Example only

Energy Resources of Australia Ltd

Ranger 3 Deeps Exploration Decline: Water Management Plan

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Status	Project Number	Description
Draft	2-6240	Water Management Plan

Approvals

	Name	Position	Signed	Date
Originator	G Woodrow	Major Project Specialist		Xx/07/2012
Checked	B McTavish	Superintendant (Water Management)		Xx/07/2012
Checked & Approved *("Approver")*	J Clark	Study Manager		Xx/07/2012

Revisions

	Date	Description	By	Check	Approved
0.12.00	July 2012	Internal Distribution	G Woodrow	B McTavish	J Clark

Contents

Figures

Tables

1. Introduction

1.1 Purpose of the Exploration Decline Water Management Plan

The Exploration Decline Water Management Plan (EDWMP) sets out how any potential human health or environmental impacts associated with surface water or groundwater will be managed as part of the construction and operation of the Ranger 3 Deeps (R3D) exploration decline project.

The Ranger Water Management Plan (WMP) is updated annually and submitted to the Supervising Authority for approval. It sets out in detail ERA's water management objectives and monitoring programs for Ranger mine. The most recently approved version of the Ranger Water Management Plan is dated January 2012.

1.2 Term of this Exploration Decline Water Management Plan

The EDWMP will be valid for the life of the Ranger 3 Deeps exploration programme. Reviews of this plan will be undertaken annually, or when conditions change, or in response to incidents or investigations. Consistent with these requirements, the EDWMP has been updated to reflect any incremental changes associated with phase 2 of the exploration decline. All reviews and amendments to the plan will be undertaken by the Exploration Decline Project Team after consultation with the Ranger Tailings and Water Department in consultation with the Minesite Technical Committee in parallel with the annual review and update of the Ranger WMP.

2. Current Project Site Conditions

2.1 Climate

The local climate for the Ranger Project Area is described as 'wet/dry tropical'. The monsoonal wet season accounts for the majority of precipitation (all as rainfall) between November and April (inclusive) and is typified by hot and humid conditions. Rainfall comes via localised storm activity, tropical depressions and cyclonic activity. The dry season occurs between May and October and is characterised by warm-hot, dry conditions with little precipitation.

2.1.1 Rainfall

Rainfall measurements have been made at Jabiru East airport since 1971. Daily records have been kept at Oenpelli since 1910. The rainfall dataset indicates significant temporal and spatial variance over the short term. Analysis of the long-term trend indicates significant temporal variation (year to year) but little spatial variance (place to place). For this reason it has been possible to combine the Oenpelli and Jabiru Airstrip datasets to establish a historic mean for the Ranger Project Area.

The average annual rainfall for the Ranger area since 1971 is approximately 1,532mm (Bureau of Meteorology, Jabiru East weather station). Monthly averages during this period are presented in Table 1.

A Rainfall Intensity-Frequency-Duration (IFD) relationship has been derived for the Ranger site (Figure 1). The Rainfall IFD is used as a consideration in the design of water impoundments, embankments and diversion structures including drains and culverts.

