# KEROSENE CREEK DIVERSION MANAGEMENT PLAN

Document No: ARMS-0000-H-PLN-N-0003 Rev 1

Project Name: Nolans Rare Earth Project

## REVISION HISTORY

| Date | Description | Prepared | Reviewed | Approved | 3rd Party Approval |
|---|---|---|---|---|---|
| July 2022 | Rev 1<br>Issued to DITT |  <br>Michael Robinson, ESG Manager |  <br>Michael Robinson, ESG Manager |  <br>Stewart Watkins, GM Projects | |
| 15/09/2021 | Rev 0 | Michael Robinson, ESG Manager | Brian Fowler, GM NT & Sustainability | Stewart Watkins, GM Projects | |

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# 1.0 INTRODUCTION

## 1.1 Background

The Nolans Rare Earths Project (the Project) is located approximately 135 km northwest of Alice Springs, Northern Territory. The Project targets the Nolans Bore mineral deposit for rare earth elements. Activities will focus on construction, mining, processing, decommissioning and rehabilitation of an open-cut, rare earth mine and waste dumps, and associated processing facility and non-process infrastructure.

Construction of the open pit at the Nolans mine site will require the diversion of the ephemeral Kerosene Camp Creek. The diversion is planned to be implemented in two stages. Stage 1 will be a small creek diversion (approximately 1500 metres in length) constructed around the western end of the starter pit prior to the beginning of mining, which will return flows downstream into the main Kerosene Camp Creek channel. This will be an interim diversion in operation during the first 6-9 years of mining. During this time the Stage 2 diversion channel will be built to divert the upstream runoff past the later phases of the pit development.

Further details on the stages, including diversion designs are provided in Section 2.0, and shown on mine design plans in the Groundwater (ARMS-0000-H-PRO-N-001) and Surface Water Sampling (ARMS-0000-H-PRO-N-002) Procedures.

## 1.2 Purpose

The purpose of the Diversion Management Plan (DMP) is to provide a framework for the construction and management of the hydrological diversions at the mine site. This management plan has been created to provide the necessary information to guide and manage the planned diversion, while meeting the regulatory requirements and approval conditions related to these works, as per the statutory sequirements, set out in Section 3 of the Mine Management Plan (MMP). The DMP is also required as per one of the sixteen recommendations set out by the NT EPA, Environmental Assessment Report 84, Nolans Project Arafura Resources Ltd December 2017.

This document and its subsequent revisions form an integral part of the Project's Mining Management Plan (MMP) and should be read in conjunction with the MMP and associated environmental management plans (EMPs). It is a dynamic document which is to be reviewed and updated as determined by the MMP and any pertinent approvals, enabling an accurate reflection of current operational requirements and practices whilst allowing for responsiveness to conditions, input from stakeholders, and flexibility in planning and prioritisation where required.

The commitments and accountabilities for the implementation of this plan are outlined in Table 3—3.

## 2.0 DESIGN OF DIVERSIONS

The design criteria for the Kerosene Camp Creek diversion includes:

- development of a stable channel, which is unlikely to undergo significant geomorphic change over time.
- reduce the need for ongoing maintenance where possible; and
- ensure sufficient capacity to convey and safely discharge the estimated peak flow from a 0.1% Annual Exceedance Probability (AEP) storm event.

Where practical the diversions have been designed to incorporate and maintain sediment transport comparable to adjacent watercourses.

The Project proposes a staged approach of a smaller Stage 1 creek diversion lasting approximately 6-9 years, which will divert the creek around the starter pit for the mine. This will be followed by a more substantial Stage 2 diversion for the creek around the entire open pit area. As a contingency, if mining were to cease prior to the Stage 2 diversion excavation, the Stage 1 channel has been designed to enable the system to remain operational and meet closure requirements.

It is a condition of the Assessed Project that Arafura maintain the existing regional hydrologic regime by effectively maintaining the natural flows of Kerosene Camp Creek. This will apply to the interim diversion as well. Knight Piésold (2018) was engaged to conduct a definitive feasibility surface water management study, capturing Stage 1 and Stage 2 diversion designs. Following a hydrologic assessment to determine catchment response and peak flows, both diversion channels were designed to control and discharge the upstream runoff of a 0.1% AEP rainfall event (Knight Piésold, 2018).

