>Turbidity</strong></td>
<td>Note: Seawall breach rebuilding was complete as of March 2018</td>
</tr>
</tbody>
</table>

**Phase 2** - Water Quality of Direct Release of waters for Pit Dewatering (Figure 4)

- **Turbidity**
  - On days of discharge, daily median turbidity at NC-2\(^{\theta}\) or SC-1\(^{\theta}\) > 95\(^{th}\) percentile\(^{\wedge}\) at the reference site SOUTHREF\(^{2}\) and, also exceeds 4NTU
- **Salinity**
  - Daily median salinity at NC-2\(^{\theta}\) or SC-1\(^{\theta}\) > 95\(^{th}\) percentile\(^{\wedge}\) or < 5\(^{th}\) percentile\(^{\wedge}\) at the reference site SOUTHREF\(^{2}\)
- **Temperature**
  - Daily median temperature at NC-2\(^{\theta}\) or SC-1\(^{\theta}\) > 95\(^{th}\) percentile\(^{\wedge}\) or < 5\(^{th}\) percentile\(^{\wedge}\) at the reference site SOUTHREF\(^{2}\)
- **Dissolved oxygen**
  - Daily median dissolved oxygen at NC-2\(^{\theta}\) or SC-1\(^{\theta}\) < 80% saturation

**Phase 3** - Water Quality of Pit Dewatering Release via Settlement Pond and Diffuser (Figure 4)

- **Turbidity**
  - On discharge days, daily median turbidity exceeds 6NTU at S1 pond offtake
- **Salinity**
  - Daily median salinity\(^{\wedge}\) at DIFF-A\(^{\theta}\) or DIFF-B\(^{\theta}\) > 95\(^{th}\) percentile\(^{\wedge}\) or < 5\(^{th}\) percentile\(^{\wedge}\) at SOUTHREF reference site\(^{2}\)
- **Temperature**
  - Daily median temperature at DIFF-A\(^{\theta}\) or DIFF-B\(^{\theta}\) > 95\(^{th}\) percentile\(^{\wedge}\) or < 5\(^{th}\) percentile\(^{\wedge}\) at SOUTHREF reference site
- **Dissolved oxygen**
  - Daily median dissolved oxygen at DIFF-A\(^{\theta}\) or DIFF-B\(^{\theta}\) < 90% saturation

\(\wedge\) Because of directional flow past monitoring sites, the periods of comparison will be on flood / run-in tides at SC-1 and DIFF-B OR runout (ebb) tides for NC-2 and DIFF-A. Data at each site will be monitored with remotely-deployed submersible dataloggers (SDLs).

\(^{2}\) The higher value of either the previous tidal cycle (neaps to spring) or the current three days of half hourly logger readings at site SOUTHREF. This approach allows comparison to the more recent recent effector of ambient water quality of either long-term variability or short-term weather/tidally induced conditions.

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Plate 1: KOOLAN ISLAND MAIN PIT WATER SURFACE 16/01/16

Table 3-3 – Management responses to exceeding Triggers stipulated in Table 3-2

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Trigger Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phase 1: Water Quality associated with Seawall Re-build</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Engineered fill will be released from land and sea onto the sea surface on existing disturbed seawall footprint | - Within two weeks, conduct a monitoring event on runout tide in receiving waters to examine where the zone of influence occurs (ie ambient turbidity > 90th%ile) radiating seaward of the works into The Canal.  
- If trigger continues or re-occurs within three weeks, repeat monitoring monthly and conduct BPPH monitoring event within two weeks of the trigger exceeded a second time.  
- If trigger continues or re-occurs within three weeks, conduct a round of BPPH monitoring by video within two weeks. Do an interpretive analysis for coral health at Site C1 / Zone 2 and another reference zone (Z1, Z3 or Z4) in Figure 5 and compare BPP to baseline.  
- If by CPCe analysis a reduction in BPP cover and/or increase in sediment greater than 20% occurs, change the construction sequence of seawall works to reduce sediments emitted from breach area including by changing works in certain tidal conditions &/or use sediment containment measures (bunds and curtains).  
- Should trigger events re-occur, do follow up BPP monitoring every two months during period and at completion of work.

*Note: The seawall breach re-build was complete as of March 2018*

| **Phase 2: Water Quality associated with Direct Release during Pit Dewatering** |
| **Moored outlet would be installed in The Canal beyond 100 metres from mapped BPPH (see Figure 4)** |
| If a trigger is met (and for turbidity >4NTU but <6NTU) | - i) Examine vertical profiling in Main Pit water quality and vary intake of waters accordingly for likely compliant emissions at the NC-2 or SC-1 monitoring sites as indicated by MGX in-house dilution modelling |

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- ii) Within a week, compare monitoring results from the nearest hard coral sites NC-2 or SC-1 are within reference conditions at site SOUTHREF (see Table 3-2 and footnote). If so, continue operations;
- If (ii) not met:
  o reduce release rate at direct outfall; and/or
  o direct waters to the settlement pond prior to release via the ocean diffuser, or
  o cease discharge until water quality trigger is met and re-commence release if coral condition at Arbitration Cove meets Plan.

If a trigger is met (and for turbidity >6NTU) - iii) Pump waters with quality in excess of 6 NTU to settlement pond to meet trigger prior to release via the ocean diffuser, and/or
- Use turbid waters for dust suppression around built infrastructure (eg crusher / ROM) and/or WRLs (at least 50m from native vegetation because of salts);

---

Phase 3: Water Quality associated with Pit Dewatering Release via Settlement Pond and Ocean Diffuser

**Approaching trigger to be met:**
- i) During releases that approach trigger, conduct a monitor of receiving waters condition from diffuser (DIFF-A or DIFF-B) to confirm water quality within acceptable conditions (Table 3-2) beyond LEPA boundary (Figure 4).
- Return water from settlement pond to Main Pit for containment; or
- Use turbid waters in pond for dust suppression around built infrastructure and/or WRLs (at least 50m from native vegetation because of salts);
- Subject to i) above, within two days of exceeding trigger, conduct a trial release for six hours with monitoring in receiving waters examining ambient turbidity at DIFF-A and DIFF-B. If median within reference range (<95%ile) at SOUTHREF (see Table 3-2 and footnote), continue release via outfall and continue monitoring; or
- Cease release of waters from pond to the ocean via diffuser until trigger is met with increased holding time in pond.
Plate 2: KOOLAN ISLAND MAIN PIT >20M DEPTH 16/01/16 – Footwall inspection survey photograph –noting minor re-suspension of settled silts and algae as ROV hits bed of pit.