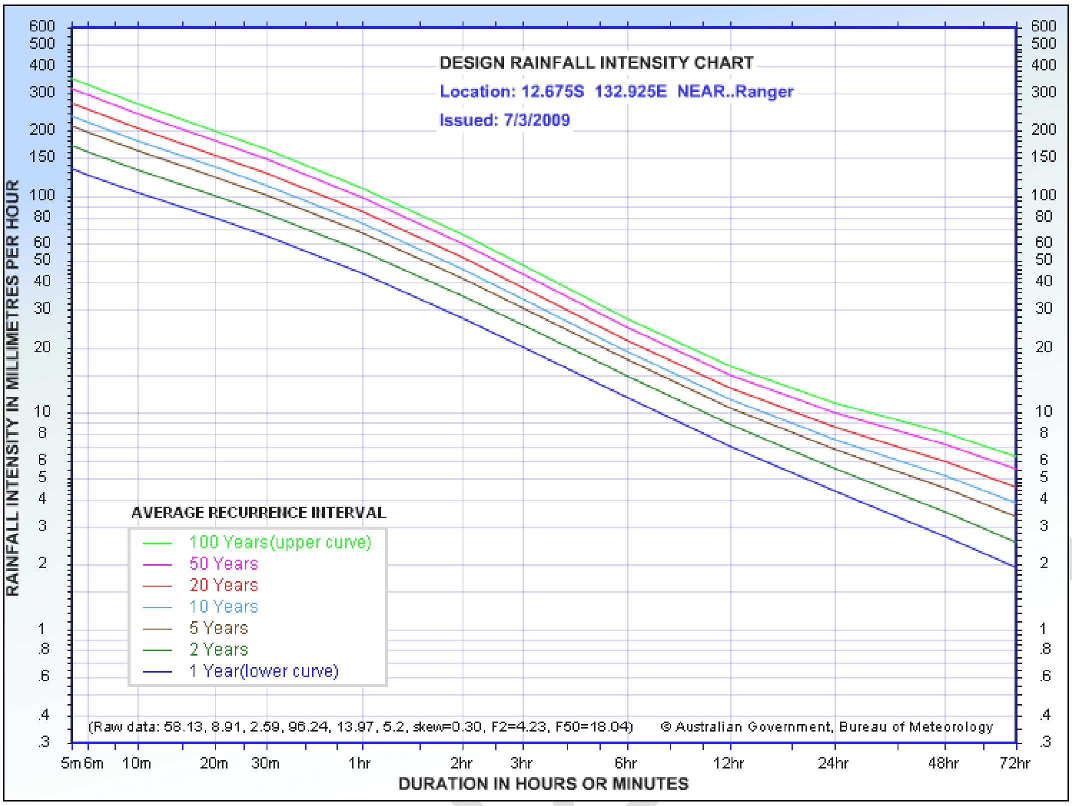


Figure 1: Design Rainfall Intensity

2.1.2 Evaporation

Evaporation measurements have been made at Jabiru East airport since 1971 using a Class A pan evaporator (ERA 2011, Jabiru East weather station). Since that time, a yearly average pan evaporation of 2,570mm has been adopted for planning and design purposes (ERA 2011). Monthly average totals are provided in Table 1. Chiew & Wang (1999) established a set of pan factors for the Jabiru East station which relate evaporation measured with a Class A pan to evaporation from an open water surface. These factors have been adopted as the pan factors for Ranger and are also provided in Table 1.

Table 1: Monthly totals for Jabiru Airport (from 1971 to August 2011)

Month	Average Rainfall	Average Pan Evaporation	Pan Factor	Average Pond Evaporation
September	6.5	273	0.66	180
October	41.6	295	0.66	195
November	143.2	240	0.75	180
December	234.6	211	0.84	177
January	356.1	180	0.92	166
February	373.4	160	0.92	147
March	321.4	174	0.95	165
April	87.4	201	0.77	155
May	10.1	210	0.7	147
June	1.2	201	0.7	141
July	3.2	217	0.66	143
August	2.9	240	0.64	154
Total	1586.2	2628	-	1950

2.2 Surface Water Catchments

2.2.1 Surface water catchment – Pre Exploration Decline

Ranger mine is divided into a number of operational catchments. The area associated with the construction of the exploration decline was predominately a bitumen hardstand with adjacent remnant woodland. The total storm water run-off coefficient from this catchment was based on the Australian Water Balance Model (AWBM) parameters used in the 2010 validation of the Ranger OPSIM model, annual mean rainfall data sourced from BoM (climate data online, Jabiru Airport). The total volume of run-off based on the current catchment configuration would be 65 ML over an average wet season (Table 2). Approximately 46 ML of this run-off was derived from the hardstand and woodland area and would be directed to the pond water circuit, whilst the remaining 19 ML would have been released to the environment via the former DJKPS09

Table 2: Storm water volume calculations for current catchment configuration

Catchment type	Surface area (ha)	Annual mean rainfall (mm) (BoM, Climate data online, Jabiru Airport)	Surface flow index (AWBM, validated OPSIM 2010, (1-base flow index))	Volume (ML)
Storage pond (DJKPS09)	1.2	1593.2	1	~ 19
Hardstand area	2.4	1593.2	1	~ 38
Woodland	0.9	1593.2	0.54	~ 8
TOTAL				~ 65