The interim (Stage 1) diversion will be located adjacent to the western edge of the starter pit, with a 35 m wide channel. The maximum flow depth will be 4 m for a design 0.1% AEP rainfall event.The base of the channel is expected to be located in rock and will be excavated with 0.5H:1V side slopes which will be flattened to 3H:1V in soil batters (nominally average 2 H:1 V). Material sourced from the channel excavation will be used to construct bunds towards the pit in areas where the storm flow depth in the channel exceeds the natural ground elevation. Along with the small design grade and the relatively slow flow velocity it is not expected that erosion protection will be required. It is possible that some erosion protection material will need to be added in areas with softer underlying soils.

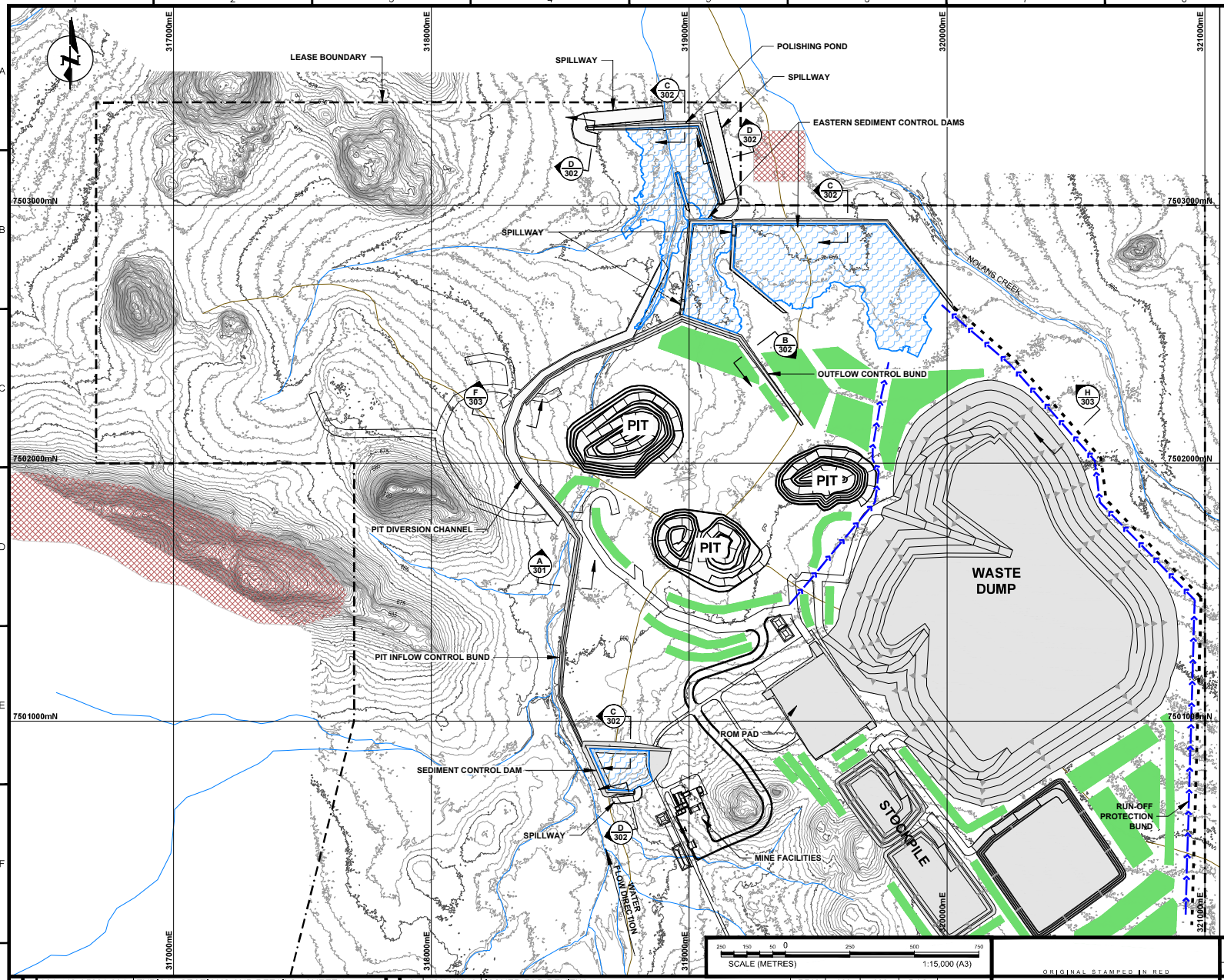
The Stage 2 diversion is approximately 3.7 kilometres in length and will require significant excavation through a saddle, with a maximum flow depth of 6.6 m for over 2 km for a design 0.1% AEP event and the channel reaching a maximum depth of 22 m (GHD, 2017). It will be approximately 8 m wide in the shallower sections and up to 27 m wide in the deepest sections (GHD, 2016). The resulting diversion will have an average gradient of 0.1 percent (%), significantly lower than the 0.25% gradient of the existing creek (GHD, 2016).