The stipulated trigger levels, management and monitoring will provide adequate opportunity for monitoring feedback for adaptive management of potential off site and/or permanent effects. Given the limited period, sediment avoidance / treatments and relatively low levels of emissions from seawall and dewatering works (in the order of 6 to 8 months), it is very unlikely that ecological effects would arise from occasional or low level turbidity/suspended solids (<6NTU). Should triggers be exceeded, BPP monitoring would commence and intensify in space and time as a result of ‘triggered’ water quality conditions. This would enable assessment of the following threshold level and action (Table 3-4) to be applied, irrespective of the source or phase of turbidity/suspended solids emission:

Table 3-4 - Thresholds which, if exceeded, and Table 3-3 triggers activated indicate non-conformance

<table>
<thead>
<tr>
<th>Threshold Parameter</th>
<th>Threshold Action (refer Figure 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seawall Re-build; Direct Release of Pit Dewatering; and, Pit Dewatering Release via Sediment Pond and Diffuser</td>
<td></td>
</tr>
<tr>
<td><strong>BPP cover</strong></td>
<td>Reduction of more than twenty percent of the mapped live Hard Coral in Zone 2 (Figure 5)</td>
</tr>
<tr>
<td><strong>Parameter</strong></td>
<td><strong>Threshold Action</strong></td>
</tr>
<tr>
<td><strong>BPP cover</strong></td>
<td>Apply rehabilitation according to Section 3.6; offset any significant reduction in area of live Hard Coral</td>
</tr>
</tbody>
</table>

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Figure 5: Benthic habitat types and monitoring zones (Hydrobiology, 2015). Note ADCP was moored until Mar 2015 and recovered.
3.2 **Basis of Environmental Quality Framework**

*Level of protection*

The Koolan Island MMP follows the original guidelines set by the Environmental Protection Authority (EPA) Environmental Quality Management Framework for the marine waters of Western Australia and the requirements of MS715. Therefore, the project must adhere to the original EPA Environmental Quality Criteria (EQC) for marine conservation. This is consistent with the National Water Quality Management System and the Western Australian State Water Quality Management Strategy. In Version 16 of this MMP, the following figure was adopted for use:

![Map of Koolan Island showing zones of environmental protection](image)

*Figure 6 - Map of Koolan Island showing zones of environmental protection (blue – HIGH level of protection, yellow – MODERATE level, red – LOW level), and monitoring sites (solid circles). Also displayed is the location of the diffuser outlet, wharf and settlement ponds.*

Waters surrounding Koolan Island are in a natural condition and typically the majority warrant a high level of protection (*Table 3-5; Figure 6* beyond the marked yellow and red areas). However, much of the southern shoreline of Koolan Island adjacent to the project infrastructure has been modified by past mining activities; when combined with mixing and hydrodynamic characteristics of the area, some level of environmental modification has occurred within some zones. A zone seaward of the low tide mark adjacent to the seawall at Arbitration Cove is assigned a moderate level of protection (shown as yellow in Figure 6) and the mixing zone around the Main Pit dewatering discharge (current DER licence L8148/2006/4 defines this area as 150m either side of the diffuser and 100m wide) is an area of low protection (shown as red in *Figure 4*). Note that the monitoring sites in *Figures 3 and 4* falls within the Moderate Level of Protection zone in *Figure 4*. 
Table 3-5: Levels of ecological protection for the maintenance of ecosystem integrity defined by the original EPA Environmental Quality Criteria and the earlier versions of the MMP

<table>
<thead>
<tr>
<th>Level of Protection</th>
<th>Environmental Quality Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contamination</td>
</tr>
<tr>
<td>High (blue)</td>
<td>Very low level of contaminants</td>
</tr>
<tr>
<td>Moderate (yellow)</td>
<td>There may be elevated levels of contaminants</td>
</tr>
<tr>
<td>Low (red)</td>
<td>There may be high levels of contaminants</td>
</tr>
</tbody>
</table>

In the Port of Yampi Sound Security Regulated Port boundary, benthic primary producer habitat (hard coral) loss and impact monitoring will be based on a cumulative threshold consistent with Category E described as 'Development Areas' in *Environmental Assessment Guideline No. 3* (EPA, 2009). Category D 'Non designated Areas' would apply elsewhere in Port of Yampi Sound. Reef slope coral is the principal benthic primary producer habitat (BPPH) that was impacted by development as approved by MS715 or that may be affected indirectly by the approved proposal into the future. Note that the waters surrounding Koolan Island have not been included and are not being considered for inclusion in the WA government’s Kimberley marine reserve system. In accordance with the proposal approved by MS715, the loss of coral habitat must be kept within that predicted within the Environmental Referral Document (*Ecologia* 2005).