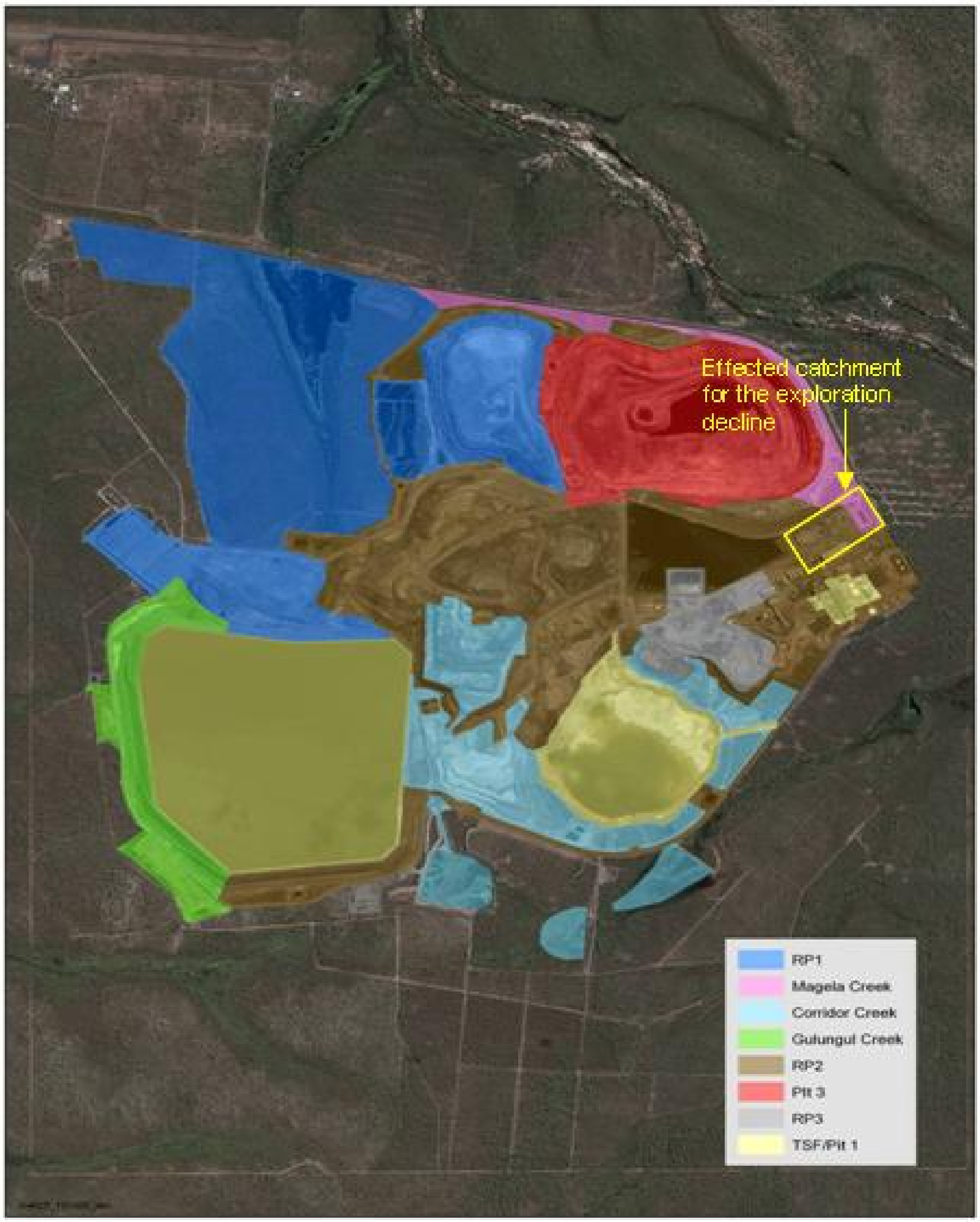


Figure 2: Existing Ranger surface water catchments

2.2.2 Changed surface water catchment as part of the exploration decline

Figure 3 depicts the proposed changes to catchment management as part of the exploration decline project. The key changes to the catchment are:

1. removal of DJKPS09 from the catchment area; and
2. replacement of the 1.2 ha of the former DJKPS09 footprint and 0.9 ha of woodland with non-mineralised waste rock.

The total volume of water reporting to the pond water circuit via storm water run-off from the exploration decline catchment will be 46 ML (Table 3) over an average wet season; therefore there will be no change in the volume of water reporting to the pond water circuit as a result of the catchment changes.

Table 3: Storm water volume calculations for proposed catchment changes

Catchment type	Surface area (ha)	Annual mean rainfall (mm) (BoM, Climate data online, Jabiru Airport)	Surface flow index (AWBM, validated OPSIM 2010, (1-base flow index))	Volume (ML)
Waste rock	2.1	1593.2	0.25	~ 8
Hardstand area	2.4	1593.2	1	~ 38
TOTAL				~ 46

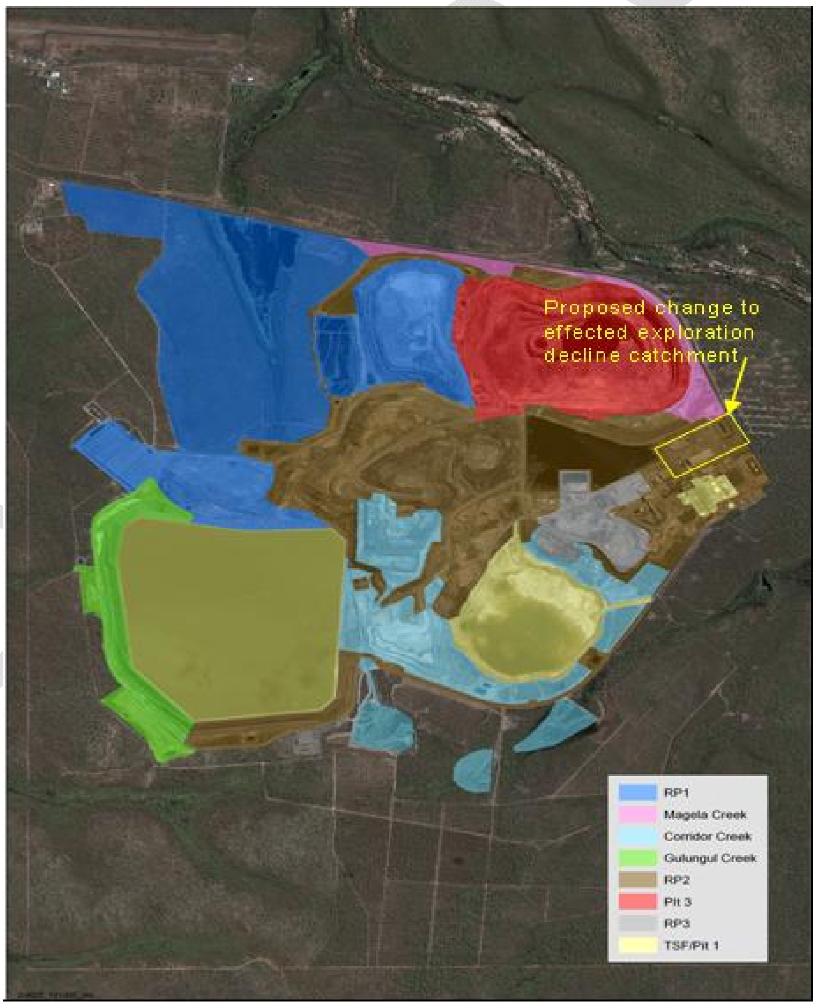


Figure 3: Proposed catchment areas during the exploration decline project

2.3 Groundwater Resources

Groundwater occurrence, monitoring data for nearby bores, ongoing observations of inflows into Pit #3, and the results of various investigations of recharge-discharge processes, all consistently indicate that the underground development will not intersect significant quantities of groundwater (Coffey Geotechnics 2009). Groundwater inflow into the decline has been estimated to be up to approximately 6 L/s or 500 kL/day.