A backwater bund is also included downstream of the pit to prevent inflow during flood conditions (due to the expected flood depth and very flat topography), and sediment control structures will be built downstream of the mining area which will minimise sediment escaping from the project area.

It is not expected that any waste haulage across the channel is required as the mining fleet will focus on material movements to the east. Potential impacts associated with the interim diversion channel are addressed in Table 3—1. Stage 1 and Stage 2 diversion channels are presented on Figure 2—1 and Figure 2—2.

**Table 2—1 Kerosene Camp Creek diversion(s) - key design parameters (Knight Piésold 2018b)**

| Surface Water Management Key Design Criteria | |
|---|---|
| Design Climatic Conditions | Annual Rainfall:<br>Average: 291 mm<br>1% AEP Dry: 30 mm<br>1% AEP Wet: 847 mm<br>Design Storm Depth:<br>1% AEP 24 hour storm: 196 mm<br>1% AEP 72 hour storm: 298 mm<br>PMP 24 hour storm: 670 mm<br>PMP 72 hour storm: 1,090 mm<br>Annual Penmen Lake Evaporation: 1,982 mm<br>Dominant Wind Direction: SEE to NWW |
| Catchment | Area Upstream Pit: 2,265 ha<br>Peak Upstream Runoff:<br>10% AEP: 64 $m^3$/sec<br>1% AEP: 164 $m^3$/sec<br>0.1% AEP: 324 $m^3$/sec |
| Diversion Channel Hydraulic design | Channel / erosion protection sized to accommodate:<br>Stage 1 diversion – 0.1% AEP storm event<br>Stage 2 diversion – 0.1% AEP storm event |
| Embankment Freeboard | The critical elevation out of:<br>Minimum of 1.0 m to maximum design pond.<br>Minimum of 0.1 m for maximum spillway flow (1% AEP).<br>Dedicated embankment overflow sections to manage up to PMP flow. |
| Sediment Management Structures | Sized to remove particles up to the medium to coarse silt fraction for flows up to 1 % AEP Storms. |
| Sediment Management Structures - Spillway capacity | Sized to safely discharge:<br>1% AEP Storms.<br>Embankment designed to manage overtopping for flows up to PMF. |
| Design earthquake loading | OBE 1 in 1,000 year: 0.024 g<br>MDE 1 in 10,000 year: 0.045 g<br>Post Closure MCE: 0.053 g |
| Stability minimum factor of safety | Long term drained 1.5<br>Short term undrained<br>Potential loss of containment 1.5<br>No potential loss of containment 1.3<br>Post seismic: 1.0 to 1.2 |




## LEGEND:

- EXISTING WATER COURSE
- EXCLUSION ZONE - LIMITED WORK
- POND EXTENTS
- TOPSOIL STOCKPILE
- LEASE BOUNDARY
- FLOOD PROTECTION BUND
- DIVERSION DRAIN
- RUN-OFF PROTECTION BUND

## NOTES:

1. 1m CONTOUR INTERVALS SHOWN. TOPOGRAPHY PROVIDED BY ARAFURA, JUNE 2018.
2. YEAR 8 PIT LAYOUT SHOWN.