As the EQC relates to the loss of hard coral habitat, trigger criteria that this EQC has been breached will be taken to be where, outside of the development footprint approved under MS715:

- There has been any apparent significant change in composition or health of benthic communities (hard corals) at any test site since the previous survey;
- Evidence of broken corals not observed in previous surveys;
- Bleaching or abnormal sediment deposition on corals;

The following illustration summarises the process to be applied to determine the cause of the apparent exceedance.
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- Monitoring habitat – routine or in response to water quality trigger

  - Observed live coral less than at designated reference sites in the same survey
    - No action
    - YES
      - Compare to baseline and other previous surveys
        - NO
          - Continue annual surveys
        - YES
          - Visible decline relative to baseline and previous
            - NO
              - Implement investigation program and develop management program
                - Liaise with EPA, DPAW and DER on program as necessary
            - YES
              - Examine spatial pattern of decline and develop program to investigate causation

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3.2.1 Monitoring Results to inform Decision making

Dewatering from Main Pit is to be released to the marine environment either directly or after treatment; thus, the quality of discharge water must be monitored and managed. Water is directed from the Main Pit to a settlement pond where suspended solids settle out prior to discharge. The settlement pond / sedimentation basin reduces turbidity and suspended solids prior to discharge into the marine environment. The pond has been lined with 250mm compacted clay/siltstone with an engineered permeability of $< 10^{-8}$ m/s, and a high density poly-ethylene (HDPE) plastic. Water from the pond is decanted into an outflow pipe and then gravity fed to the diffuser outlet 70 m offshore. The settlement pond is designed to provide a minimum 40 hour retention period and a minimum 98% reduction in suspended solids. This treated water is then discharged into the ocean through a diffuser outlet outside the pit on the sea floor. This action is also regulated by DWER through Environment Protection Licence 8148.

During dewatering, monitoring will also be conducted as per the requirements in DWER Licence L8148. The triggers established by this MMP shall be applied to monitor performance beforehand and at all times. Further contingency actions may include adding a filtration system to the discharge circuit or the recycling of dewatering discharge until quality attains acceptable levels. Action may also include the initiation of a dedicated monitoring event for habitat/coral community health.

In the past, a review of the discharge water quality indicated that there were no months where the average TSS exceeded the 20 mg/L level (Figure 7) (equivalent to less than 7NTU), showing that there have been no prolonged events of poor water quality. Although there have been single instances where the suspended solids results from the discharge have exceeded this level, these occurrences have and will continue to be managed as per conditions of L8148.

![Figure 7](image.png)

Figure 7 - Plot of Monthly Average TSS measured in the settlement pond (black dots, solid line); dotted line represents original L8148 reporting limit for treated emissions

As an indication of past ambient conditions, the following graphs show the range for water quality data at long term monitoring sites. If needed, these datasets which have been pooled (as graphed) may be disaggregated to consider effects, such as time of year, stage of tide and water column depth. However, the primary means of determining triggers during the time of
dewatering will be to compare to reference data collected contemporarily from control monitoring sites.

**Figure 8** - Box plots (20th and 80th percentiles) of in situ measured temperature (°C) recorded at southern and northern sites during Wet and Dry seasons, including the Seasonal aggregate accounting for all grouped data. 2006-2014

**Figure 9** - Box plots (20th and 80th percentiles) of in situ measured salinity (PSU) recorded at southern and northern sites during Wet and Dry seasons, including the Seasonal aggregate accounting for all grouped data. 2006-2014
Figure 10 - Box plots (20th and 80th percentiles) of in situ measured dissolved oxygen (% saturation) recorded at southern and northern sites during wet and dry, including a seasonal aggregate accounting for all grouped data. 2006-2014. There is no upper guideline defined in ANZECC/ARMCANZ (2000)

Figure 11. Box plots (20th and 80th percentiles) of in situ measured turbidity (NTU) recorded at southern and northern all and reference sites during wet and dry seasons, including a seasonal aggregate accounting for all grouped data. 2006-2014. The upper guideline defined in ANZECC/ARMCANZ (2000) for turbidity is 20 NTU, outside the bounds of the presented axis scale.
Figure 12 - Box plots (20th and 80th percentiles) of in situ measured pH (pH unit) recorded at southern and northern sites during wet and dry seasons, including a seasonal aggregate accounting for all grouped data. 2006-2014

3.3 THREE YEARLY SAMPLING, TESTING AND REPORTING OF SEDIMENT QUALITY AND INVASIVE PESTS

The monitoring and testing of these three-yearly programs are not anticipated to be required during the Stage 1- re-construction and capital dewatering unless there is an unforeseen event.

Since the baseline survey, sediment monitoring has been, and will continue to be, undertaken at three year intervals as sediment quality would change very slowly, unless impacted by major spills where contaminants settle. Where such spillage occurs and it is determined that it is necessary, a sediment survey will be undertaken within 2 months of the spillage and the results will be reported to agencies within a further two months on the outcomes of that monitoring. A dedicated sediment survey may also be triggered by exceedance of water quality EQC. The requirement for this will be determined on a case by case basis.

There is a risk of invasion by introduced pests but pests are likely to take time to become established to a level that can be detected by sampling. Therefore, monitoring for marine pests will be undertaken every three years alongside the sediment monitoring program.

3.3.1 Sediment Monitoring

Potential impacts

Potential impacts resulting from shiploading, discharge of sediment in dewatering and runoff include:

- increased sedimentation during operation and pit-dewatering, including potential for mobilisation of certain naturally occurring elements
- disturbance and resuspension of sediment from ship movements
- ship antifouling residues accumulated in sediments
- spillage of ore, materials or fuel

Monitoring design
Sediment monitoring will be undertaken at the three southern sites; Arbitration Cove, Wharf, and Southern Reference (Appendix C). Sediment will also be monitored at one northern site at Mullet Bay as the baseline survey highlighted some heavy metal enrichment in this area. Samples will be collected in pairs (approximately 1 to 5m apart) at five subsites within each site. The calculation of trigger values will take into consideration the distribution of replicates (see Appendix B).