3. Water Management System

All water at Ranger mine is managed according to quality, based on the objectives set in the 2011-12 WMP. Water relating to the exploration decline project is expected to fit into the following classes:

- managed release water (makeup water if RP2 uranium concentrations exceed the management value).
- pond water (makeup water, storm water runoff, groundwater inflows and recycled decline waters.

An indicative water quality for both of the water classes is provided in Table 4.

Table 4: Indicative water quality for the R3 Deeps exploration decline project (ERA 2011)

Parameter	Pond water	Managed release water
pH	7.8	7.2
EC (µS/cm)	1185	526
Aluminium (mg/L)	0.82	0.009
Calcium (mg/L)	27	6.7
Magnesium (mg/L)	182	61.2
Manganese (mg/L)	0.33	0.011
Uranium (mg/L)	5.2	0.007
Ammonium (mg/L)	0.09	0.014
Sulfate (mg/L)	720	238
Radium-226 (mBq/L)	5385	77

3.1 Water Use in Exploration Decline Operations

Water requirements for the project are expected to be up to ~12 L/s (1,000 kL/d). This would be supplied by estimated groundwater inflows of ~6 L/s (~500 kL/d), and an additional ~6 L/s of makeup water. The hydraulic pressures will be such that it is highly unlikely that water introduced into the decline during operations will be able to enter surrounding groundwater aquifers.

Makeup water will be drawn predominately from existing pond water retention structures and will be used for dust suppression, hydroscaling, muck pile watering, development drilling and diamond drilling. The makeup water requirements for the already approved decline activities will not incrementally change once phase 2 decline development commences. Managed release water will be used when there is a human health risk associated with prolonged exposure to pond waters based on a total uranium concentration which exceeds 15,000 µg/L.

Pond water that is used as makeup in the exploration decline operations will be chlorinated in a system located in the vicinity of the portal prior to use to control the risk of *Legionella* and other biological pathogens. The residual free chlorine and biological indicators will be monitored routinely as described in Table 5.

Underground mobile equipment will be washed at a designated wash bay. Used water from the wash bay will be directed to RP2.

3.2 Water Management Infrastructure

Runoff waters from the office, hardstand and backfilled portal areas will be directed to the existing storm water drainage and reporting to RP2.

Groundwater inflows to the exploration decline will be collected in sumps that will be located approximately 200-300 m apart along the decline. Used water will be pumped from the decline and pass through a trash screen and oil/water separator to a surface holding pond, rather than being allowed to pool. Water held in the surface pond will transfer to a header tank for use in the decline. Excess water held in the surface pond will be directed to pond water inventory.

The general arrangement of the water management infrastructure associated with the project including the surface pond, header tank, decline transfer system and drainage system to the pond water circuit has been provided in Figure 4.

The design of the dewatering and treatment infrastructure is provided in Figure 5.

As identified under the previous EDWMP, DJKPS09 has been decommissioned and replaced with the southern holding pond DJKPS12. The pond location and construction design have been provided in Figure 4 and Figure 6. The ponds storage capacity is 9 ML.

There are no additional infrastructure requirements for the activities described for phase 2 of the exploration decline.