**Figure 2—1 Stage 1 Diversion Channel Alignment**

| SHEET SIZE A3 | DRAWING No. | DRAWING TITLE |
|---|---|---|
| REFERENCES | 801-140-A5001-301 | TYPICAL SECTIONS AND DETAILS - SHEET 1 |
| | 801-140-A5001-302 | TYPICAL SECTIONS AND DETAILS - SHEET 2 |
| | 801-140-A5001-303 | TYPICAL SECTIONS AND DETAILS - SHEET 3 |

| REVISIONS | REV | DATE | DESCRIPTION | DRN | DESIGN | CKD | APP | CLIENT APP |
|---|---|---|---|---|---|---|---|---|
| | A | 30/11/2018 | ISSUED FOR REVIEW | PRK | AM | AM | BAS | |

ORIGINAL STAMPED IN RED

| DATE | DESIGNED | CHECKED | APPROVED | CLIENT APP'D |
|---|---|---|---|---|
| | | | | |

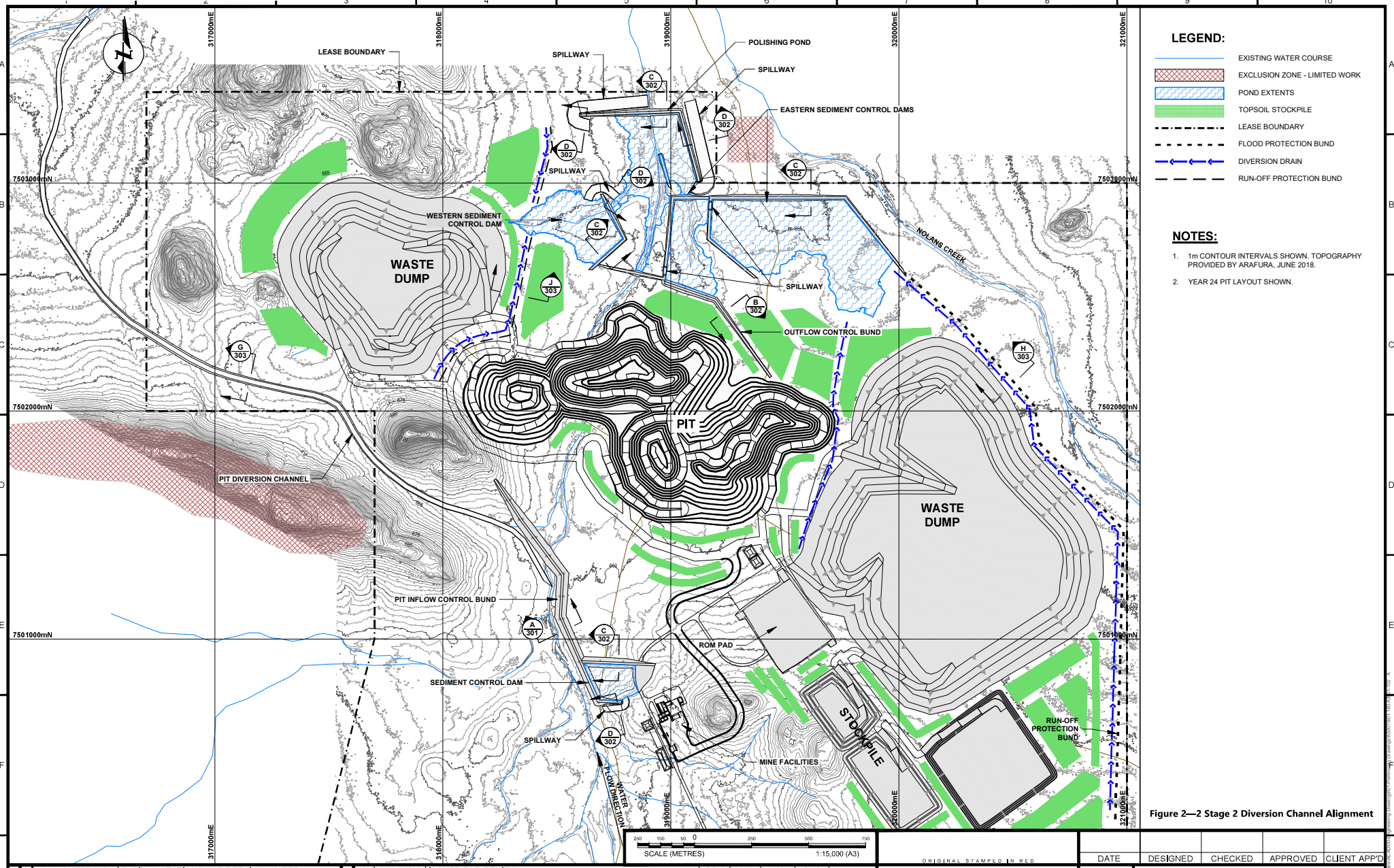
Knight Piésold CONSULTING

CONSULT AUSTRALIA Member Firm



**ARAFURA RESOURCES**
**NOLANS PROJECT**
**MINING AREA SURFACE WATER MANAGEMENT**
**GENERAL ARRANGEMENT - STAGE 1**

SCALE 1:15,000
STATUS: IFR
DRAWING NUMBER **801-140-A5001-101**
REV **A**




## LEGEND:

- EXISTING WATER COURSE
- EXCLUSION ZONE - LIMITED WORK
- POND EXTENTS
- TOPSOIL STOCKPILE
- LEASE BOUNDARY
- FLOOD PROTECTION BUND
- DIVERSION DRAIN
- RUN-OFF PROTECTION BUND

## NOTES:

1. 1m CONTOUR INTERVALS SHOWN. TOPOGRAPHY PROVIDED BY ARAFURA, JUNE 2018.
2. YEAR 24 PIT LAYOUT SHOWN.

**Figure 2—2 Stage 2 Diversion Channel Alignment**

| DRAWING No. | DRAWING TITLE |
|---|---|
| 801-140-A5001-301 | TYPICAL SECTIONS AND DETAILS - SHEET 1 |
| 801-140-A5001-302 | TYPICAL SECTIONS AND DETAILS - SHEET 2 |
| 801-140-A5001-303 | TYPICAL SECTIONS AND DETAILS - SHEET 3 |

