Appendix 18.

SLR Consulting Australia (2020i) *Rum Jungle Rehabilitation – Stage 2A Engineering Design – Site Erosion and Sediment Control Measures.* Report to the Department of Primary Industry and Resources, Northern Territory.

NORTHERN TERRITORY GOVERNMENT

Department of **Primary Industry and Resources**

RUM JUNGLE REHABILITATION - STAGE 2A DETAILED ENGINEERING DESIGN

Site Erosion and Sediment Control Measures

Prepared for:

Department of Primary Industry and Resources
PO Box 4550
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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Department of Primary Industry and Resources (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
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1 Introduction

1.1 Project Background

The Northern Territory Government (NTG), represented by the Department of Primary Industry and Resources (DPIR), proposes the rehabilitation of the former Rum Jungle Mine site (the Project), located 6 km north of Batchelor, Northern Territory (NT). The project location and regional setting are shown on Figure 1.

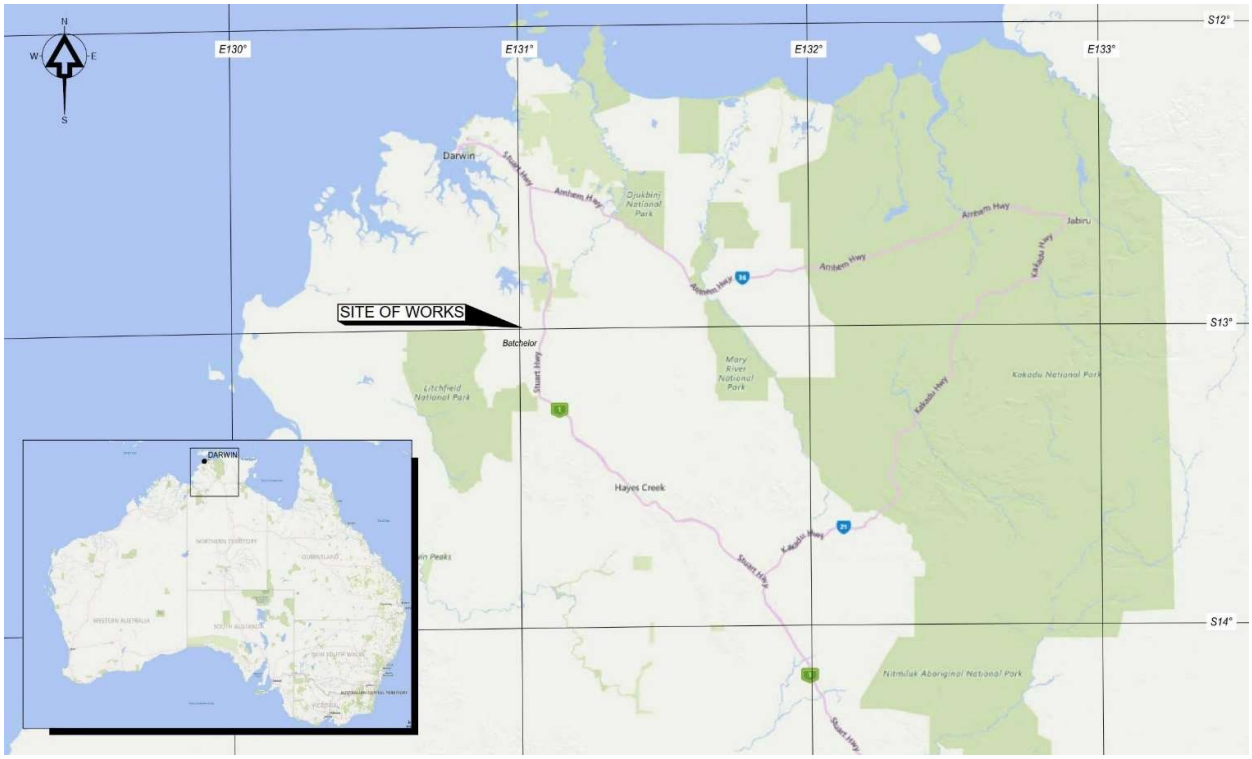

Figure 1 Project Location

The former Rum Jungle mine was rehabiliated in the 1980s, however recent studies indicate that not only has the site deteriorated and needs further rehabilitation, but that the traditional Aborignal owners cultural requirements have not been met. Since 2009, the NTG and the Australian Government have been working under a National Partnership arrangement to complete investigative work to inform a rehabilitation plan, deliver site maintenance and continue environmental monitoring. The results of these programs have been used to develop an improved rehabilitation strategy that is consistent with the views and interests of traditional Aboriginal owners and that meets contemporary environmental and mined land rehabilitation standards.

The Project's high-level objectives are two-fold and focus on environmental remediation and restoration of cultural values of the site as described below:

- Improve the environmental condition onsite and downstream of site within the East Branch Finniss River (EBFR). This includes the following key outcomes:
  - Improved surface water quality conditions within EBFR in accordance with locally derived water quality objectives (LDWQOs).

  - Achieve chemically and physically stable landforms.
  - Support self-sustaining vegetation systems within rehabilitated landforms.
  - Develop physical environmental conditions supportive of the proposed Land Use Plan.
- Improve site conditions to restore cultural values. This includes the following key outcomes:
  - Restoration of the flow of the EBFR to original course as far as possible.
  - Remove culturally insensitive landforms from adjacent to sacred sites and relocate ensuring a culturally safe distance from the sacred sites.
  - Return living systems including endemic species to the remaining landforms.
  - Preserve Aboriginal cultural heritage artefacts and places.
  - Isolate sources of pollution including radiological hazards.
  - Maximise opportunities for Traditional Owners to work onsite to aid reconnection to country.

1.2 Rehabilitation Strategy

The rehabilitation strategy has been developed from an understanding of current site conditions, contamination processes and a Land Use Plan goals as established with Traditional Owners. There are several key elements that have been incorporated in the strategy in order to satisfy the cultural needs of sacred site Custodians.