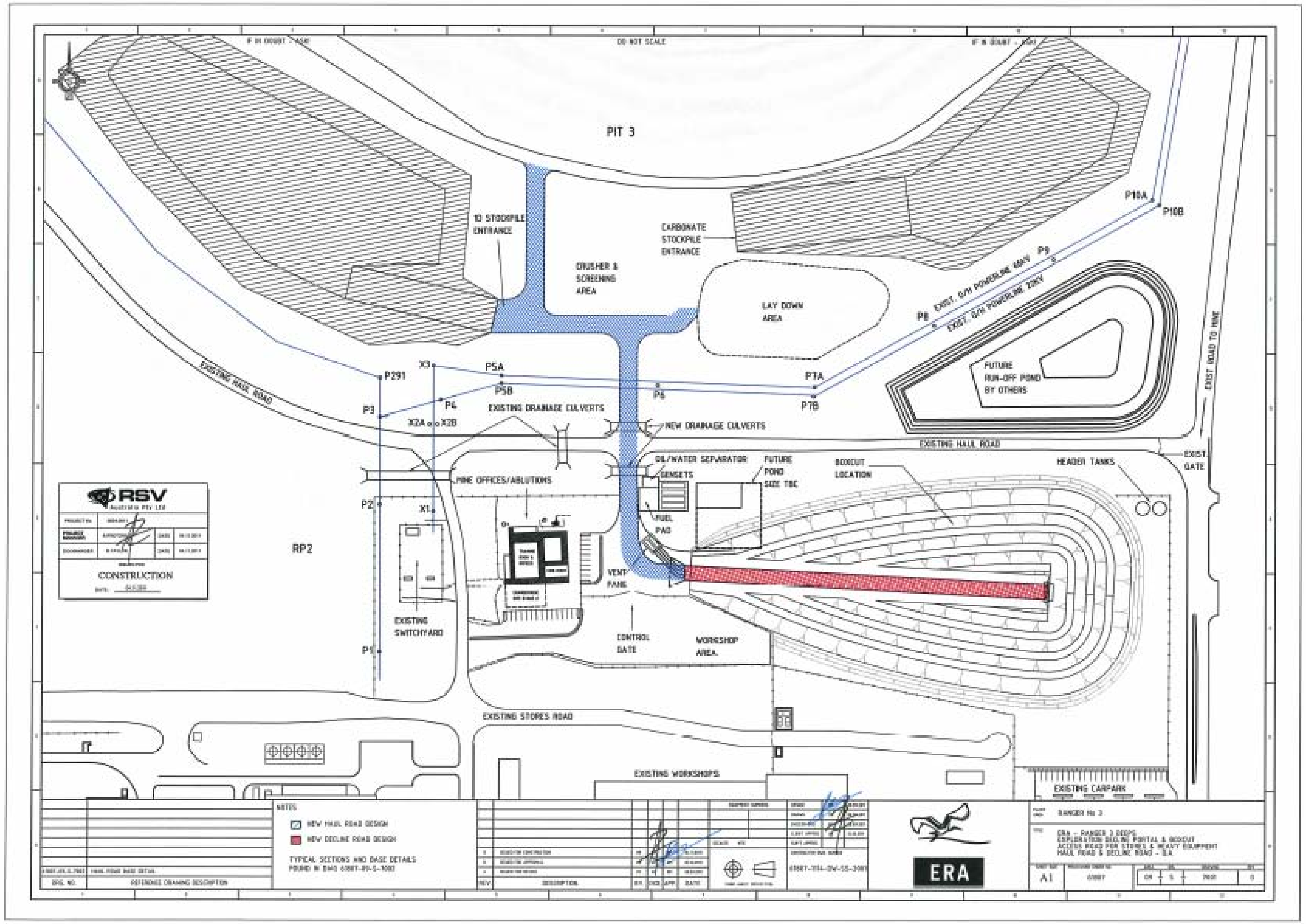


Figure 4: R3 Deeps exploration decline water management locality map and site plan