SHEET SIZE A3 — REFERENCES

| REV | DATE | DESCRIPTION | DRN | DESIGN | CKD | APP | CLIENT APP |
|---|---|---|---|---|---|---|---|
| A | 30/11/2018 | ISSUED FOR REVIEW | PRK | AM | AM | BAS | |

REVISIONS

ORIGINAL STAMPED IN RED

| DATE | DESIGNED | CHECKED | APPROVED | CLIENT APP'D |
|---|---|---|---|---|
| | | | | |

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**ARAFURA RESOURCES**
**NOLANS PROJECT**
**MINING AREA SURFACE WATER MANAGEMENT**
**GENERAL ARRANGEMENT - STAGE 2**

SCALE 1:15,000
STATUS: IFR
DRAWING NUMBER **801-140-A5001-102**
REV **A**

# 3.0 MANAGEMENT AND MITIGATION

The general approach for management of the Kerosene Creek Diversion during and after Project construction and operations is structured below as follows:

- **Key Activities and Impacts:** A summary of the key activities being undertaken during the management period. The potential environmental impacts are identified for each environmental aspect, which then requires mitigation measures to be implemented.
- **Objective:** The guiding environmental management objective(s) and activities that apply to the element.
- **Mitigation Measures:** The procedures to be used to ensure that the relevant objectives are met.
- **Responsibility:** Nominates the responsible position for implementing actions and monitoring.
- **Trigger, Action, Response Plan (TARP):** The actions to be implemented in the case of non-compliance. This includes strategies of remediation and the person(s) responsible for the actions.