1.2.1 Remediation Action Plan

The actions planned to address contamination processes and improve prospects of future land use are:

- Slow down or halt the acid metalliferous drainage (AMD) production reactions from potentially acid forming (PAF) waste rock onsite by consolidating waste rock into one of three new facilities based on the PAF characteristics. These facilities are:
  - Within the Main Pit backfill zone – ~1.47 Mm3 storage for waste rock;
  - East Waste Storage Facility (WSF) – ~3.77 Mm^3 storage volume; and
  - West WSF – ~1.88 Mm^3 stored volume.
- Slow down or halt the future generation and transportation mechanisms for copper and other metals in the new WSFs by adopting leading practice methodology for storage of PAF waste rock.
- Treat existing groundwater sources (i.e. the Main and Intermediate Waste Rock Dumps (WRDs)) that contaminate the EBFR by pumping and treating these impacted waters.
- Treat other AMD-impacted groundwater that does not contribute to the EBFR copper load (i.e. old ore stockpile area) by pumping and treating these impacted waters.
- Isolate radiological, AMD or metal impacted soils at the Rum Jungle site, Mt Burton and Mt Fitch from environmental and human receptors by relocating these soils to the new WSFs on site.
- Isolate asbestos materials at the Rum Jungle site from environmental and human receptors by removing from surface soils and relocating to the new WSFs or by another approved means offsite.

1.2.2 Reestablishment of Cultural Values

The actions that are planned to address the compromised environmental and cultural values that are not related to contamination processes are:

- Return the EBFR to its original course as far as possible.
- Restore land parcels that are poorly vegetated such as the Old Tailings Dam area and vine thicket stand.
- Revegetate new landforms to stabilise the surface and restore ecological function as far as practicable.

The relevant Project locations are shown on **Figure 2.**

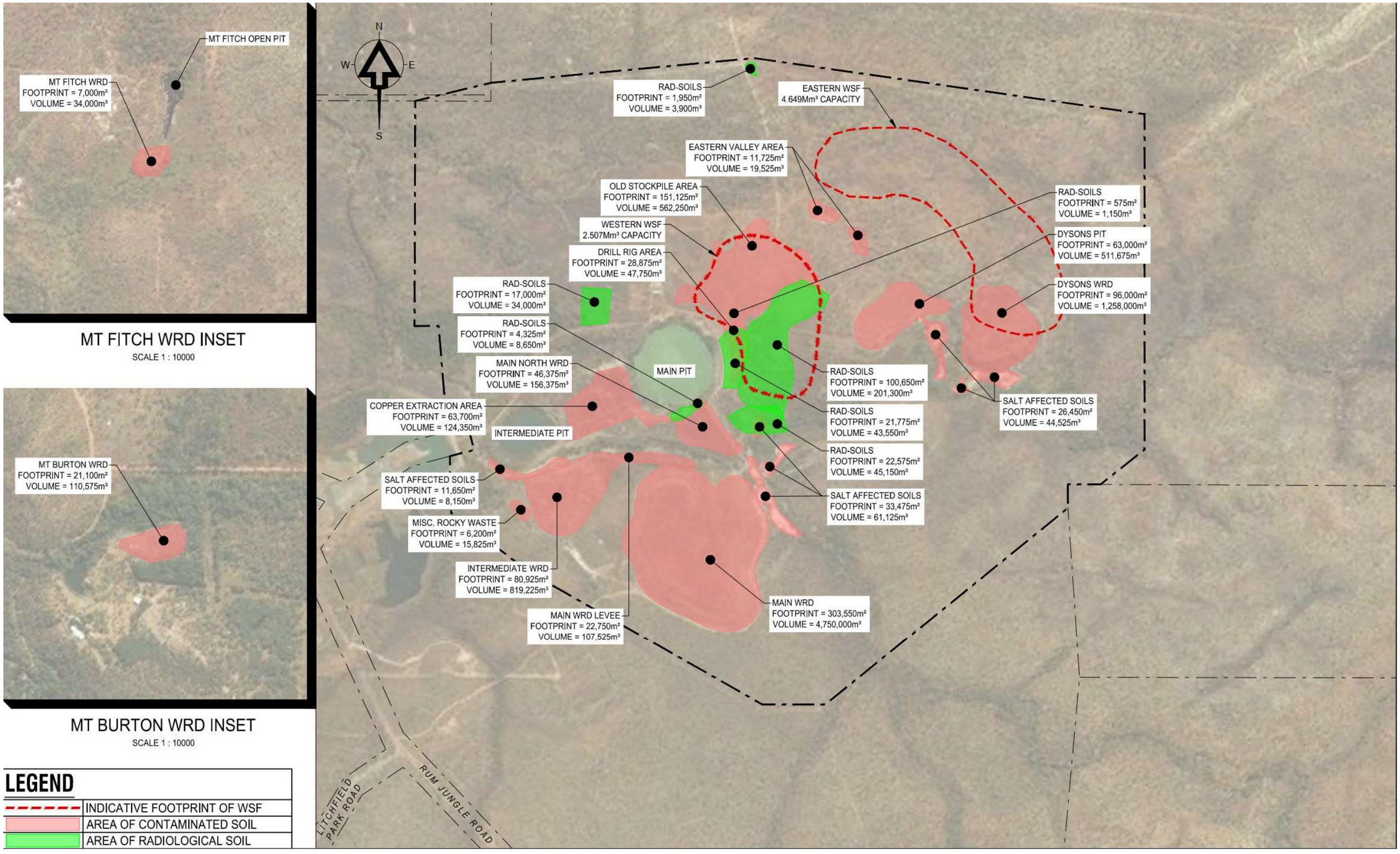

Figure 2 Waste Rock and Impacted Soil Areas

1.3 Stage 2A Detailed Engineering Design for Rehabilitation

SLR Australia Pty Ltd (SLR) has been engaged to deliver the Stage 2A detailed engineering design to meet the engineering requirements for construction of the rehabiliation strategy (referred to as Stage 3 Rehabiliation Construction). This report forms part of the design works. For full design details refer (SLR, 2020a).

1.4 Objectives and Scope of Works for Erosion and Sediment Control Measures

This report summarises the erosion and sediment control measures required for the proposed rehabilitation works during both the construction phase and for longer term after site works are complete. This Erosion and Sediment Control Plan (ESCP) report should be read in conjunction with drawings **680.10421-SUW -D01 to D12**.

2 Battery Limits

This ESCP has been prepared to support construction and post-construction activities at the Rum Jungle site, including:

- Construction of the new WSFs;
- Construction of haul roads, including the EBFR diversion drain crossing, required during construction;
- Activities associated with the new Water Treatment Plant (WTP);
- Footprints associated with where existing waste rock dumps and impacted soils will be relocated from;
- Realignment of the EBFR to original alignment after construction works are complete; and
- Works required on the existing EBFR diversion when decommissioned.