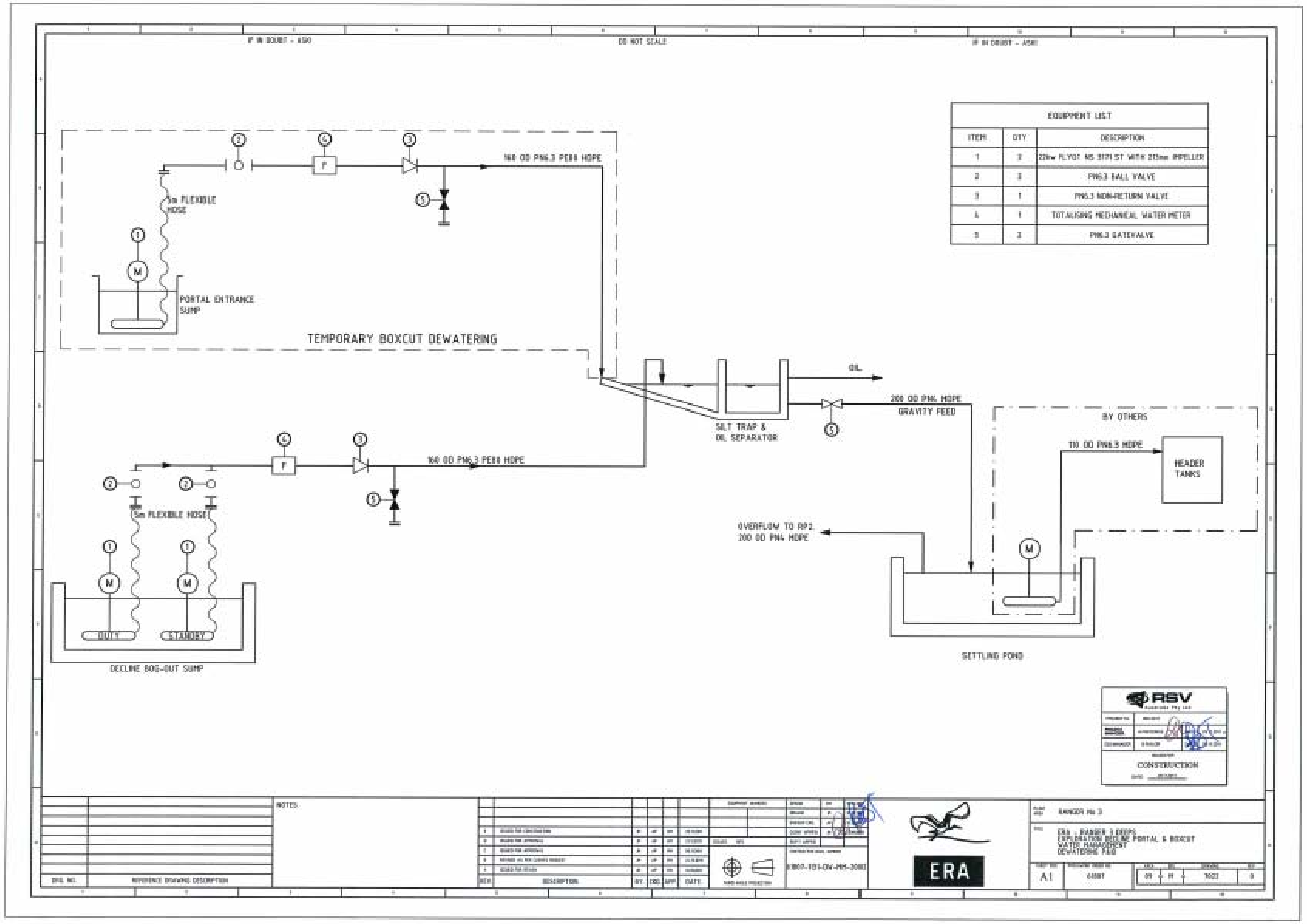


Figure 5: Design of the dewatering and treatment system

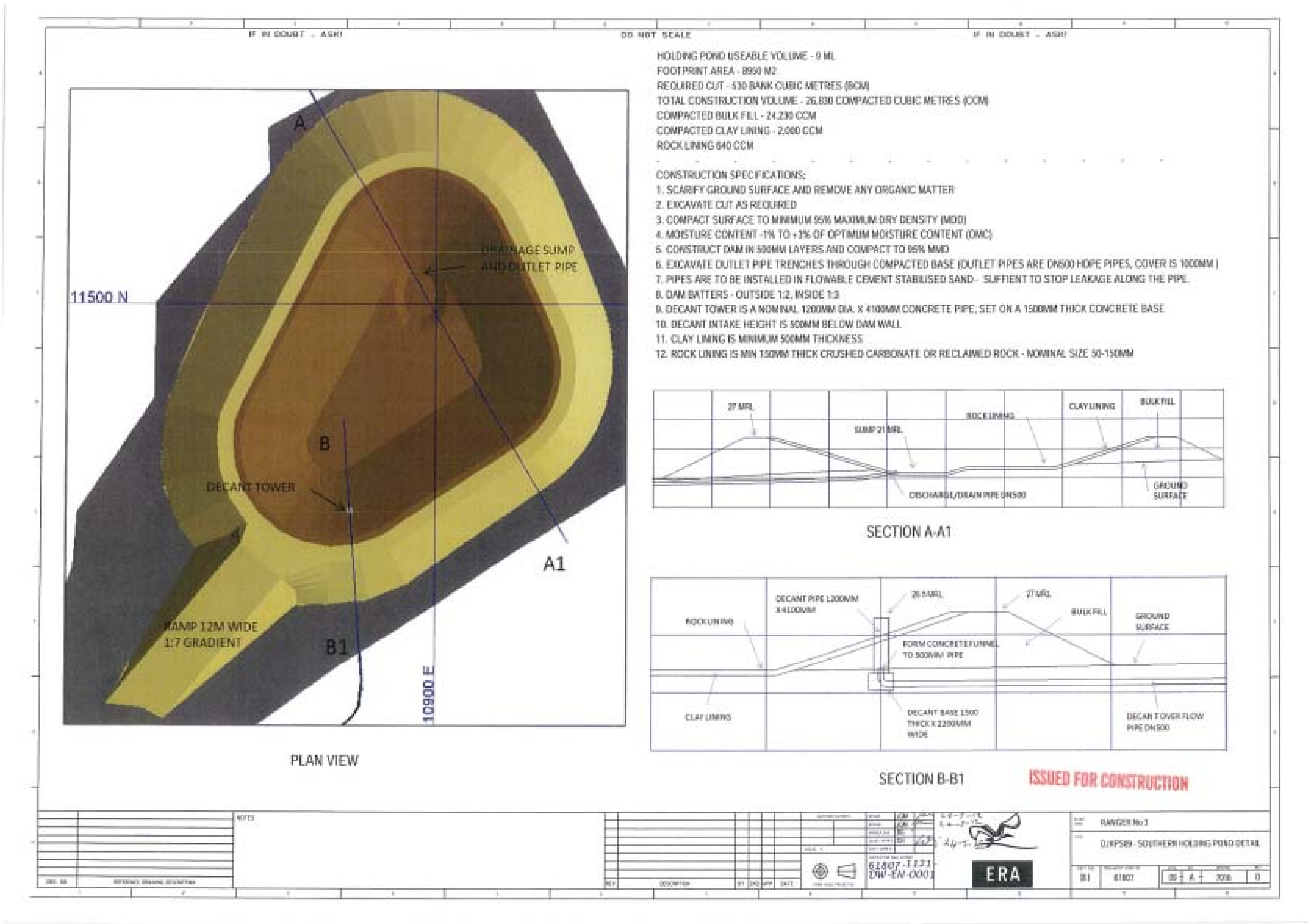


Figure 6: Design of the relocated DJKPS09 (Southern Holding Pond)

4. Surface Water Management

4.1 Potential Contaminants and Impacts

The main potential contaminants relating to the proposed activities are magnesium and sulfate which will be leached from the box-cut excavation or from waste rock excavated from the decline. Elevated levels of uranium are only likely if there is inadvertent intersection of mineralised material.

4.2 Discharge

The risk of impact to Magela Creek water quality will be mitigated by directing runoff waters from the disturbed waste rock catchment to a holding sump which reports to RP2. There will be no release of water to the external environment from this project.

4.3 Abstraction

Makeup water will require abstraction from retention pond systems such as RP2, RP5 and RP6. As identified in 3.1, RP1 water will be preferentially used if the uranium concentration of pond water exceeds the management value. A total of ~500 kL/d is the maximum expected abstraction rate for makeup water.

5. Groundwater Management

5.1 Potential Contaminants and Impacts

It is not expected that the construction of the exploration decline or the proposed underground exploration programme will have any impact on groundwater quality. During construction of the decline and the exploration drilling programme, groundwater inflow will be observed, monitored and tested for quality.