## 3.1 Key Activities and Impacts

The key activities and potential environmental impacts that have been identified for the stage 1 diversion are outlined in Table 3—1.

**Table 3—1 Key Activities and Impacts**

| ID No | Activity | Potential Environmental Impact |
|---|---|---|
| 1 | Stage 1 - 2 diversion creates a change to the hydrological regimes. | Impacts on localised hydrological processes, failing to effectively deliver the natural flows of Kerosene Camp Creek to the downstream environment |
| 2 | Diversion channel will be directed across an area of potential mineralisation (5 – 10%) | Leachate from the interim diversion basement rocks has the potential (barrel leach testing indicates this is low risk) to impact on surface water and/or groundwater quality. It is intended that where the planned interim diversion contacts the underlying Nolans mineralisation, that the base of the creek diversion will be over excavated and then backfilled with non-mineralised waste rock to minimise creek flow contact with this underlying mineralisation. It should be noted that the existing natural creek already contacts Nolans mineralisation over an extensive area in the base of the Kerosene Camp Creek. |
| 3 | Increased stream velocity through changes to channel dimensions. | Erosion and mobilisation of sediments. |

## 3.2 Mitigation Objectives

The Kerosene Creek Management Plan mitigation objectives have been established and are detailed in Table 3—2.

**Table 3—2 Mitigation Objectives**

| Objective | Target | KPI |
|---|---|---|
| Minimal impacts on hydrological regime | Maintain the hydrological regimes of groundwater and surface water so that environmental values are protected. | No evidence of rill erosion or slumping or evidence of geomorphically unstable erosion and sediment deposition.<br>No evidence of accumulation or reduced waterway access. |
| Minimise impact on flora and fauna | Maintain diversion channel so that it does not impact flora and fauna on site. | No evidence of weed growth or death of vegetation adjacent to diversion channel. Reestablishment of native vegetation to the riparian zone.<br>No evidence of hazards presented to the public, poor aesthetics, feral animals, or geomorphically instability. |
| Water quality | Maintain the quality of groundwater and surface water so that environmental values including ecological health, land uses, and welfare and amenity of people are protected. | Water quality is maintained within baseline conditions prior to the diversion. |

## 3.3 Mitigation Measures

Mitigation measures have been developed to minimise potential impacts and meet the mitigation objectives.

**Table 3—3 Mitigation Measures**

| Mitigation Measure | Timing | Responsibility |
|---|---|---|
| **Runoff Model Calibration (Risk Activity 1)** | | |
| Installation of automatic flow monitoring station at the inlet to the pit diversion channel. Calculation of the rainfall runoff specifics for the actual catchment and calibration of the runoff model over the construction period will enable a check of the diversion channel design prior to construction of the Stage 2 diversion. | Construction | Environmental Officer |
| **Erosion and Sediment Control (Risk Activity 1- 3)** | | |
| Temporary diversions will be constructed upslope of the diversion to redirect flows around active work areas. Temporary diversions will be constructed and stabilised in a manner to minimise erosion. A temporary dam will be constructed at the downstream end of the diversion to prevent the discharge of sediment laden water from the works area into the downstream environment. | Operation (Stage 1 and 2 Diversion) | Environmental Officer |
| Where practical, the stage 2 diversion will be designed to maintain sediment transport comparable to surrounding watercourses. | | |
| Check dams within the Stage 1 and 2 creek diversions to slow flow velocities and encourage sediment accretion. | | |
| Clean water diversion drains to divert runoff around the works area. | | |
| **Revegetation (Risk Activity 1)** | | |
| Spreading of topsoil and the establishment of a native cover crop (grasses) to stabilise exposed surfaces and minimise sediment generation during rainfall events.<br>Direct seeding and planting of native vegetation within disturbance areas to establish riparian zone vegetation.<br>Only locally occurring, native vegetation and seeds will be used for any rehabilitation taking place at the mine site. | Operation (Stage 1 and 2 Diversion) | Environmental Officer |
| Ongoing removal of weeds, as per the Weed management plan.<br>Supplemental seeding and planting where necessary. Identification and undertaking of remedial actions. | | |
| **Inspection and Monitoring (Risk Activity 1 – 3)** | | |
| Water quality will be monitored as per the Mine Site Water Management Plan (NRE-0000-O-PLN-O-0001 Rev 0). | Operation (Stage 1 and 2 Diversion) | Environmental Officer |
| Flora and Fauna to be monitored as per the Biodiversity Management Plan (ARMS-0000-H-PLN-N-0002 Rev 0). | | |