3 Design Guideline/Standards

This ESCP has been prepared to manage potential erosion and sediment control (ESC) impacts of the proposed works in accordance with the *'Best Practice Erosion and Sediment Control*' guideline (IECA, 2008), the Project Draft Environmental Impact Statement (NT-DPIR, December 2019) and best practice.

4 Assumptions

This ESCP report and the associated drawings **680.10421-SUW - D01 to D12** provide a reference design with preliminary strategies and details for the implementation of erosion and sediment controls during the construction works at Rum Jungle, and document minimum requirements. It is assumed that the Construction Contractor(s) will refine and update details of progressive ESCP's as the works take place.

Further assumptions made in preparing the ESCP are outlined in Sections 4.1 and 4.4.

4.1 General

- The WSF construction works will take around 5 to 7 years and during that period there will be progressive revegetation of the final surfaces;
- Sediment dams are considered temporary, but will be required during both the construction phase and monitoring phase (~15 years);
- Where practical, sediment dams will be located above the 5-year Average Recurrence Interval (ARI) flood level; and
- Run-off from the Western WSF will report to the Main Pit (rather than a separate sediment dam).

4.2 Construction and Deconstruction Approaches

With regard to WRD deconstruction an approach consistent with the Draft EIS (NT-DPIR, December 2019) has been assumed with regard to progressive staging and protection of works during the wet season.

The existing Main, Intermediate and Dyson's WRDs as well as Dysons Pit Overburden are to be deconstructed progressively over the Stage 3 works. The deconstruction methodology proposed has been developed to address, as far as practicable, the potential environmental and safety risks of handling AMD and low-grade uranium materials. The deconstruction of each facility is to be carried out in vertical segments rather than horizontal slices to reduce, as far as practicable, the exposed surface area of waste rock. Minimising exposed waste rock surfaces is important during the wet season as there is a high risk of mobilisation of existing contaminants and acid from the waste rock, resulting in further sulphide oxidation. This may create surface water runoff from the work area that has low pH and elevated heavy metals. The existing cover systems will remain in place for as long as possible and will be stripped progressively, as needed, as a new vertical segment is prepared for relocation.

Generally, the cellular WSF construction methodology is the same principle as that applied to the vertical segment deconstruction methodology described above for the WRDs. It is also noted that scheduling of high risk PAF-I waste rock material movement to the dry season. A surface water collection sump on each work area will collect runoff and allow treatment for pH and turbidity as required.

4.3 Specific Requirements

Sediment dams will be required outside of the facility footprints to capture and treat runoff from earthwork areas and final external batters. A reference design for the proposed sediment basins has been prepared based on the following assumptions:

- East WSF - Sediment dams will be provided assuming that the final stage and/or final external batters comprise catchment areas as shown in drawing **680.10421-SUW-D03**, and that the final landform is progressively rehabilitated. Construction will proceed in 'vertical strips' and internal sumps should be utilised to manage runoff from the active work area.
- West WSF - Internal sediment sumps should be utilised as described above for initial stages of the facility construction. For the final stage and establishment of external batters, runoff can discharge directly to the Main Pit via a collection drain around the toe. Assumed catchment areas are shown in drawing **680.10421-SUW-D04.**
- WRD deconstructions - Construction is to include internal sediment sumps as described above for all but the final stages and external slopes. This is consistent with the earthworks strategy for the waste rock decommissioning, which assumes staging in 'vertical strips' to limit the area of waste rock exposed to the elements. Sediment dams are to be provided to capture and treat runoff from the external batters of the WRDs, but assuming progressive revegetation of the final cover system.
- The extent of progressive revegetation assumed when sizing sediment basins for the above WRD's and WSF's is indicated by the green shaded 'rehabilitated catchment areas' shown on drawings **680.10421-SUW - D02 to D05**.

4.4 Performance Specification

The Contractor is to ensure that all times during progression of the works, and when works are ceased during the wet season, that:

- Internal sumps are provided to collect and treat runoff from disturbed areas within the WSF's and WRD's; and/or
- An external sediment basin is provided to collect and treat runoff from the disturbance area plus any clean water run-on. External sediment basins may be constructed in accordance with the SLR Reference Designs shown on drawings **680.10421-SUW - D02 to D12**, or where construction situation is altered from the assumptions documented above, the sediment basin provision must be altered to ensure compliance with the IECA Guidelines (IECA, 2008).

5 General ESC Principles

The proposed water management and ESC measures have been designed to minimise the potential impact on downstream water quality. Wind and water erosion of disturbance areas cannot be eliminated completely, however measures will be taken to minimise the impact by:

- Conducting best practice land clearing procedures for all proposed disturbance areas;
- Undertake disturbance works, as much as is practically possible, during the dry season (May to November) and during periods when good weather is forecast;
- Stabilised rock pads (vibration grid) and/or wash down facilities will be installed at all site entry / exit points during the construction and rehabilitation works (refer to the **SUW Detailed Design Drawing** set);
- Appropriate storage of soil stockpiles in areas away from roadways and other drainage lines. Suitable sediment control measures will be installed downslope of soil stockpiles and upslope clean water runoff diverted (where possible). Refer to the **SUW Detailed Design Drawing** set;
- Minimising the disturbance footprint;
- Coordinating works to minimise the exposure duration of disturbed soils;
- Separation/diversion of 'clean' water catchment runoff from disturbed areas (where practical) to minimise sediment-laden runoff volumes requiring treatment;
- Containment of all contaminated water on-site prior to treatment or disposal of in a suitable manner;
- Minimising soil erosion (i.e. rehabilitation, drainage and erosion control measures including rock mulching) at the source, rather than trapping resultant sediment;
- Ensuring sediment-laden runoff is treated via designated sediment control devices;
- Clearly identifying/communicating no-go areas to maintain disturbance areas and traffic movement to the designated areas;
- Conducting bank stabilisation works for vegetation clearing required at creek crossings;
- Revegetation of disturbed areas as soon as possible following the completion of ground disturbance activities;
- Effective dust suppression measures;
- Any liquid wastes, fuels and oils stored on-site will be sufficiently bunded to contain any potential spills. Accidental spillage or poor management of fuels, oils, lubricants, hydraulic fluids, solvents and other chemicals during the construction phase will be controlled through spill management actions (including the availability of spill kits) to prevent water quality and ecological impacts and no further mitigation measures are considered necessary. Captured liquid wastes, fuels and oils should be pumped out by a liquid waste contractor and disposed of at an appropriately licenced facility; and
- Implementing an effective monitoring and maintenance program for the site.