**Monitoring parameters**

Sediments at each of the test and reference sites will be sampled for each of these parameters and the agreed screening (trigger) levels:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Statistic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium</td>
<td>Median</td>
<td>&gt;80th percentile of reference sites</td>
</tr>
<tr>
<td>Arsenic</td>
<td>Median</td>
<td>&gt;2 mg/kg dry weight</td>
</tr>
<tr>
<td>Antimony</td>
<td>Median</td>
<td>&gt;20 mg/kg dry weight</td>
</tr>
<tr>
<td>Cadmium</td>
<td>Median</td>
<td>&gt;1.5 mg/kg dry weight</td>
</tr>
<tr>
<td>Chromium</td>
<td>Median</td>
<td>&gt;80 mg/kg dry weight</td>
</tr>
<tr>
<td>Copper</td>
<td>Median</td>
<td>&gt;65 mg/kg dry weight</td>
</tr>
<tr>
<td>Iron</td>
<td>Median</td>
<td>&gt;2 x mean of reference site</td>
</tr>
<tr>
<td>Lead</td>
<td>Median</td>
<td>&gt;50 mg/kg dry weight</td>
</tr>
<tr>
<td>Nickel</td>
<td>Median</td>
<td>&gt;21 mg/kg dry weight</td>
</tr>
<tr>
<td>Zinc</td>
<td>Median</td>
<td>&gt;200 mg/kg dry weight</td>
</tr>
<tr>
<td>Tributytin</td>
<td>Median</td>
<td>&gt;9 ug Sn/kg dry weight</td>
</tr>
<tr>
<td>TRH</td>
<td>Median</td>
<td>&gt;550 mg/kg dry weight</td>
</tr>
</tbody>
</table>

Sediment samples will be obtained from a boat using a hand-operated 2.4L stainless steel Petite Ponar Grab Sampler. For detailed methodology see Appendix B.

**Management**

If a trigger is exceeded, MGX will liaise with DWER to determine a course of action. The first action will be characterise the extent of any elevated parameter in surficial sediments but conducting further sampling and testing within 3 months of the event that determined the trigger.

### 3.3.2 Introduced Marine Pests

**Potential impact**

Introduced marine organisms may compete with, predate on, or parasitise native flora and fauna, disrupting the local ecosystem and potentially spreading to other Australian ports. Within the Buccaneer Archipelago, introduced marine pests may also pose a significant threat to the local fishing and aquaculture industries.

**Monitoring design**

Monitoring for the presence of marine pests will be carried out at the sites frequented by shipping, and thus, are most likely to become invaded. These sites are Arbitration Cove and Wharf. Marine pests will be monitored through the deployment of collectors for three months.
Marine pest collectors will be deployed in pairs, with one collector in the intertidal zone and one at around 10m depth. Collectors will be deployed on a 3-yearly basis.

**Monitoring parameters**

Collectors are designed according to CSIRO standards, and consist of four 150mm x 150mm x 4mm PVC tiles for sessile invertebrate recruitment and two 200mm x 200mm sections of “Astroturf” material for mobile invertebrate recruitment. Invertebrates removed from the collectors after the deployment period will be preserved and identified by specialists. The results of taxonomic assessments of the plants and animals collected will be compared with the 2005/6 baseline.

**Management**

The risk of introduction of marine pests on vessels used during construction was evaluated on the basis of the origin of those vessels. Where vessels originated outside Australia, hull inspections were required. Where vessels were from within Australia, the location of vessels within the past 12 months was evaluated to determine whether a hull inspection was required. If any exotic marine organisms, especially those on the ‘international target species list’, were identified at any time, the WA Department of Fisheries was notified. There were no known occurrences of this during construction and, as construction has been completed, this management measure is no longer implemented.

### 3.4 WILDLIFE

Humpback whales (*Megaptera novaeangliae*) migrate between summer polar feeding grounds and winter tropical breeding grounds each year (Dawbin 1966). Whales travel through the Kimberley area between late July and early September. Whales and calves spend time in northern waters between mid-August to mid-September, resting in Camden Sound before heading south. A number of whale sightings from boat based surveys have been made around Koolan Island (Jenner *et al.* 2001).

There is little information regarding dugong distribution and abundance in the Kimberley area. There are no published records of turtles from Koolan Island; however, marine turtles, particularly flatbacks (*Natator depressus*), are known to reside in nearby coastal areas. Both dugong and turtle usage of the area immediately surrounding the mine site is likely to be by transient animals. Saltwater crocodiles (*Crocodylus porosus*) are relatively common in the nearshore waters of the western Kimberley. Several crocodiles have been observed around the Koolan Island mining development.

Potential impacts on marine wildlife falls into four categories; noise, vessel interactions, human interactions and turbidity:

- Noise levels generated during pile installation during re-instatement of the seawall or during mine site operations (ship loading, vessel movement, mine and crusher plant operations) has potential to disturb or displace marine wildlife;
- Noise emissions may occur during piling. Such an activity, if required, would be very limited in time and there is no mitigation needed to be applied outside of the peak of whale migration period (July to September annually);
- The movement of bulk container ships through cetacean migratory pathways, and breeding and resting areas of marine fauna may interrupt natural habits and pose a risk of vessel strike;
- Increased turbidity from earthwork, and water discharge may disrupt fauna habits, reduce visibility and possibly cause algal and benthic habitat effects.

**Noise**

On the basis that The Canal area appears to be of little primary importance to whales, dugong or turtles, there is unlikely to be a risk of impact from noise sufficient to require monitoring. Anecdotal evidence and observations from visitors to the Island suggest that whale numbers around the Island have not declined over the life of the mine. Shipping noise may disturb humpback whales, where bulk carriers pass through the migratory path of the whales, however, since mining commenced there has been no evidence to suggest this is the case. Whales are observed frequently around nearby Cockatoo Island, sometimes with calves, where blasting is a daily occurrence at some times of the year. There are no studies on the effects of blasting noise on dugongs or turtles that may occupy waters of The Canal. However, blasting noise is unlikely to disturb turtles as there is no evidence of nesting on the limited areas of beach on Koolan Island. Lengthy piling campaigns (weeks to months in duration) may potentially effect megafauna and their habits including their occurrence in nearby waters.

Should piling be required into the seabed (below high water datum) or the ground (within twenty linear metres of high tide datum), a management procedure will be developed in consultation with EPA and applied for the duration of the piling works.