| Mitigation Measure | Timing | Responsibility |
|---|---|---|
| The diversion will be inspected after significant rainfall events and as required to ensure components of the diversion are performing satisfactorily and no geomorphology signs such as impacts to the channel bank, inverts, or significant deposition of sediment or debris can be observed. Sediment dams and pit diversion infrastructure will undergo annual audits by a suitably qualified geotechnical engineer to ensure that the facilities are operating in a safe and efficient manner.<br>Diversions (channels and bunds) will be equipped with monitoring bores and vibrating wire piezometers (VWP) to aid inspections and reporting.<br>A full maintenance programme for the sediment dams and pit diversion system will be incorporated into the operating manual (to be issued prior to commissioning of the sediment dams and pit diversion system). | | |

## 3.4 Trigger, Action and Response Plan

The Trigger, Action and Response Plan (TARP) outlines remedial actions and responses to the situation. The levels of incidents and TARP are provided in Table 3—4.

**Table 3—4 Trigger, Action and Response Plan**

| Trigger | Action | Response |
|---|---|---|
| Minor erosion (<0.5 m deep) observed within diversion or downstream of diversion. | Environmental officer to record inspection date, rainfall totals and any associated flow records.<br>Mark point of erosion for ongoing assessment and observation. | Notify Area Manager and note area of concern for standard inspection quarterly or after next rainfall event. |
| Scouring (> 0.5 m deep) observed within diversion or downstream of diversion. | Environmental officer to record inspection date, rainfall totals and any associated flow records.<br>Mark point of erosion for ongoing assessment and observation.<br>Fill affected areas and line with riprap to minimise erosion and scouring. | ESG manager to review hydraulic modelling of the diversion against rainfall and flow records of previous storm event.<br>Review selection of lining material along length of diversion.<br>Engage professional hydrologist to verify if additional actions are required. |
| Vegetation loss due to high flow event. | Environmental officer to note location of vegetation loss and schedule area for revegetation.<br>Check downstream for debris / blockages. | Engage professional hydrologist to verify if additional actions are required. |

# 4.0 PERFORMANCE REVIEW

A regular review of performance of this management plan is to coincide with the review process of the Project's Mining Management Plan (MMP).

The review process is to assess performance against objectives of this plan and the stated actions within the MMP, with any relevant outcomes, supporting information, reports and/or data, discussed within the relevant section of the MMP, and supporting information/reports provided within the appendices.

Any outcomes of the performance review that will assist in continually improving this management plan, it's objectives, methods or controls, are to be included or reflected in an updated version of this document.

The mitigation objectives and measures outlined in this EMP have been developed to reduce the risk of key project activities to an acceptable level (as low as reasonably practical (ALARP)) for construction and operation of the Project to proceed.

# 5.0 REFERENCES

## 5.1 Third Party Documents


| Ref No. | Title | Document Number |
|---|---|---|
| C1. | GHD (2016). *Nolans Project Environmental Impact Statement, May 2016*. A report for Arafura Resources Limited. | |
| C2. | GHD (2017). *Nolans Project Environmental Impact Statement - Supplementary Report, October 2017*. A report for Arafura Resources Limited. | |
| C3. | GHD (2018). *Impact of Proposed Operational Changes to EIS*. A report for Arafura Resources Limited. | |
| C4. | GHD (2019) *Nolans Project – Section 14A Notification May 2019*. A report for Arafura Resources Limited. | |