6 Soil Stripping and Stockpiling

Topsoil is a valuable resource for erosion control as it provides the basis for successful land stabilisation once earthworks have been completed. Topsoil can greatly increase the chances of groundcover germination and survival, and in many cases the topsoil will contain a viable seed bank that will germinate and survive well if appropriate conditions are maintained. This means that the correct management of topsoil can provide significant environmental and economic returns, as it is a cost-effective method of achieving land stabilisation without the need to import additional materials.

Best practice (IECA, 2008) soil management are implemented where appropriate:

- Topsoil should be preserved for reuse on the site wherever possible;
- Wherever reasonable and practicable, strip and stockpile topsoil immediately before bulk earthworks, and confine any soil disturbance to the immediate construction stage;
- Topsoil should be stripped only while in a light moisture condition. If the soil is too dry, stripping it will pulverise the soil, if too wet it may lead to clodding or hardsetting – particularly if the soil has a high silt or clay content;
- To the maximum degree practicable, topsoils should not be mixed with subsoils during the stripping and stockpiling procedure, especially if the subsoils are dispersive;
- If it is desirable to retain the seed content of the soil, then the stockpiling should consist of long low mounds no greater than 1 to 1.5 m in height, otherwise topsoils stockpiles should not exceed 3m in height. Long term stockpiles (i.e. >12 months) may need to be mulched or temporarily vegetated to prevent weed infestation;
- Stripped topsoil should be used as soon as possible, and preferably not stockpiled for more than 12 months. Long term stockpiling can degrade its biological and chemical qualities;
- Maintain all stockpiles in a free draining condition to avoid long-term soil saturation;
- All topsoil should be tested for fertility and adjusted (where necessary), even if the soil originated from the site;
- Soil should be removed from stockpiles in a manner that avoids vehicles travelling over the stockpiles if possible;
- Exposed sub-soils should be covered as soon as practicable, especially if dispersive;
- After spreading topsoil, ensure the surface is left in a scarified (roughened) condition to assist moisture infiltration and inhibit soil erosion;
- When working adjacent to a waterway, avoid spreading topsoil at a significantly different elevation form where it originated;
- Ensure all exposed sub-soils are covered, especially if dispersive; and
- Soil stockpile areas should be rehabilitated as soon as reasonable and practicable after the material has been removed.

7 Proposed ESCP

7.1 General Strategy

The site has been divided into number of sub-catchments as shown in drawing 680.10421-SUW-SERIES-D01. The ESCP strategy for the various catchments is summarised in the following sections.

7.1.1 Catchment 1

Catchment 1 is located just north of the main site. Using the Revised Universal Soil Loss Equation (RUSLE) for soil loss estimation as per the IECA Guidelines, Catchment 1 runoff can be managed using sediment fencing downstream of the proposed works without the need for a sediment dam. A clean water diversion is also proposed directly upstream of the proposed works to redirect runoff from upslope catchments.

7.1.2 Catchment 2

Catchment 2 is located west of the main site. Using the RUSLE equation for soil loss estimation as per the IECA Guidelines, Catchment 2 runoff can be managed using sediment fencing downstream of the proposed works (annual soil loss < 150m^3) without the need for a sediment dam. In order to satisfy the IECA requirements, Catchment 2 will require mulching over the entire catchment. A clean water diversion is also proposed directly upstream of the proposed works to redirect runoff from upslope catchments.

7.1.3 Catchment 3

Catchment 3 is associated to the Water Treatment Plant (WTP), this catchment is designed to be self-contained and ESC measures for this catchment constitute of sediment fencing and hydro-mulching (as required) of the batters.

7.1.4 Catchment 4

Catchment 4 is located between the Main and Intermediate Pits. Due to the close proximity of Main Pit, it is proposed to build a conveyance structure to the north of Catchment 4 which would discharge into Main Pit. Further ESC measures as such as mulching should be used over the proposed disturbance area to reduce potential erosion risks.

7.1.5 Catchment 5

Catchment 5 is located directly south of Main Pit and it is proposed to let the catchment discharge straight into Main Pit. Further ESC measures as such as mulching should be used over the proposed disturbance area to reduce potential erosion risks.

7.2 West WSF Catchment Area

The West WSF is located directly east of the main pit and it is proposed to use two toe drains (around the north and south of the west WSF) to direct the generated runoff towards Main Pit.

7.3 East WSF Catchment Areas

The East WSF has been divided into a north and a south sub-catchment and is proposed to be managed as follows:

7.3.1 North of East WSF

The north sub-catchment runoff will be managed by two toe drains redirecting flow to the proposed sediment dam SD1.

7.3.2 South of East WSF

The south sub-catchment, Dysons Pit Overburden and Dysons WRD runoff will be managed using a system of sediment dams (SD2, SD3 and SD4) and conveyance channels. Where runoff can't be redirected towards a sediment dam, it is proposed to use sediment fencing and mulching of the disturbed areas as required. Further ESC measures as such as mulching should be used over the proposed disturbance area to reduce potential erosion risks where typical ESC measures aren't adequate.

7.4 Main Waste Rock Dump Catchment Area

The Main WRD is located directly south of the EBFR diversion. This catchment will be managed by sediment dam SD5 using two conveyance channels to redirect runoff as well as sediment fencing and mulching where runoff can't be directed to SD5. A clean water diversion drain is also proposed to redirect flows from upslope catchments.

7.5 Intermediate Waste Rock Dump Catchment Areas

The Intermediate WRD is located just south of the Intermediate Pit separated by the EBFR diversion. This catchment will be managed by sediment dam SD6 using two conveyance channels to redirect runoff as required. A clean water diversion drain is also proposed to redirect flows from upslope catchments.

7.6 Mt Burton Waste Rock Dump

The Mt Burton WRD is approximately 2.5km west of the main Rum jungle mine site. The site is not large enough to warrant a sediment basin for erosion control. A clean water diversion drain is required to divert run-on from the work area.

7.7 Mt Fitch Waste Rock Dump

The Mt Fitch WRD is also remote from the main Rum jungle mine site. Clean water diversion drains are required to divert run-on from entering the work site, or in the longer term eroding the final landform. Sediment control will include two conveyance channels to convey water from the WRD site to a sediment basin located immediately downslope.