**Vessel Strikes**

The movement of bulk container ships through migratory pathways, and potentially through breeding and resting areas of humpback whales poses the risk of vessel strike. Since vessels operating in the immediate vicinity of Koolan will be infrequent (generally four or less per month) and generally slow-moving (less than 10 knots in the vicinity of the Island) there is little chance of vessel strike on whales. Further from the Island, inbound and outbound iron ore carriers will be requested to avoid whale calving areas and restrict ship speeds to less than 14 knots while passing through the known migratory pathways during peak migration periods.

**Human Interaction**

Inductions will include a section on the *Wildlife Conservation Act* and Regulations and the workforce will receive instruction to avoid direct human-wildlife interaction. The primary aim of the management plan will be to reduce human-crocodile interaction, so that these fauna do not pose a risk to human safety, without the need to trap or destroy crocodiles. Inductions will provide information directing people away from situations where crocodile attack is likely and firearms will be prohibited on the mine site. When approach to operational areas occurs crocodiles will be relocated to the channel by trained MGI environmental staff.

**Turbidity**

An increase in turbidity in the marine environment may occur as a result of mining earthwork, clearing of vegetation and water discharge. The main potential impact of increased turbidity on marine vertebrates is through the reduction of light penetration, which could disrupt natural behavioural patterns. Severe increases in turbidity, coupled with nutrient input, can also cause blooms of toxic algae. Through monitoring of turbidity and water quality (see above), significant degradation will be detected and the aim will be to keep TSS below 20mg/L. Sediment and
drainage controls have been put in place to reduce discharge into the marine environment, therefore increased turbidity around Koolan Island is unlikely to impact on marine vertebrate behaviour.

3.5 **EMERGENCY SPILL MANAGEMENT**

*Potential impact*

Spillage of liquids or solids into the environment may occur and can impact marine condition. In the event of a spill, emergency management will be required. The most likely spillages are:

- Hydrocarbons spilt during fuel or waste oil transfer to and from barges
- Loss of containment of hydrocarbons from vessels (e.g. tugs, bulk carriers)
- Loss of containment of hydrocarbons from fuel storage or plant on land

*Management*

The Koolan Island Emergency and Crisis Management Plan is the current standard for response to environmental incidents, including marine spills. Spill response and contingency plans will be maintained and reviewed as required and training exercises will be carried out with the relevant employees.

Hydrocarbon spill procedures (including operational and contingency standards) and equipment are to be in place at all times for land and marine based spills. A vessel must be retained on-site to deploy booms or other containment devices for minor spills. The marine contractor responsible for incoming vessel operations is required to carry oil spill response equipment on board all vessels used.

The operation will maintain a register of staff with appropriate spill response training including the use of spill containment and clean-up equipment. The Emergency Response Team will be sent to training courses, such as those run by WA DPI as it is required or deemed necessary. When it is deemed necessary, the entire team will undertake an internal drill exercise which will simulate a potential scenario or incident, such as a small spill and clean-up in the marine environment. As required, a simulation exercise will be conducted under the supervision of WA DPI or regional ports, if these authorities express an interest in being involved.

3.6 **REHABILITATION PLAN**

If significant reductions in water and sediment quality are detected, those impacts will be investigated and assessed with a view to implementing measures which will return the water quality to acceptable levels (below trigger values). If coral communities become impacted while there is no detectable decline in water quality, it may be necessary to revise the water quality and sediment trigger values to prevent further deterioration; this will be determined on a case by case basis. Where exotic species are detected, action must be taken to minimise the impacts of invasive marine species. The area may be quarantined to prevent further spread and an eradication program may be implemented.

At the finalisation of the project, monitoring will continue for two years (one annual sample each year for water quality and coral habitat, plus a once off sediment and invasive pest sample). This information will be compared with baseline data collected in 2005. Where a significant difference in environmental quality is detected, restoration efforts will be
investigated and undertaken as deemed necessary. The aim will be to return water and sediment quality to a natural state with time, and a revised monitoring program may be required to ensure this occurs. If degradation of coral has occurred, these populations should be monitored under a suitably designed monitoring program. Where improvement does not occur, MGI may attempt to re-establish coral through a transplant and recovery program, or by some other reasonable offset means.

The results of past regular monitoring indicate that rehabilitation plan implementation will not be required.

As approval conditions against the mining tenements, KIO lodges a Mine Closure Plan (MCP) for the approval of Department of Mines, Industry Regulation and Safety (DMIRS). Version 4 of the Plan was approved by the Department in April 2017 (Reg ID 56401), with the next revision of the MCP to be lodged with DMIRS in 2019.

3.7 REPORTING AND REVIEW

Monitoring and observational data collected under this marine management plan will be provided annually to the DWER. An Annual Environmental Report (AER) will be prepared and submitted to the Department by 31st July each year. This report will be developed in accordance with the auditing requirements of Statement 715 and DWER’s post-assessment guideline for Compliance Assessment Reports.

Reporting of Thresholds

Meeting and exceeding the threshold(s) in Table 3-4 would be reported to DWER within 7 days of its determination. Any such report would characterise the change in the stated parameters and outline the timing for the management actions to be adopted and implemented.

Review of the Plan

This Marine Management Plan will be reviewed every four years, as required by Ministerial Statement 715, and because of Stage 2 – Project Re-implementation will be reviewed within one year of approval of this plan version. This revision will take into account the analyses of trends in the data and will include an assessment of the management plan’s relevance to the current operations:

- A revision of the effectiveness in meeting the environmental objective (Ministerial Statement 715)
- Recommendations for changes to be made in response to significant changes in the operation and operational risk profile

A review record including summary of changes must be incorporated into the management plan and updated with each review. The latest approved revision of the Marine Management Plan will be made publicly available on the Mount Gibson Iron Limited website.