Any changes in magnesium or uranium concentration that is on an increasing trend and exceeds 2 times the 90th percentile for that particular bore will be investigated. Outcomes of any investigation will be reported to MTC including the corrective actions taken. Table 7 outlines the internal management values for each of the bores to be monitored.

5.2 Abstraction

It is expected that groundwater inflows will be of the order of ~6 L/s and will be used in construction and as part of underground exploration works. No additional extraction of groundwater is required.

6. Monitoring

6.1 Surface Water

The surface water monitoring programme is provided in Table 5.

Table 5: Surface water monitoring programme

Site	Frequency	Analyte	Internal Management value
RP2	weekly	pH, EC, Mg, SO_4^{2-}, Ca, Mn, U	U not to exceed15,000 µg/L
Surface pond	weekly	pH, EC, Mg, SO_4^{2-}, Ca, Mn, U	U not to exceed15,000 µg/L
Surface pond	weekly	Transfer volume to RP2	
Surface pond	weekly	Transfer volume to the header tank	
Header tank	weekly	pH, EC, Mg, SO_4^{2-}, Ca, Mn, U	U not to exceed15,000 µg/L
Header tank	weekly	Residual Free Chlorine	Not to exceed 5 mg/L
Header tank	fortnightly	E.coli Legionella Total coliforms	Not detectable in 100 mL
Header tank	weekly	Transfer to the decline	

6.2 Groundwater

Groundwater will be monitored for inflows to the decline, groundwater levels in the surrounding catchment for dewatering impacts and groundwater quality within the effected catchment boundaries. The bore construction details and summarised lithologies for each of the bores to be monitored have been provided in Table 6.

The proposed groundwater monitoring bores were chosen as they intersect the down gradient areas of the project and they are currently part of the operational/statutory monitoring programme at Ranger. As such, a significant data set and baseline has been established at these bores. Hence it will be possible to differentiate between natural fluctuations in groundwater level and quality with changes that could be attributed to the decline construction and operation.

6.2.1 Monitoring of groundwater inflows

Groundwater inflows into the active sumps along the decline will be monitored fortnightly for pH, EC, major cations and anions, filtered manganese and uranium, and monthly for 226-radium and radon.

Flow meters will be installed at appropriate locations to determine water transfer rates, water consumption and groundwater inflows in accordance with Table 5. These records will be managed and reported as part of the quarterly project reporting to MTC.

The monitoring programme will be reviewed after six months.

6.2.2 Monitoring of groundwater levels in surrounding areas

Water levels in groundwater bores surrounding the exploration decline will be monitored to provide early warning of any effects that construction of the decline may have on local aquifers, including those associated with Magela Creek. The monitoring bores are listed in Table 6 and located in Figure 7.

Groundwater level monitoring will be undertaken monthly for the first six months of the project and the frequency of monitoring then reviewed and the programme re-assessed.

6.2.3 Monitoring of groundwater quality

Water quality in selected groundwater bores surrounding the exploration decline (83/1 deep, 23562, MC12 deep, MC27 deep and OB27) will continue to be measured using micropurge equipment as part of the existing operational and statutory monitoring programme as per the 2011-12 Ranger WMP (Table 7). A map for the location of these bores is provided in Figure 8.

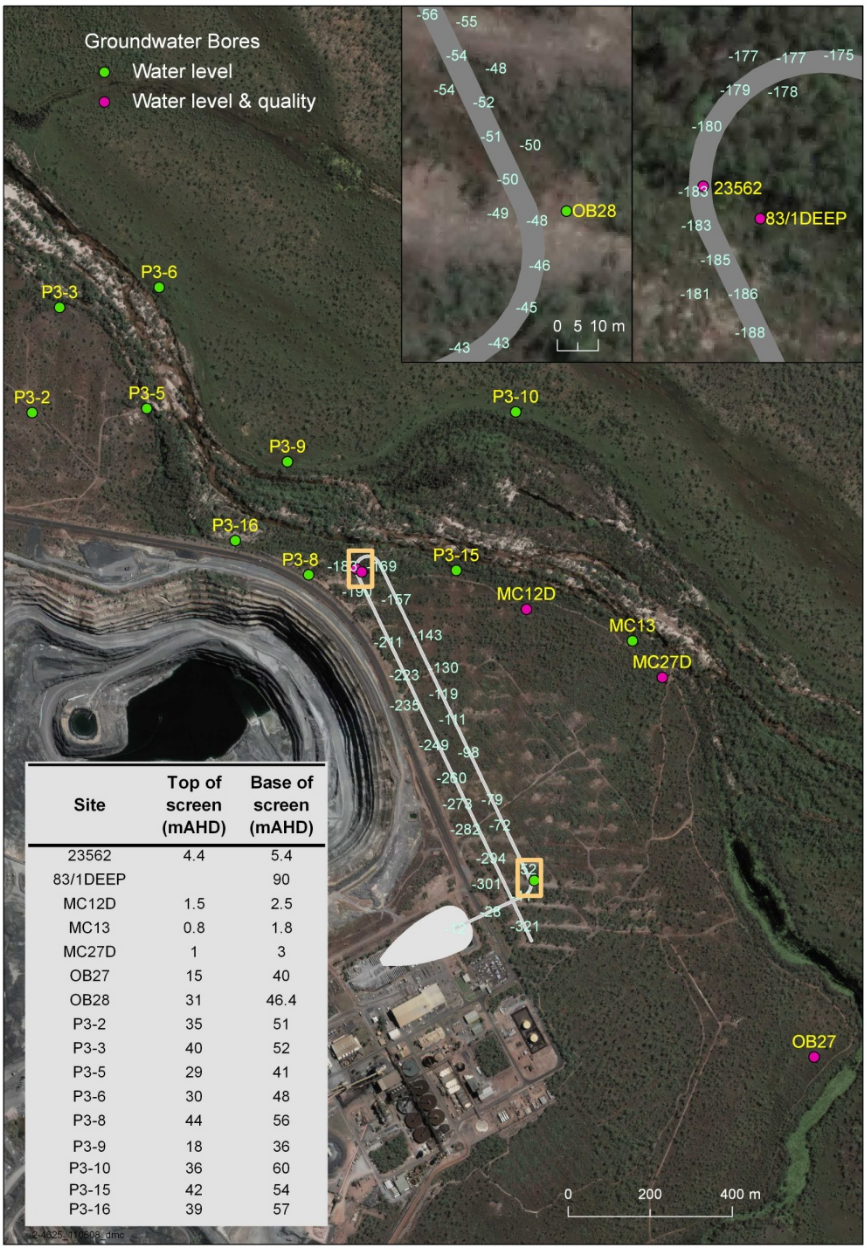
Interim internal management triggers have been established for uranium and magnesium concentrations for each of the groundwater bores (Table 7). Should the uranium and/or magnesium concentrations in the groundwater bores listed in Table 7 exceed these values then a second sample will be collected and analysed to confirm the result. If the secondary result remains above the trigger then an investigation will be undertaken to determine the cause of the concentration change. Any remediation action will be proposed as part of the investigation. The management triggers will be reviewed after 6 months of monitoring.