An extract from Drawing **680.10421.SUW.D02** indicating the overall arrangement of drains and basins is shown on **Figure 3** the next page.

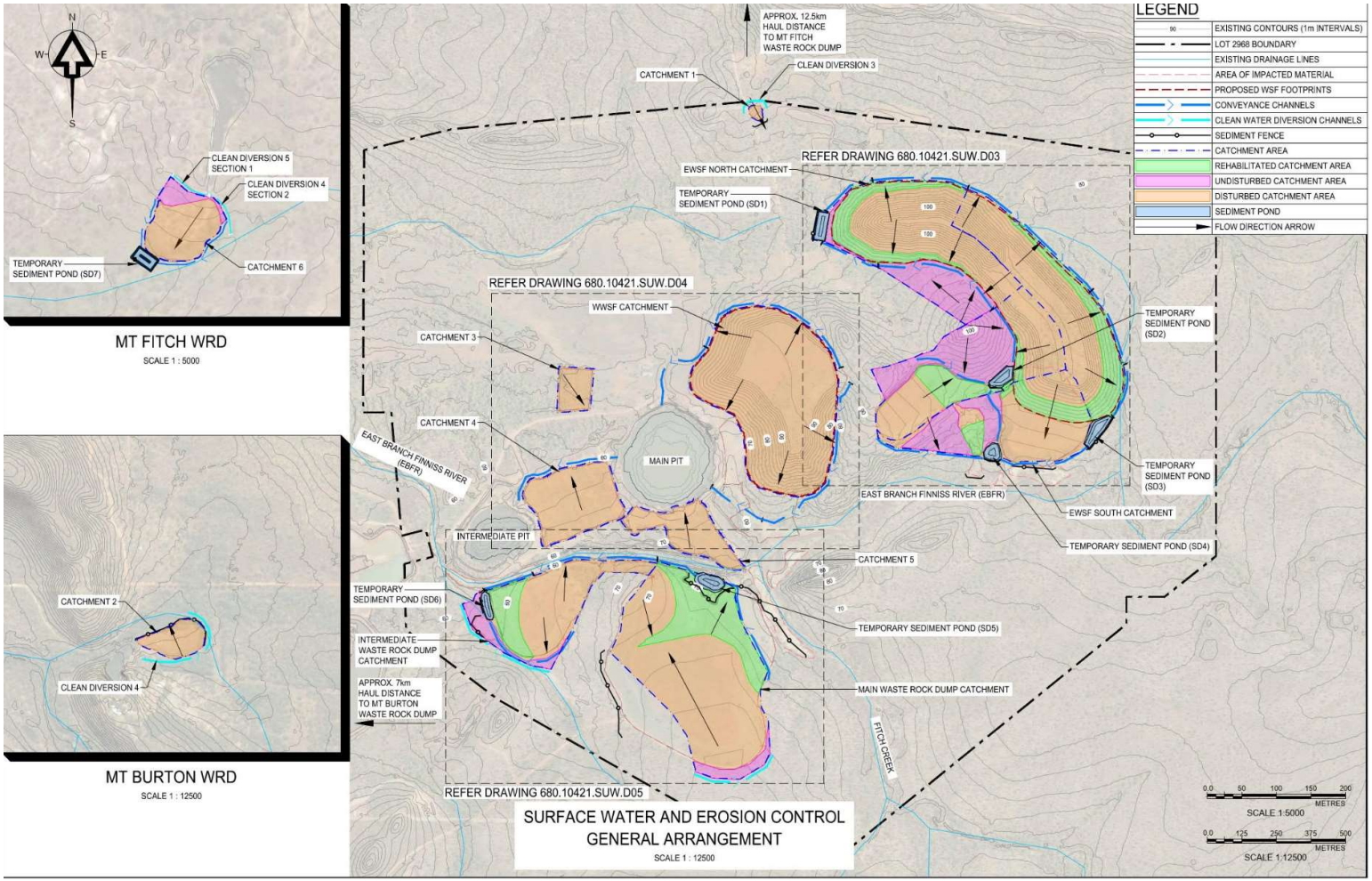

Figure 3 Overall scheme (Extract from drawing 680.10421.SUW.D02)

8 Sediment Dams

Due to the extent of the proposed disturbance areas, a number of sediment dams will be required to manage dirty water runoff in accordance with the IECA guideline.

Dam storage calculations were undertaken in accordance with (IECA, 2008) and include the following design criteria and assumptions:

- Capacity calculations based on a 5 day, 85th percentile rainfall depth of 46.7 mm derived from Equation B8 of the IECA Guideline;
- The respective catchment areas have been assumed to be approximately 25% rehabilitated for this assessment;
- Type F/D dams;
- Disturbed runoff coefficient of 0.69 in accordance with Table B7 of the IECA guideline for a type D hydrological group with rainfall between 40 – 50 mm;
- 'Clean' water runoff coefficient from undisturbed areas of 0.3;
- The sediment storage zone determined based on a management period of 12 months (i.e. the sediment dam would be desilted once a year);
- Sediment dams will be constructed with suitably designed spillways to manage overflows during significant storm events. The dams will also be constructed such that they are safe to people, vehicles and wildlife during their operation; and
- For construction purposes, it was assumed that the sediment dams will be cut in the natural surface allowing for an embankment above the dam spill levels (ie: freeboard).

Table 1 below shows the required sediment dams sizing as per the IECA Guidelines.

Table 1 Sediment Dams Capacity Requirements

	SEDIMENT DAM SIZING TABLE				
ID	Catchment Area (ha)	Design Storm	Settling Zone Capacity (ML)	Sediment Zone Capacity (ML)	Total Required Capacity (ML)
SD1	21.06	5 day 85th	5.22	2.61	7.84
SD2	18.12	5 day 85th	4.11	2.06	6.17
SD3	15.89	5 day 85th	4.41	2.21	6.62
SD4	14.83	5 day 85th	3.68	1.84	5.52
SD5	28.06	5 day 85th	7.70	0.68	8.38
SD6	12.25	5 day 85th	3.26	0.28	3.53
SD7	0.95	5 day 85th	0.3	0.1	0.4

9 Monitoring and Maintenance

9.1 Monitoring

The performance of ESC devices will decline if they are not maintained. All ESC devices (including sediment dams) will be inspected regularly as part of the site's environmental inspection program. Notifications of non-compliance will specify the type(s) of non-compliance, the corrective actions needed and a time schedule for achieving compliance.