Significant environmental incidents with potential to damage the environment will be reported as soon as practical to DWER in accordance with the regulations under the Environmental Protection Act and Part V L8148, and stipulations of Statement 715.
4 RECOMMENDATIONS

The following alterations (Table 4-1) have been incorporated into the management plan since EPA approval of Version 19 and they have been retained in this version to increase the consistency, and thus effectiveness of the monitoring program.

Table 4-1 - Areas where the monitoring program could be improved, how it was fixed, and what this achieved

<table>
<thead>
<tr>
<th>Version</th>
<th>Monitoring Program Element</th>
<th>Issue</th>
<th>How it was fixed</th>
<th>What this achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>17-18 Water quality</td>
<td>Inefficient frequency of WQ sampling</td>
<td>WQ monitoring should be undertaken annually, post wet season</td>
<td>No loss of rigour, however the process is more efficient</td>
<td></td>
</tr>
<tr>
<td>17-18 Habitat</td>
<td>No quantitative measure of potential loss of coral cover</td>
<td>Take stills from video footage, overlay points and use CPCE to calculate percent cover</td>
<td>Remove observer bias, allow for comparison between sampling times</td>
<td></td>
</tr>
<tr>
<td>17-18 Rehabilitation Program</td>
<td>Non-existent</td>
<td>Devise a plan, detail in report, implement in case of incident</td>
<td>In case of incident, sites can be treated</td>
<td></td>
</tr>
<tr>
<td>19    Level of replication for routine operations; Assignment of BPPH categories</td>
<td>Too frequent/extensive monitoring for level of risk</td>
<td>Amendment to the sampling effort and replication</td>
<td>Alignment of sampling effort to potential marine effects</td>
<td></td>
</tr>
<tr>
<td>20 (this version) Re-implementation of seawall construction and Main Pit capital dewatering</td>
<td>Previous approved Plans did not describe management and monitoring of these aspects</td>
<td>Addition of mitigations and monitoring based on previous risk assessment. Adaption of EAG17 triggers and thresholds.</td>
<td>Make ready MMP for re-implementation of Proposal.</td>
<td></td>
</tr>
</tbody>
</table>
5 REFERENCES


National Assessment Guidelines for Dredging, Commonwealth of Australia, Canberra, 2009


6 APPENDIX A

Risk Assessment

Prior to revising the Koolan Island MMP a risk assessment was carried out to quantify the likelihood and severity of impacts (Table A3). Then a revised assessment was carried out based on a reduction in likelihood as a result of implementing control measures. Severity cannot be reduced as the impact remains the same and control measures only reduce the likelihood of it occurring. Risks are ranked as low, moderate, significant or extreme based on a combination of categorising consequence and likelihood. This has been done based on Table A1 and A2 as per MGX-HSEC-CP-PRO-005 Risk Management Procedure.

In areas where high and moderate ecological protection are stipulated (Figure 6) by the EPA, the risks must not exceed a moderate level. Thus in cases where the risk is categorised as high or extreme initially, management must reduce the frequency to a level that allows the rank to fall into the moderate or low categories.
### Table A1 – Consequence and Likelihood Matrix.

To be read in conjunction with Table A2.

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>1 Insignificant</th>
<th>2 Minor</th>
<th>3 Moderate</th>
<th>4 Major</th>
<th>5 Catastrophic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Almost Certain:</strong> to happen. (Expected to happen in most circumstances, e.g. once per week)</td>
<td>Green</td>
<td>Blue</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td><strong>Likely:</strong> To happen at some point. (Will probably occur in most circumstances. E.g. once per month)</td>
<td>Green</td>
<td>Blue</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td><strong>Possible:</strong> heard of it so it might happen. (Should occur at some time, e.g. once per year.)</td>
<td>Yellow</td>
<td>Green</td>
<td>Blue</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td><strong>Unlikely:</strong> Not likely to happen. (Could occur at some time e.g. once per ten years.)</td>
<td>Yellow</td>
<td>Green</td>
<td>Blue</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td><strong>Rare:</strong> Practically impossible. (e.g. greater than thirty years.)</td>
<td>Yellow</td>
<td>Green</td>
<td>Blue</td>
<td>Red</td>
<td>Red</td>
</tr>
</tbody>
</table>
### Table A2 – Risk Levels

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Priority</th>
<th>Example Risk Response Action</th>
<th>Authority for approving tolerance of risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme</td>
<td>1</td>
<td>Detailed research and planning required; determine whether activity or task should be stopped pending further investigation</td>
<td>Board</td>
</tr>
<tr>
<td>Significant</td>
<td>2</td>
<td>Senior management attention; immediate corrective and preventative action required</td>
<td>Chief Executive Officer</td>
</tr>
<tr>
<td>Moderate</td>
<td>3</td>
<td>Management responsibility assigned; corrective and preventative action plan developed</td>
<td>Executive and General Managers</td>
</tr>
<tr>
<td>Low</td>
<td>4</td>
<td>Manage by routine procedures; accept risk</td>
<td>Managers</td>
</tr>
</tbody>
</table>

**MGX Standard 4.11 Marine Management**

<table>
<thead>
<tr>
<th>MGX-HSEC-KI-XXX-XXX</th>
<th>Marine Management Plan</th>
<th>Date effective</th>
<th>Revision status</th>
<th>Set Review</th>
<th>Planned Review</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>04/04/2018</td>
<td>Ver 20</td>
<td>Yearly</td>
<td>30/12/2018</td>
<td>45</td>
</tr>
</tbody>
</table>

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Check the MGX Intranet for the latest version of this document.
Table A3 – Risk assessment for potential impacts of Koolan Island mining activities and revised assessment after implementation of management controls