Table 6: Groundwater bore construction and lithology data

Site	Monitoring	Monitoring method	Easting	Northing	Date drilled	Depth	TOC mAHD	Top of screen (mAHD)	Base of screen (mAHD)	Screen type	Lithology
23562	Water quality	conventional	274407	8598254	24/11/1984	5.5	13.22	4.4	5.4	slotted pvc	sandy clay
83/1DEEP	Water quality	conventional	274421	8598246	26/02/83	90	12.6			open	weathered & fresh micaceous schist carbonate & schist
MC12D	Water quality & level	conventional	274822	8598155	1/06/1985	24.1	13.638	1.5	2.5	slotted pvc	clayey micaceous quartz gravel
MC13	Water level		275080	8598078	01/06/1985	85	14.398	0.8	1.8	s/steel	quartz gravel
MC27D	Water quality	conventional	275160	8598995	1/04/1986	3	15.86	1	3	slotted pvc	weathered quartz sericite schist
OB27	Water quality	conventional	275522	8597062	1/11/1979	40	14.17	15	40	slotted pvc	quartz micaceous schist & quartz chlorite sericite schist
OB28	Water level		274841	8597493	19/11/1981	46.4	23.92	31	46.4	slotted pvc	fresh quartz feldspar micaceous schist
P3-2	Water level		273619	8598635	29/08/2005	51	16.42	35	51	slotted pvc	weathered biotite banded quartz schist
P3-3	Water level		273686	8598892	1/09/2005	52	12.45	40	52	slotted pvc	weathered biotite banded quartz schist
P3-5	Water level		273898	8598645	26/08/2005	41	12.18	29	41	slotted pvc	weathered schists, quartz
P3-6	Water level		273928	8598941	16/09/2005	78	12.04	30	48	slotted pvc	weathered schists, quartz
P3-8	Water level		274292	8598239	18/08/2005	80	14.46	44	56	slotted pvc	highly weathered micaceous schist
P3-9	Water level		274240	8598515	20/09/2005	48	12.52	18	36	slotted pvc	highly weathered schist
P3-10	Water level		274796	8598637	22/09/2005	60	12.84	36	60	slotted pvc	highly weathered micaceous schist
P3-15	Water level		274651	8598250	24/08/2005	54	13.46	42	54	slotted pvc	highly weathered schist
P3-16	Water level		274113	8598323	8/09/2005	57	12.69	39	57	slotted pvc	weathered schist

Table 7: Groundwater quality monitoring programme

Bore	Chemical parameters	Frequency	Management value	
			Filtered U	Mg
83/1 Deep	pH, EC, Temperature, major cations and anions, filtered Mn and U	Quarterly for the life of the project	5 µg/L	15 mg/L
23562			10 µg/L	10 mg/L
MC12 Deep			5 µg/L	15 mg/L
MC27 Deep			5 µg/L	45 mg/L
OB27			5 µg/L	50 mg/L



Site	Top of screen (mAHD)	Base of screen (mAHD)
23562	4.4	5.4
83/1DEEP		90
MC12D	1.5	2.5
MC13	0.8	1.8
MC27D	1	3
OB27	15	40
OB28	31	46.4
P3-2	35	51
P3-3	40	52
P3-5	29	41
P3-6	30	48
P3-8	44	56
P3-9	18	36
P3-10	36	60
P3-15	42	54
P3-16	39	57

Figure 7: Location of the groundwater monitoring bores

7. Reporting

Data from the project will be provided quarterly to MTC and interpretations will be presented in the annual Ranger Wet Season Report.

8. References

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