Regular visual inspections of rehabilitated areas will be undertaken to ensure water is safely conveyed from the areas and that a stable landform is being created. The inspections will also include assessing vegetation cover to ensure that erosion potential is minimised.

Table 2 contains the inspection schedule used to ensure the ESC's are functioning effectively at the site. The inspections will also determine the scheduling of maintenance required for the ESC structures.

Table 2 ESC Inspection Schedule

To Be Inspected	Frequency
All ESC Structures and Stockpiles	Weekly (December to April), monthly (May to November) or following significant rainfall events (i.e > 15mm in 24hr period)
Rehabilitated Areas (Water Management Structures and Vegetation Cover)	Monthly or following heavy rainfall events (i.e > 15mm in 24hr period)
Road Drainage works	Quarterly or following heavy rainfall events (i.e > 15mm in 24hr period)
Equipment That Utilise Hydrocarbons	Daily for spills and leaks

Inspections of the proposed sediment dams, once constructed, will include the general condition of the dams, evidence of overflow, water colour, evidence of eroding surfaces, approximate retained capacity recorded and whether any desilting is required (if sediment has accumulated to the Sediment Storage Zone).

Water quality sampling shall also be undertaken prior to any controlled release of water to ensure that the water quality is suitable for release. Water quality parameters that are to be tested for and generally accepted water quality limits for offsite release within the region are described as the Construction Phase Locally Derived Water Quality Trigger Values**.** These values are reported within the EIS and supporting documentation.

Runoff that does not meet the relevant quality criteria will be contained on-site and will be treated, if required, to allow it to be discharged off-site. Flocculation of the water contained within the sediment dams can be undertaken with an approved flocculant to improve the TSS of the water prior to release. Similarly, pH dosing with approved substances can also be undertaken to improve the pH of the water prior to release.

9.2 Maintenance

All erosion and sediment control measures are to be maintained in a functioning condition until individual areas have been deemed "successfully" rehabilitated. Where controls are observed to not be functioning correctly, the controls are restored to meet the required standard. Where significant erosion is observed to be occurring on a regular basis, additional controls are to be implemented.

9.2.1 Sediment Dams

Sediment dams are to be regularly drawn down following rainfall (within 5 days) and desilted (if required) to ensure that the Settling Zone Volume is available within the dams to accept runoff from future rainfall events. This is to ensure that the dams are operated in accordance with the requirements of the IECA Guidelines to minimise the chances of an uncontrolled discharge. The drawn down water can be released downstream, provided the water quality requirements are met, or can be transferred into the Main Pit or the Water Treatment Plant (WTP).

If sediment does build up to the Sediment Zone Volume the dams will need to be desilted with the sediment disposed of in a suitable manner. It is recommended that depth markers are installed to assist with determining when the sediment dams require desilting. It is believed that the sediment dams will require desilting, on average, once a year which would typically be undertaken at the commencement of the wet season.

9.2.2 Drainage Channels

Any signs of erosion along the length of the drains should be noted and remedial works undertaken as required. Where significant erosion is observed, additional erosion controls are constructed e.g. establishment of vegetation cover, use of temporary sediment devices until the vegetation is established, scour protection (rock check dams) of the channel surface.

9.2.3 Temporary ESC Structures

Regular visual checks are to be made of any temporary sediment controls such as sediment fences, check dams etc to ensure that they are functioning adequately and repaired where required.

9.2.4 Roads / Access Tracks

Periodic maintenance of the haul roads and access tracks will include checking the drainage systems to remove any debris that may block culverts, cross drain outlets and table drains. Any erosion will be remediated with additional ESC measures implemented, as required.

9.2.5 Rehabilitated Areas

Regular visual inspections of the rehabilitated areas are to be undertaken in accordance with **Table 2** This highlights any maintenance that needs to be undertaken to ensure water is safely conveyed from the areas and that a stable landform is being created. The inspections also include assessing vegetation cover to ensure that erosion potential is minimised. Where required, bald or patchy areas are either re-ripped and seeded or have a maintenance application of fertiliser to encourage growth.

10 Conveyance Channel Design

10.1 Rainfall – Runoff Modelling

A hydrological model (using XP-RAFTS) was developed to determine the peak flow rates expected to be generated from the Rum Jungle waste dump landforms so that the conveyance channels could be designed. Rainfall was estimated for the region based on Intensity – Frequency – Duration (IFD) data and design temporal patterns for the Rum Jungle area in accordance with the data presented in (ARR, 2016).

The hydrological model was based on the following data/assumptions/parameters:

- The proposed conveyance was developed using the 2016 Lidar for the design landform contours (provided by DPIR);
- Sub-catchments were modelled with grades varying from 1% to 30% depending on the location of the sub-catchment on the landform;
- The proposed conveyance channels were designed to safely convey the estimated runoff from a 10% AEP rainfall event in accordance with the ICEA Guideline. The proposed spillways were designed to safely convey the estimated runoff from a 5% AEP rainfall event;
- Runoff coefficient used for natural areas of the landform were modelled with an initial loss of 20mm and a continuing loss of 3.2mm/hr. The runoff coefficient used for the disturbed final landforms were an initial loss off 15mm and a continuing loss of 2.5mm/hr. There is little published data available for what runoff coefficient should be used for deep overburden dumps. The data that is available ranges widely which is a reflection of the range of infiltration rates applicable to overburden, subsoil and topsoil used in mine rehabilitation. The soil parameters used are based on SLR's recommended values from a review of the published data available;
- The Mannings 'n' roughness coefficient of the disturbed and rehabilitated landform was 0.06;
- The Mannings 'n' roughness coefficient of the natural landform was 0.066; and
- The Mannings 'n' roughness coefficient of the proposed conveyance channels and spillways was 0.035 and 0.045 respectively.

10.2 Conveyance Channels Design Results

The proposed conveyance channels were modelled in XP-RAFTS as shown in the design drawings. Cross-sectional dimensions of the proposed conveyance structures to convey the 10% AEP design storm event are provided in **Table 3**. All proposed conveyance channels have 3(H):1(V) side slopes. Design **Drawings 680.10421.SUW. D01 to D11**, further outline the design of the proposed conveyance channels (including construction notes).