<table>
<thead>
<tr>
<th>Potential Impact</th>
<th>Initial Assessment</th>
<th>Control Measures</th>
<th>Revised Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Consequence</td>
<td></td>
<td>Consequence</td>
</tr>
<tr>
<td></td>
<td>Likelihood</td>
<td></td>
<td>Likelihood</td>
</tr>
<tr>
<td></td>
<td>Rank</td>
<td></td>
<td>Rank</td>
</tr>
<tr>
<td>Decline in water quality</td>
<td>Moderate</td>
<td>Retention of discharge in settlement pond and daily monitoring for TSS</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Possible</td>
<td></td>
<td>Rare</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td></td>
<td>Moderate</td>
</tr>
<tr>
<td>Loss of coral</td>
<td>Moderate</td>
<td>Monitor WQ to detect increases before coral loss occurs</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Possible</td>
<td></td>
<td>Rare</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td></td>
<td>Moderate</td>
</tr>
<tr>
<td>Contamination of sediment</td>
<td>Moderate</td>
<td>Retention of discharge in settlement pond for contaminant reduction prior to release</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Possible</td>
<td></td>
<td>Rare</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td></td>
<td>Moderate</td>
</tr>
<tr>
<td>Pest invasion</td>
<td>Moderate</td>
<td>Monitor for presence</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Unlikely</td>
<td></td>
<td>Rare</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td></td>
<td>Moderate</td>
</tr>
<tr>
<td>Wildlife disturbance</td>
<td>Minor</td>
<td>Limit noise, vessel speed</td>
<td>Minor</td>
</tr>
<tr>
<td></td>
<td>Unlikely</td>
<td></td>
<td>Rare</td>
</tr>
<tr>
<td>Human-wildlife interaction</td>
<td>Minor</td>
<td>Induction and training, relocation of wildlife if necessary</td>
<td>Minor</td>
</tr>
<tr>
<td></td>
<td>Unlikely</td>
<td></td>
<td>Rare</td>
</tr>
<tr>
<td>Loss of other habitat species (NOTE little to no seagrass in area)</td>
<td>Insignificant</td>
<td>Monitor WQ to detect increases before loss occurs</td>
<td>Insignificant</td>
</tr>
<tr>
<td></td>
<td>Possible</td>
<td></td>
<td>Rare</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td></td>
<td>Low</td>
</tr>
</tbody>
</table>

MGX Standard 4.11 Marine Management
7 APPENDIX B – SAMPLING METHODS

This appendix presents detailed methods for the monitoring program. Measurements are taken from the respective sites, and in some cases this is broken down into zones (inner and outer) and depths. It would be inappropriate to combine inner and outer (distance from impact) samples, samples from different impact and reference sites, or data from different depths. Thus, the calculation of means for comparison to trigger values (and in some cases the calculation of trigger values) shall be broken into site, zone and depth categories where appropriate.

Water quality monitoring methodology

All impact and reference sites will be sampled in situ for turbidity, temperature, salinity, dissolved oxygen, metals and nutrients. Turbidity, temperature, dissolved oxygen and salinity will be recorded with a YSI 6820 (or equivalent) water quality sonde. In water less than 10 m, samples will be taken one metre from the surface and one metre from the bottom. In water greater than 10m, a mid layer sample will also be taken. The depth of each site will be measured using the depth sounder on the survey vessel. A graduated cable connected to the YSI will be used to accurately measure depth.

Water samples for metal and nutrient analysis will be collected in a clean 2.4L Niskin Bottle. Similar to the YSI, the depth of each site will be measured using the depth sounder on the survey vessel. A graduated rope connected to the Niskin Tube will be used to accurately measure depth. Water will be passed through a 0.45 μm sterile filter into four vials for laboratory analysis. These four subsamples will be; 1 x 100 ml for Mercury, 1 x 10 ml for filtered metals and 2 x 10 ml for nutrients. Sealed bottles will be stored in a dark ice-filled esky and flown to Perth for analysis at a NATA accredited laboratory in Perth as soon as possible.

In order to prevent sample contamination the vessel will be thoroughly washed down onsite prior to any sampling taking place, the Niskin bottle will be rinsed with 2 volumes of water between sample collection, and filters will be rinsed through with a minimum of 10 ml of sample prior to filling the sample vessels. New, non-powdered nitrile gloves and filters will be used by all sampling personnel at each sampling site and depth, and once sampling has commenced great care will be taken to avoid touching the inside of lids or rims of any of the sampling containers. Sample handling and processing should be done on a table/bench covered in a new clean plastic sheet and when sampled waters are exposed to the environment/air care is taken to avoid contamination by dust, exhaust and other possible sources. (Note that sun screens are also a potentially significant source of some metal contaminants).

Benthic habitat/coral monitoring methodology

One minute of video and still camera footage will be taken within a 5m x 5m area, at each of the sample points. Samples must be taken at a consistent height above the substrate. For best image quality the ideal height above the coral is one meter.

Once returned to the laboratory this footage will be broken down into individual stills and 10 will be randomly selected from each piece of footage. In order to randomly select stills, the total number of stills will be determined, and a random number generator will be used to produce 10 numbers which represent the stills selected for analysis. Coral Point Count with Excel Extensions (CPCE) will be used to analyse percent cover and species diversity by overlaying 30 random points on each image. Thirty points per image will be selected because previous studies have found that this achieved the highest level of precision whilst considering...
efficiency (Stoddart et al. 2005). Notes will also be made where excessive sedimentation, coral breakage, bleaching or any apparent change in composition or health in the community is visible in the imagery since the previous survey.

Sediment monitoring methodology

Sediment samples will be obtained from a boat using a hand-operated 2.4L stainless steel Petite Ponar Grab Sampler which is designed to sample the top 5 to 10 cm of seabed sediment. The depth of each site will be measured using the depth sounder on the survey vessel. A graduated rope connected to the Grab Sampler will be used to accurately measure depth. Sediment for analysis will be taken from the top 2 cm of the sediment profile in each grab that comes aboard, taking care to avoid sediment that is in contact with the metal sides of the grab. Various samples will be taken from each grab; the first for original assay, the second held for any confirmation if required and the third held to determine bioavailability if required, if the first and second are elevated. All samples will be placed into laboratory cleaned glass jars and sealed with Teflon lids. Samples will be held in an esky with ice, then refrigerated according to laboratory and NAGD (2009) requirements. The second and third samples will be frozen until required.

In the first instance, all raw samples collected would be submitted for analysis. Should in field ‘bulking’ of samples (one composite from each of five sub-sites) be made for the first sample sent for assay, KIO would adopt industry standard methods applied by qualified scientists and technicians in the framework established by National Assessment Guidelines for Dredging (Commonwealth of Australia, Canberra, 2009) as the guidance on sampling, handling, testing and reporting. KIO would report the adopted method to DWER in any mandatory report required to be made.
8 APPENDIX C – STAGE 1 RE-CONSTRUCTION ACTIVITY

Monitoring sites GIS coordinates for BPPH sites.

<table>
<thead>
<tr>
<th>Location</th>
<th>Site</th>
<th>Easting (MGA94 Z51)</th>
<th>Northing (MGA94 Z51)</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Reference</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SREF-1</td>
<td>575583</td>
<td>8217814</td>
</tr>
<tr>
<td></td>
<td>SREF-10</td>
<td>575809</td>
<td>8217504</td>
</tr>
<tr>
<td>Wharf West</td>
<td>WFW-01</td>
<td>579932</td>
<td>8214617</td>
</tr>
<tr>
<td></td>
<td>WFW-02</td>
<td>579906</td>
<td>8214643</td>
</tr>
<tr>
<td>Diffuser</td>
<td>DIFF-01</td>
<td>579501</td>
<td>8215196</td>
</tr>
<tr>
<td></td>
<td>DIFF-02</td>
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<td>Coral Reference</td>
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<td>581473</td>
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<td>SREF-15</td>
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<tr>
<td>Arbitration Cove</td>
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<td>AC-01</td>
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<td>AC-02</td>
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</table>
## 9 APPENDIX D – MONITORING SCHEDULE FOR STAGE 1 OF 2

<table>
<thead>
<tr>
<th>ID</th>
<th>Aspect</th>
<th>Activity</th>
<th>Event</th>
<th>Monitoring Parameters</th>
<th>Trigger levels</th>
<th>Monitoring Sites</th>
<th>Method of Monitoring</th>
<th>Timing and Frequency of Monitoring</th>
<th>Trigger assessment and actions</th>
<th>Further monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Direct Pit Dewater</td>
<td>Direct discharge of water from Main Pit (up to 25GL)</td>
<td>Release of high quality water</td>
<td>TURB; SAL; TEMP; DO</td>
<td>Stated in Table 3-2</td>
<td>See Figure 4; P1, P2, NC-100m, C1 (SC-100m) and SOUTHREF</td>
<td>Calibrated YSI multisensory; at depth of intake. Loggers at NC-100m, C1 (SC-100m) and SOUTHREF</td>
<td>Weekly to confirm acceptability; For 3 days in Pit prior to commencing.</td>
<td>Apply Table 3-3</td>
<td>Nil (this event requires acceptability)</td>
</tr>
<tr>
<td>2</td>
<td>Pit dewatering via Pond</td>
<td>Treatment of water from Main Pit before release via ocean diffuser</td>
<td>Release of high quality water</td>
<td>TURB; SAL; TEMP; DO</td>
<td>Stated in Table 3-2</td>
<td>See Figure 4; S1, DIFF-A, DIFF-B and SOUTHREF</td>
<td>Calibrated YSI multisensory; spot checks and/or deployed to log at S1 at intake; depth profiles in The Canal</td>
<td>Daily for 3 days at S1 in Pond prior to commencing; daily for 3 days after commencing, then weekly for six weeks and monthly or to meet L8148 thereafter.</td>
<td>Apply Table 3-3</td>
<td>Nil (this event requires acceptability)</td>
</tr>
<tr>
<td>3</td>
<td>Direct Pit Dewater</td>
<td>Direct discharge of water from Main Pit (up to 25GL)</td>
<td>Water quality Table 3-2 (1 or more) Triggers not met</td>
<td>TURB; SAL; TEMP; DO</td>
<td>Stated in Table 3-2</td>
<td>See Figure 4; NC-100m, C1 (SC-100m) vs SOUTHREF</td>
<td>Calibrated multisensory sonde loggers: - Half hourly recording at NC-100m, C1 (SC-100m) and SOUTHREF</td>
<td>Download within 1 week of event. Telemetry of live results at C1 (SC-100m).</td>
<td>Apply Table 3-3</td>
<td>If there are two repeat events of this nature, liaise with DWER.</td>
</tr>
<tr>
<td>4</td>
<td>Pit dewatering via Pond</td>
<td>Treatment of water from Main Pit before release via ocean diffuser</td>
<td>Water quality Table 3-2 (1 or more) Triggers not met</td>
<td>TURB; SAL; TEMP; DO</td>
<td>Stated in Table 3-2</td>
<td>Figure 4; S1 &gt; 4 NTU, then DIFF-A and DIFF-B; S1 = 6NTU, then DIFF-A and DIFF-B; SOUTHREF</td>
<td>Calibrated multisensory sonde loggers: - Half hourly recording at DIFF-A, DIFF-B; SOUTHREF</td>
<td>Scheduled one-off event Trial release event for 6 hours</td>
<td>Apply Table 3-3</td>
<td>Nil</td>
</tr>
<tr>
<td>5</td>
<td>Seawall Partial Rebuild Complete</td>
<td>Engineered rockfill into earthworks for seawall reconstruction</td>
<td>Ebb tide turbid plume</td>
<td>TURB</td>
<td>Stated in Table 3-2</td>
<td>See Figure 4; C1; reference data</td>
<td>Visual observations and photos; YSI (spot check profiles); EXO 2 naph moored to frame to log</td>
<td>Daily; Continuous</td>
<td>Apply Table 3-3</td>
<td>Within 1 weeks of trigger, monitor the turbid zone of influence. Assess coral health as needed within 3 months using CPCe at monitoring sites in Figure 3 per Annual monitoring.</td>
</tr>
</tbody>
</table>