Lining of the conveyance is recommended as per **Table 3** to resist erosion and scouring caused by flow velocities and associated shear stresses. The water conveyance channels should be regularly monitored for signs of erosion (especially following construction and significant rainfall events). If significant erosion is observed, then appropriate rehabilitation and rectification measures should be undertaken.

Table 3 Recommended Minimum Conveyance Channels Dimensions and XP-RAFTS Results

Conveyance Channel	Section	Length	Slope (%)	Base Width (m)	XP-RAFTS Max 10yr ARI Flowrate (m^3/s)	XP-RAFTS Max 10yr ARI Velocity (m/s)	XP-RAFTS Max 10yr ARI Depth of Flow (m)	Channel Minimum Depth Required (m) [1]	Lining
1	1	384	1.9	3	1.46	1.39	0.3	0.8	Seeded
	2	213	1.6	3	2.01	1.47	0.3	0.8	Seeded
2	1	579	1.0	1	1.77	1.26	0.5	1.0	Seeded
	2	292	2.6	3	3.04	1.96	0.4	0.9	Jute Mesh
	3	205	1.0	3	4.27	1.54	0.6	1.1	Jute Mesh
3	1	479	1.8	3	2.36	1.59	0.4	0.9	Jute Mesh
	2	222	2.3	3	3.69	1.95	0.4	0.9	Jute Mesh
4	1	213	5.8	5	2.36	1.75	0.1	0.6	Jute Mesh
5	1	269	2.8	5	1.36	1.38	0.2	0.7	Seeded
6	1	395	1.0	1	1.14	0.46	0.7	1.2	Seeded
7	1	200	4.1	3	0.72	1.45	0.1	0.6	Seeded
8	1	339	1.2	5	5.94	1.77	0.5	1.0	Jute Mesh
9	1	461	1.0	0.5	0.36	0.94	0.3	0.8	Seeded
	2	186	1.2	1	0.75	1.1	0.3	0.8	Seeded
10	1	428	1.1	1	0.78	1.08	0.3	0.8	Seeded
11	1	415	1.2	1	1.44	1.31	0.5	1.0	Seeded
12	1	147	1.2	0.5	0.25	084	0.2	0.7	Seeded
13	1	676	3.9	4	1.84	1.83	0.2	0.7	Jute Mesh
	2	317	1.6	4	3.16	1.60	0.4	0.9	Jute Mesh
14	1	673	3.3	5	2.47	1.81	0.2	0.7	Jute Mesh
	2	219	1.2	5	3.78	1.48	0.4	0.9	Jute Mesh
15	Refer to River diversion drawings								
Clean Diversion 1	1	428	1.2	9	5.43	1.46	0.4	1.4	Seeded
Clean Diversion 2	1	330	1.2	0.5	0.42	0.97	0.3	0.8	Seeded
Clean Diversion 3	1	133	1.2	0.5	0.46	0.83	0.3	0.8	Seeded
Clean Diversion 4	1	420	1.3	12	6.49	1.48	0.3	1.3	Seeded
Clean Diversion 5	1	61	1.2	1	0.06	0.54	0.1	0.6	Seeded
	2	71	8.5	9	0.93	1.4	0.1	1.1	Seeded
16	1	86	8.3	1	0.15	1.37	0.1	0.6	Seeded
17	1	130	3.5	1	0.16	1.04	0.1	0.6	Seeded

[1] Includes recommended freeboard (varies between channels due to varying levels of risk)

10.3 Sediment Dam Spillway Design

The spillways of the proposed sediment dams were designed using the XP-RAFTS model to manage overflows during significant storm events. The spillway height was restricted for all sediment dams to 0.3m allowing 0.2m of freeboard between the maximum water level and reached during the 5% AEP storm event and the sediment dam crest level.

Table 4 below details the required dam spillway dimensions for each proposed sediment dam, to convey the estimated peak flow rates from the 50% AEP storm event. Further spillway design details are provided in **Drawings 680.10421.SUW.d06 to D09 and D02**.

Table 4 Dam Spillway Requirements and XP-RAFTS Results

Dam	XP-RAFTS Max 20yr ARI Flowrate (m^3/s)	Minimum Base Width (m)	Slope (%)	Side Slopes (H:V)	Depth Required Including 0.2m Freeboard (m)	Lining
SD1	6.27	13	2.5	3:1	0.5	Rip Rap (D50=150mm) (Min Rock Depth = 250mm)
SD2	4.10	9	2.5	3:1	0.5	Rip Rap (D50=150mm) (Min Rock Depth = 250mm)
SD3	4.70	10	2.5	3:1	0.5	Rip Rap (D50=150mm) (Min Rock Depth = 250mm)
SD4	8.57	18	2.5	3:1	0.5	Rip Rap (D50=150mm) (Min Rock Depth = 250mm)
SD5	1.85	4	2.5	3:1	0.5	Rip Rap (D50=150mm) (Min Rock Depth = 250mm)
SD6	1.69	3.5	2.5	3:1	0.5	Rip Rap (D50=150mm) (Min Rock Depth = 250mm)
SD7	0.40	0.5	2.5	3:1	0.5	Rip Rap (D50=150mm) (Min Rock Depth = 250mm)

11 Detailed Design Drawings

Detailed ESCP drawings are summarised in **Table 5**

Table 5 ESCP Drawings

Drawing No.	Title
680.10421.SUW.D01	CONSTRUCTION NOTES
680.10421.SUW.D02	GENERAL ARRANGEMENT
680.10421.SUW.D03	OVERVIEW PLAN 1 OF 3
680.10421.SUW.D04	OVERVIEW PLAN 2 OF 3
680.10421.SUW.D05	OVERVIEW PLAN 3 OF 3
680.10421.SUW.D06	SEDIMENT DAM DETAILED PLANS – SHEET 1 OF 3
680.10421.SUW.D07	SEDIMENT DAM DETAILED PLANS – SHEET 2 OF 3
680.10421.SUW.D08	SEDIMENT DAM DETAILED PLANS – SHEET 3 OF 3
680.10421.SUW.D09	SEDIMENT DAM TYPICAL SECTIONS
680.10421.SUW.D10	CONVEYANCE CHANNEL TYPICAL SECTIONS
680.10421.SUW.D11	SURFACE WATER AND EROSION CONTROL – PROPOSED EBFR REALIGNMENT

12 List of Supporting Documentation

12.1 Design Reports

This ESCP report is intended as a standalone report, however it forms part of a wider rehabilitation strategy for Rum Jungle and it is recommended that it be read in conjunction with the documentation listed in the Bibliography. Particular reference should be made to the overarching Detailed Engineering Design Report (SLR, 2020a).

1. Rum Jungle Rehabilitation – Stage 2A Detailed Engineering Design. Detailed Engineering Design Summary Report (SLR, 2020)

2. Rum Jungle Rehabilitation – Stage 2A Detailed Engineering Design. General Site Civil and Earthworks Work Package Technical Specification (SLR, 2020)

3. Rum Jungle Rehabilitation – Stage 2A Detailed Engineering Design. General Site Civil and Earthworks Work Package Bill of Quantities (SLR, 2020)

4. Rum Jungle Rehabilitation – Stage 2A Detailed Engineering Design. Waste Storage Facilities and General Site Civil Works Detailed Design and Construction Methodology Report (SLR, 2020)

12.2 Design Drawings

A summary of all drawings associated with these design works is given in **Table 6**.

Table 6 Supporting Design Drawings

Drawing No.	Title
GENERAL	
680.10421.GEN.D00	Locality Plan and Schedule of Drawings
680.10421.GEN.D01	Existing Site Conditions
680.10421.GEN.D02	Site Construction Works Layout
680.10421.GEN.D03	Rehabilitation General Arrangement Plan
680.10421.GEN.D04	Site Exclusion Zones
WASTE STORAGE FACILITY	
680.10421.WSF.D01	WSF General Arrangement Plan
680.10421.WSF.D02	EWSF Foundation Plan
680.10421.WSF.D03	EWSF Layout Plan
680.10421.WSF.D04	EWSF Staging Plan
680.10421.WSF.D05	EWSF Fill Elevation Plan
680.10421.WSF.D06	EWSF Sections
680.10421.WSF.D07	WWSF Foundation Plan Radiological Soil Treatment
680.10421.WSF.D08	WWSF Foundation Plan
680.10421.WSF.D09	WWSF Layout Plan

Drawing No.	Title
680.10421.WSF.D10	WWSF Staging Plan
680.10421.WSF.D11	WWSF Fill Elevation Plan
680.10421.WSF.D12	WWSF Sections
680.10421.WSF.D13	Typical Details
BULK EARTHWORKS	
680.10421.BEW.D01	Material Excavation Summary
680.10421.BEW.D02	Rip-Rap Scavenging Plan Summary
680.10421.BEW.D03	Detailed Excavation Plan – Sheet 1 of 4
680.10421.BEW.D04	Detailed Excavation Plan – Sheet 2 of 4
680.10421.BEW.D05	Detailed Excavation Plan – Sheet 3 of 4
680.10421.BEW.D06	Detailed Excavation Plan – Sheet 4 of 4
680.10421.BEW.D07	Detailed Excavation Sections – Sheet 1 of 4
680.10421.BEW.D08	Detailed Excavation Sections – Sheet 2 of 4
680.10421.BEW.D09	Detailed Excavation Sections – Sheet 3 of 4
680.10421.BEW.D10	Detailed Excavation Sections – Sheet 4 of 4
SITE REHABILIATION	
680.10421.REH.D01	Detailed Rehabilitation Plan – Sheet 1 of 4
680.10421.REH.D02	Detailed Rehabilitation Plan – Sheet 2 of 4
680.10421.REH.D03	Detailed Rehabilitation Plan – Sheet 3 of 4
680.10421.REH.D04	Detailed Rehabilitation Plan – Sheet 4 of 4
680.10421.REH.D05	Detailed Rehabilitation Sections – Sheet 1 of 4
680.10421.REH.D06	Detailed Rehabilitation Sections – Sheet 2 of 4
680.10421.REH.D07	Detailed Rehabilitation Sections – Sheet 3 of 4
680.10421.REH.D08	Detailed Rehabilitation Sections – Sheet 4 of 4
HAUL ROADS	
680.10421.CUL.D01	Reinstatement of East Branch Finniss River – Haul Road Additional Culvert Detail
680.10421.HR.D00	Haul Roads – Cover Sheet
680.10421.HR.D01	Haul Roads – Drawing List
680.10421.HR.D02	Haul Roads – Overview
680.10421.HR.D03	Haul Roads – Section A1 – Long Section
680.10421.HR.D04 and D05	Haul Roads – Section A1 – Cross Sections
680.10421.HR.D06	Haul Roads – Section A2 – Long Section
680.10421.HR.D07 to D09	Haul Roads – Section A2 – Cross Sections
680.10421.HR.D10	Haul Roads – Section A3 – Long Section
680.10421.HR.D11 to D16	Haul Roads – Section A3 – Cross Sections

Drawing No.	Title
680.10421.HR.D17	Haul Roads – Section A4 – Long Section
680.10421.HR.D18 to D20	Haul Roads – Section A4 – Cross Sections
680.10421.HR.D21	Haul Roads – Section A5 – Long Section
680.10421.HR.D22 to D23	Haul Roads – Section A5 – Cross Sections
680.10421.HR.D24	Haul Roads – Section A6 – Long Section
680.10421.HR.D25	Haul Roads – Section A6 – Cross Sections
680.10421.HR.D26	Haul Roads – Section A7 – Long Section
680.10421.HR.D27 to D29	Haul Roads – Section A7 – Cross Sections
680.10421.HR.D30	Haul Roads – Section A8 – Long Section
680.10421.HR.D31 to D33	Haul Roads – Section A8 – Cross Sections
680.10421.HR.D34	Haul Roads – Section A9 – Long Section
680.10421.HR.D35 to D39	Haul Roads – Section A9 – Cross Sections
DIVERSION DRAIN CROSSING	
680.10421.C0.CS.01	Haul Road Crossing – Cover Sheet and Drawing List
680.10421.C1.BD.01	Haul Road Crossing – Basis of Design
680.10421.C1.GN.01	Haul Road Crossing – General Arrangement
680.10421.C5.RP.01	Haul Road Crossing – Plan and Profile
680.10421.C7.TD.01	Haul Road Crossing – Sections and Details

The design drawings are not appended to this report, rather they are available as separate design packages.

13 Bibliography

ARR. (2016). *Australian Rainfall and Runoff, A Guide to Flood Estimation.*

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